Oil Spills, Shoreline Response and SCAT

Gulf of Mexico
2013

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Shoreline Response and Shoreline Oiling Assessment (SCAT) Surveys for Oil Spills in the Gulf of Mexico

Training Course Notebook
2013

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Introduction

This course is designed for Planning Section, Environmental Unit members and SCAT Program participants to provide a basic grounding on coastal processes and shoreline character, and the fate and behavior of spilled and stranded oil. A core component of the course is the shoreline oiling assessment (SCAT) process whereby field data and information are obtained to support shoreline cleanup or treatment decisions and operations. SCAT teams are involved throughout the response operation from the initial field surveys to inspection and the sign off process. Initially, SCAT data are used by the Environment Unit and Planning Section to develop recommendations. The decisions that are made based on these recommendations in turn are used to create assignment for the Operations Section. The course describes how to set up and manage a SCAT program, create consensus treatment endpoints that enable shoreline cleanup to be completed on a segment by segment basis, and how the inspection and sign-off process enables closure of field operations.

Course Objectives

The course is designed to introduce participants to the issues that are likely to arise in association with shoreline protection and shoreline treatment following a spill. Upon completion of the course the participants will know:

1. the general character of various shoreline types and the processes that act on the shorelines of the Gulf of Mexico;
2. the role of a SCAT Program in a spill response;
3. how to establish and manage a shoreline assessment (SCAT) program;
4. how to document and describe oiled shorelines;
5. how to create data for the decision process;
6. what factors are important to define nearshore and shoreline response priorities and objectives; and
7. which response techniques are practical and effective for the different shoreline types and coastal environments.

Part 1 Physical Coastal Processes and Coastal Character

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Part 1 Physical Coastal Processes and Coastal Character

1.1. Coastal Processes and Environment

The processes that can operate on the shoreline are:

❖ WAVES	exposure to waves and wave-energy levels Including seasonal and storm-related changes
❖ WIND	including storm surges
❖ TIDES	tidal range (spring and neap)
❖ FLUVIAL	rivers and stream flow
❖ MASS WASTING	cliff falls and slumping

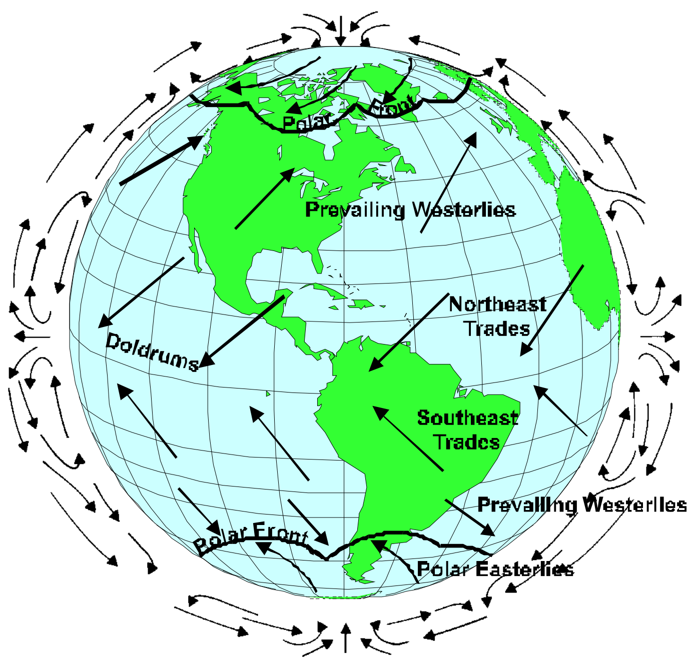
In addition, it is necessary to consider

- *CLIMATIC* and *METEOROLOGIC CONDITIONS* associated with air temperature and visibility (fog), and
- Coastal (nearshore) and oceanic *CURRENTS* that may affect boom deployment and oil movement.

1.1.1. Climatology

The general circulation of the atmosphere is an important factor in determining the variety and timing of weather events that can occur at a location. The comparative stability of the general circulation pattern produces characteristic regional weather patterns that give each region a distinctive climate. The circulation of the atmosphere and the associated pressure and wind patterns over the ocean are a key element of the wave climate (Section 1.1.3). Winds that blow over the water transfer energy from the atmosphere that, in turn, is expended when the waves reach the coast.

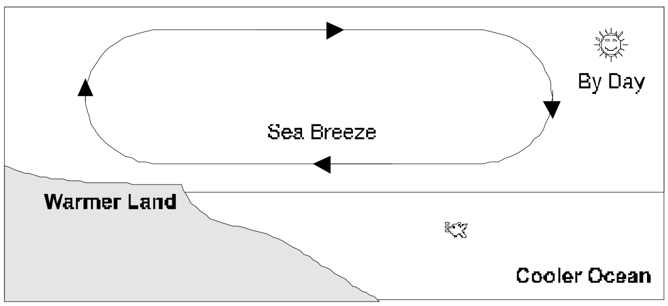
- ❖ The presence of landmasses and temperature differences between oceans and continents cause regions of high and low pressure to be broken into individual pressure cells that are distributed along bands of latitude corresponding to the pressure belts that would form on a uniform rotating earth.



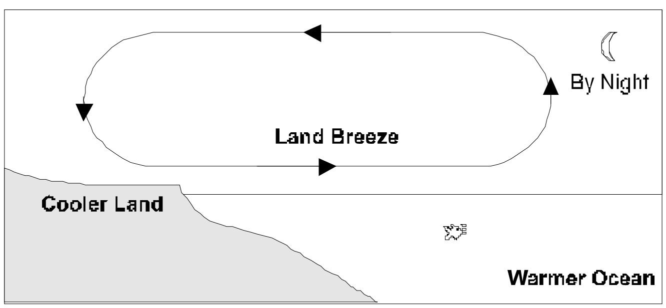
- ❖ The average distribution of surface winds is closely related to surface pressure distribution; winds tend to flow from high-pressure regions toward low-pressure regions, and are modified by friction with the Earth's surface and by the Earth's rotation.
- ❖ The distribution of pressure cells generally shifts to the north in July and to the south in January.
- ❖ The resulting seasonal shift in wind patterns generates a seasonal variation in the weather (temperature, precipitation, winds) of most regions; for example, the winds off the east coast of Africa change from northeast trades in January to southeast trades in July.

Wind Climate

- Regional and seasonal wind patterns that are generated by the mixing of air masses and by air movement along pressure gradients are modified by local influences; e.g., topographic effects can modify winds by funneling.
- Locally, land and sea breezes can occur due to temperature and pressure differences between the water surface and the land. These daily breezes can exceed 20 km/hr where the temperature differences are large.
- This diagram shows a small convective cell generated near the boundary between a warm and cool region.



— In summer, breezes towards the land occur during the day;



— and breezes towards the water occur at night.

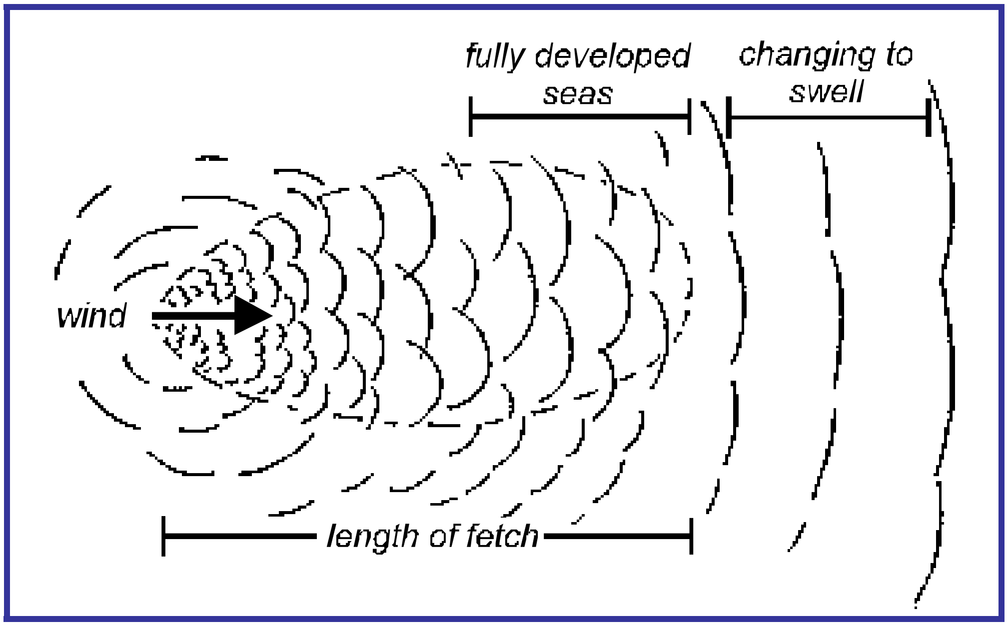
In winter, locally dominated winds are towards the water.

- Wind shifts can cause a change in the distribution of surface water temperature through upwelling (warm surface water is transported by strong winds and is replaced by cooler subsurface water).
- Winds can transport material of sand size or smaller; during periods of strong winds, large volumes of sand can be transported and can bury oil or other materials stranded on a beach.
- Wind can accelerate the weathering of oil and the evaporation of lighter fractions.
- In all cases, whether associated with air masses, cyclonic storms, a sea breeze, or a hurricane, the wind systems are the controlling factor in wave generation.

1.1.2. Waves

Although there are many processes and factors that may need to be taken into consideration to assess operational safety or the fate of spilled oil, the *dominant process on shorelines is that of wave action*.

- Waves are generated by winds that blow over the water surface.
- The character of the wave environment is controlled by the direction, strength, and length of time that winds blow over the *FETCH AREA*.
- Wave exposure is often used to describe energy-levels at the shoreline; the *FETCH WINDOW* is the angle over which a section of shoreline is open to incoming waves, and the *FETCH DISTANCE* is the length of the open-water area in that fetch window.
- Waves that leave the generating (fetch) area are called *SWELL*.



(from Bascom, 1964)

Categorization of Wave Energy Levels at the Shoreline

Fetch Distance	Fetch Window — Degrees			
	< 45	**45 – 120**	**121 – 180**	**> 180**
< 5 km	Low	Low	Low	Low
5 – 10 km	Low	Medium	Medium	Medium
10 – 50 km	Medium	Medium	High	High
> 50 km	High	High	High	High

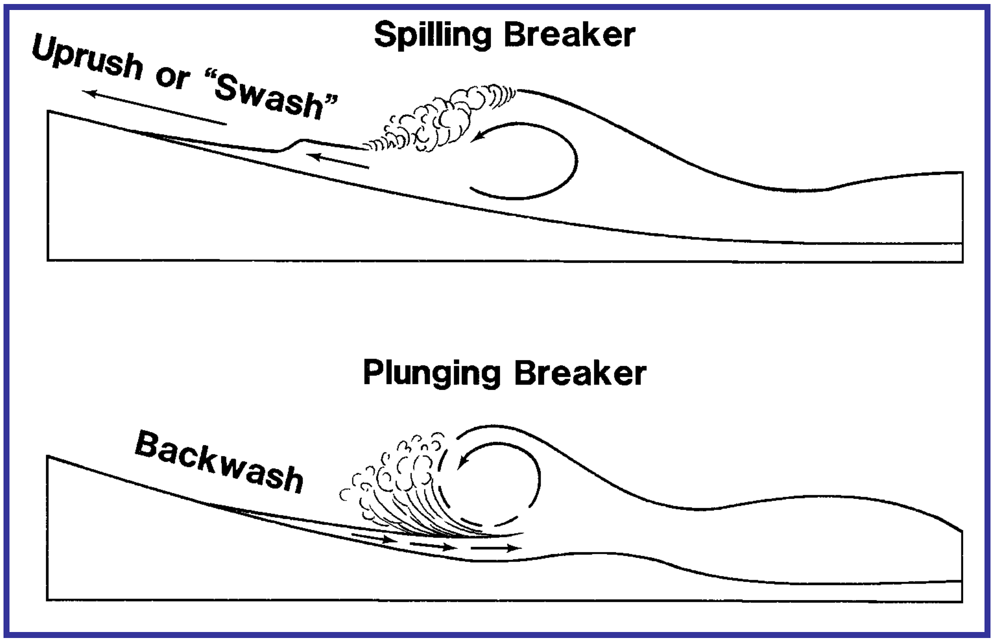
Wave Climate

- Storm-wave environments are characterized by local wave generation from winds associated with low-pressure, cyclonic systems. These storm belts extend approximately between 30° N and 60 ° N and cause the passage of low pressure systems ("cold fronts") through the Gulf region in winter.
- The remaining ocean coasts of the world are characterized primarily by swell waves (e.g., southeast Australia, California, west Africa), or by low-energy conditions (protected or semi-enclosed seas, such as the Gulf of Mexico, the Mediterranean Sea, the Gulf of St. Lawrence, and Hudson Bay).
- The Gulf region is also in the hurricane zone and the "season" extends from June 1st through November 30th. These are extremely high-energy, large-scale (in terms of area) wave events and the effects frequently are compounded by high storm-generated water levels.
- The level of wave energy at the shore depends not only on the character of the incoming waves, but also on nearshore water depths, the presence of reefs, shoals, or sand bars, and shoreline configuration.
- Energy levels at the shoreline vary depending on the orientation of the coast with respect to the direction of wave approach. Typically, the west facing coasts of continents have the greatest wave-energy levels (temperate zones).
- Wave energy levels may vary seasonally with wind velocities.
- In *rivers and channels*, wind-generated wave action is limited, however, if there is significant boat traffic, wakes can be an important factor in increasing shoreline energy levels.

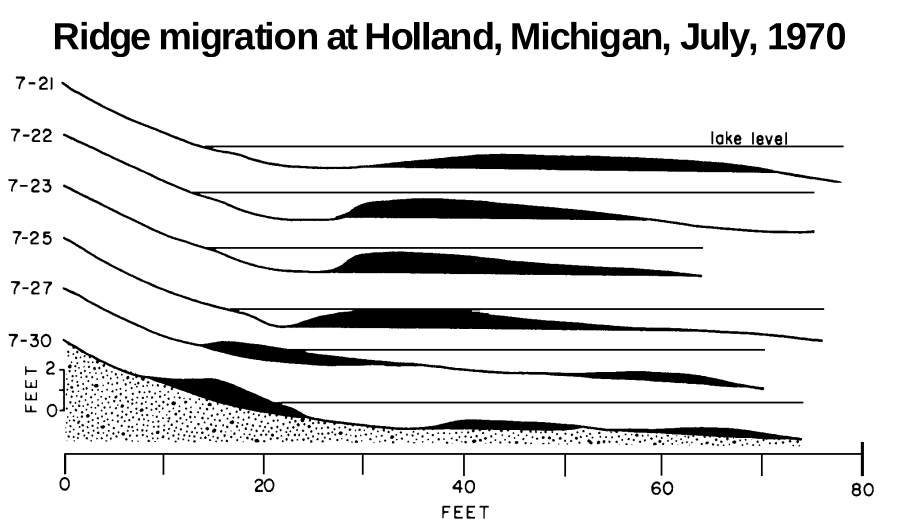
Wave Generated Beach Cycles

When waves reach the shoreline, they dissipate their energy:

- ❖ spilling or surging breakers tend to build up a beach (*ACCRETION*), and
- ❖ plunging breakers move sediments seaward causing *EROSION*.



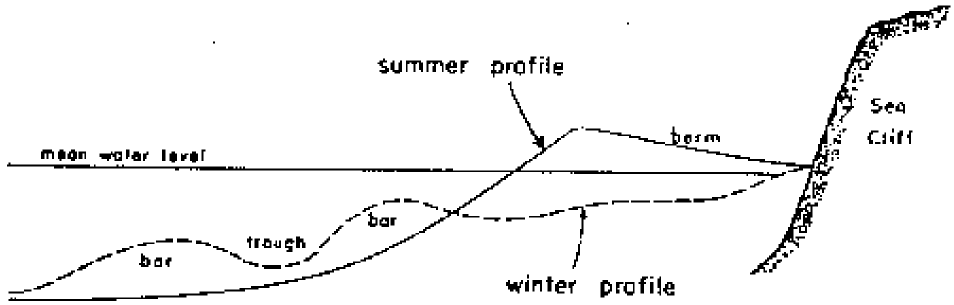
- ❖ Ridges migrate back up a beach after a period of storm wave erosion.



(from Davis, 1978)

On coasts with a strong seasonal variation in wave energy levels (strong storm/swell conditions in winter with lower energy swell in summer), a long period erosion-deposition cycle is common.

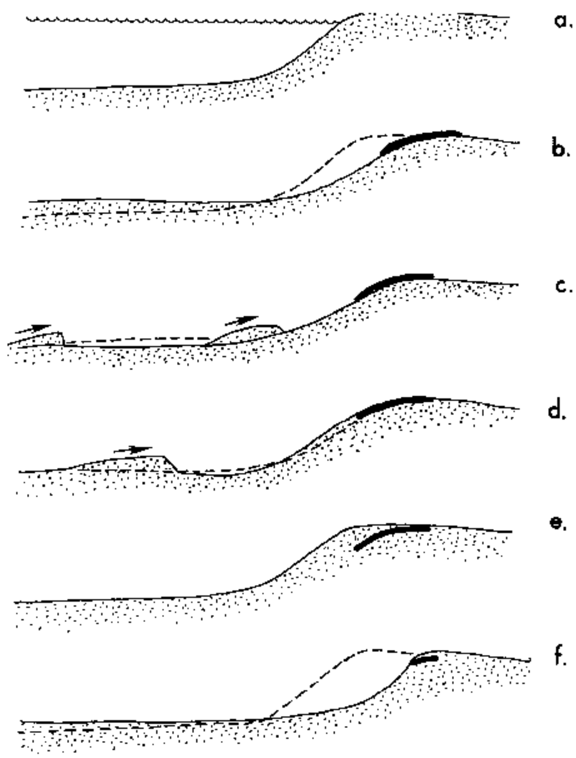
Eroded winter storm beach with nearshore bars and summer berm profiles.



(from Komar, 1976)

An idealized beach cycle (below) illustrates how oil can be buried during a period of storm erosion that is followed by oil deposition (b) and subsequent recovery (c to e). The buried oil will be exposed during the next phase of erosion (f).

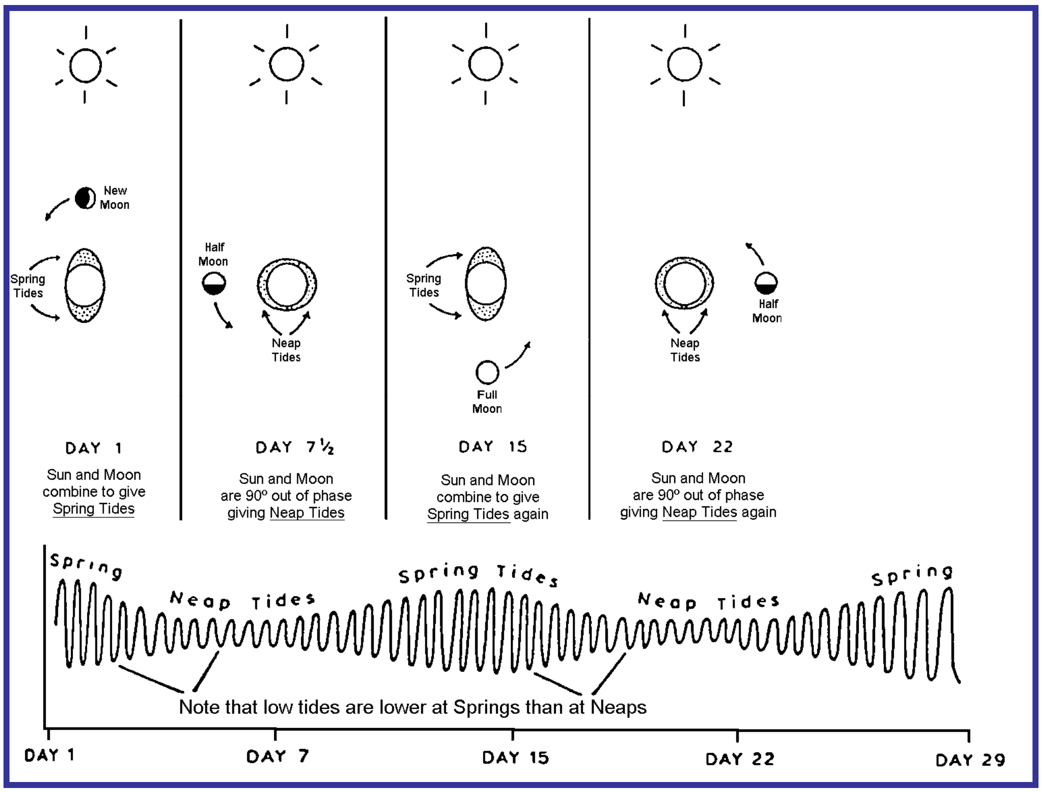
Effect of erosion-deposition cycle on a sand beach after oil is deposited on the upper beach.



(from Owens, 1994)

1.1.3. Tides

- Changes in water levels (tides) result from the gravitational interaction between (predominantly) the moon and the sun.
- The *height of the tides* varies constantly, in a predictable manner:
  - SPRING TIDES — twice each month when the sun and moon are in alignment (New and Full Moon), the high tides are above the mean high tidal level and the low tides are below the mean low tide level.
  - NEAP TIDES — as the relative position of the sun and moon changes to be out of alignment (the First and Last Quarters), the high tides are below the mean high tidal level and the low tides are above the mean low tide level.



- Tidal cycles vary throughout the year as the sun's position changes relative to the earth.
- The highest spring tidal ranges occur twice a year at the *EQUINOXES*.

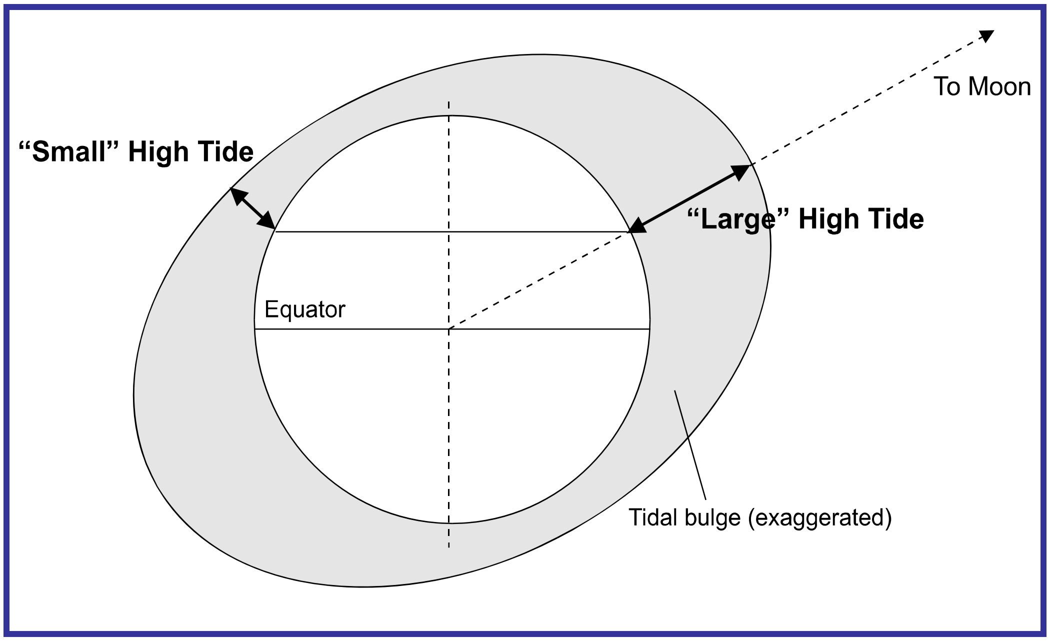
Tropic and Equatorial Tides

These tidal components are due to the moon's orbital plane, which is at an angle of 28° relative to the earth.

Tropic Tides

- Tropic tides occur when the moon is over one of the Tropics (i.e., 23° North or South of the equator).
- This creates unequal diurnal tides.

Unequal "Tropic" tides.



Equatorial Tides

- Equatorial tides occur when the moon is over the equator.
- There is no diurnal variation in the heights of the tides.

These tidal components have a 27-day cycle also, but this cycle is distinct and separate from the lunar rotation around the earth, which also is a 27-day cycle.

Tidal Zones

The coast can be divided into 3 basic zones, based on the tides:

1) **SUPRATIDAL ZONE** (also known as the *backshore*);
   - defined as the area of the shore between the mean high-water level and the landward limit of marine processes.
2) **INTERTIDAL ZONE** (also known as the foreshore);
   - defined as the area of the shore between the mean low-water level and the mean high-water level. This zone often is divided into the upper-, middle-, and lower-intertidal zones.
3) **SUBTIDAL ZONE** (also known as the nearshore);
   - this zone is always underwater and is defined as the area of the shore below the mean low-water level and extends seaward to approximately the 20-m water depth.

This tidal zonation is important as

- the effects of normal wave action are limited to the intertidal and adjacent subtidal zones;
- wave action and oil deposition occur in the *SUPRATIDAL ZONE* only during high spring tides or wind surges; oil stranded here is above the zone of normal wave action;
- the *LOWER HALF OF THE INTERTIDAL ZONE*, below the mid-tide level or mean water level, is exposed for less than half of the tidal cycle and usually stays wet; the likelihood of (a) oil being stranded and (b) sticking to the wet substrate is low — also, this is usually the most biologically productive zone;
- the *UPPER HALF OF THE INTERTIDAL ZONE* is out of the water for most of the tidal cycle and is the zone where oil is most likely to be stranded.

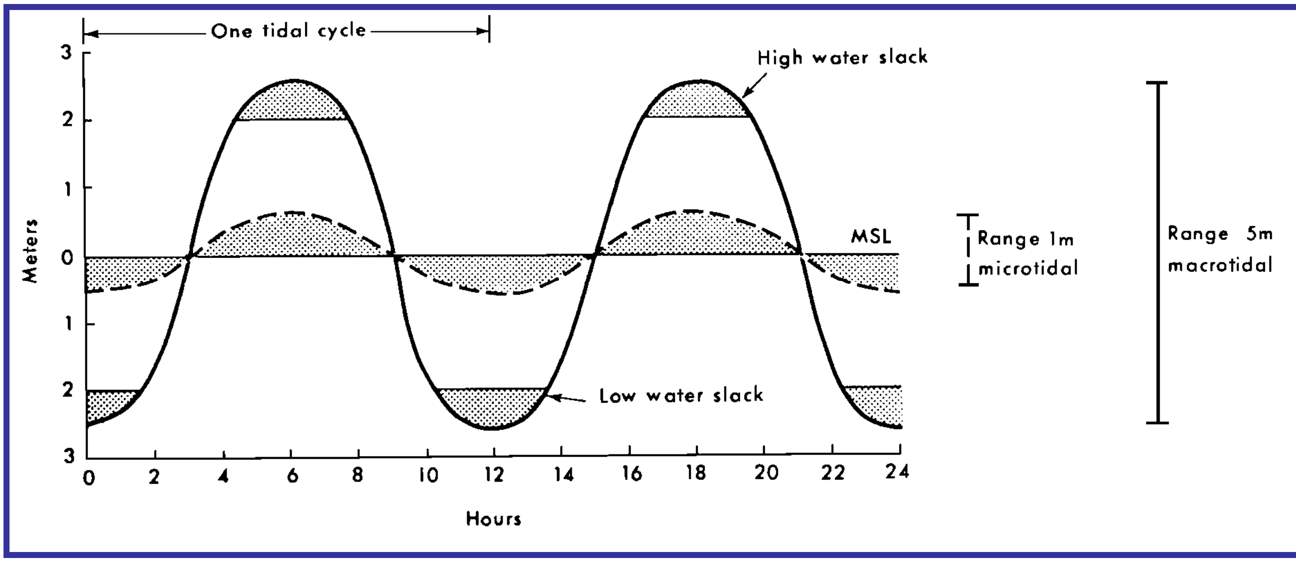
Storm Surges

- Wind-generated *storm surges*, or meteorological tides, can raise and lower water levels by piling water against or driving water away from a coastline; this can be of equal or greater significance than the astronomical tides, especially in areas with low tidal ranges such as the Gulf of Mexico.

Tidal Environments

Shoreline features strongly influence the pattern of the tides:

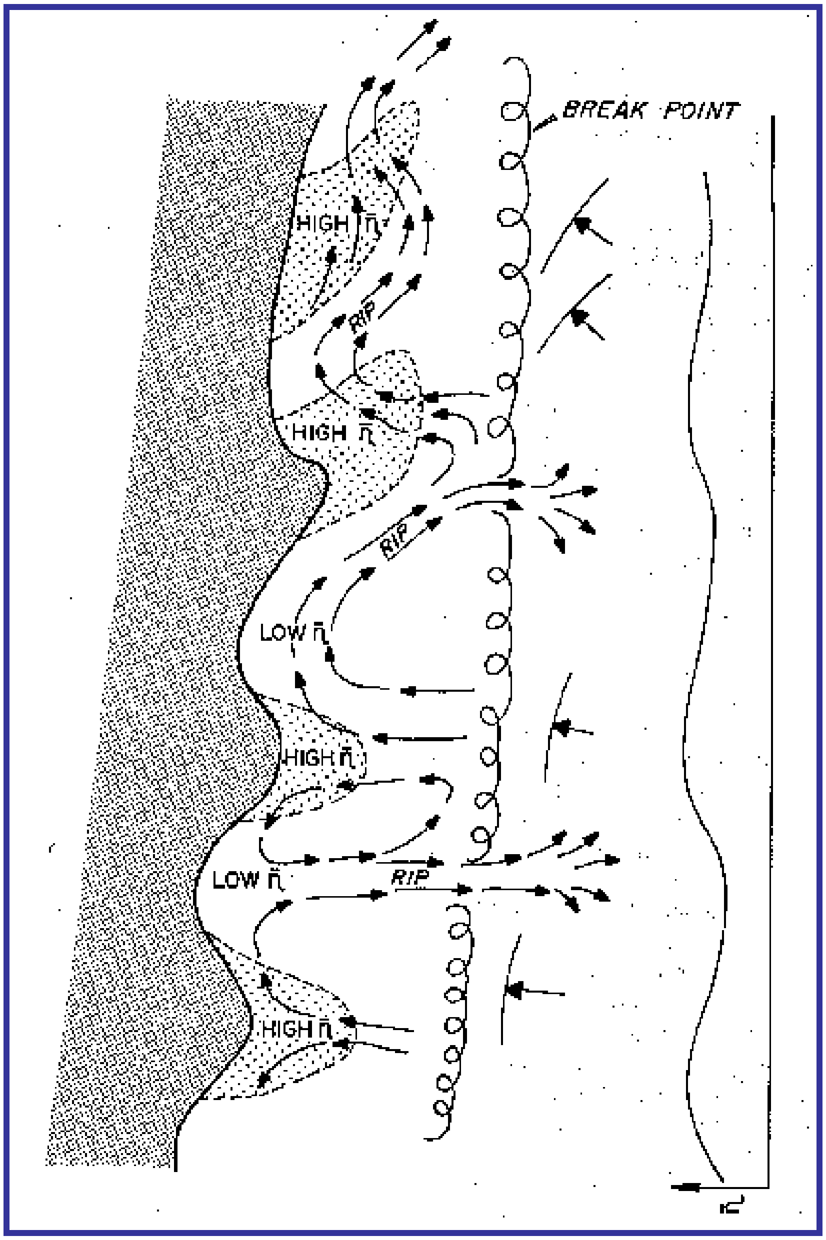
- Tidal currents are stronger where tidal ebb and flow are constricted by channels or inlets ("passes"). This is important in the transport of nearshore or intertidal sediments, and large volumes of material can be redistributed each tidal cycle.
- On low-relief coasts, even a low tidal range can expose wide areas at low tide.
- Tidal periods are generally diurnal or semi-diurnal, but may be a mixture of these two frequencies. The tidal period determines the length of time the intertidal zone is exposed or submerged each day, and wave processes can act at different levels of the shore zone.
- The effectiveness of wave action increases as tidal range decreases. This is demonstrated in the following figure where, in a micro-tidal environment, such as the Gulf of Mexico, the entire incoming wave energy during the 24-hour period is concentrated in a vertical band that is only 1 m wide. of time.



(from Owens, 1994)

1.1.4. Nearshore Currents

- Rip currents, caused by the meeting of water currents or the interaction of currents and waves, are common along the shore.

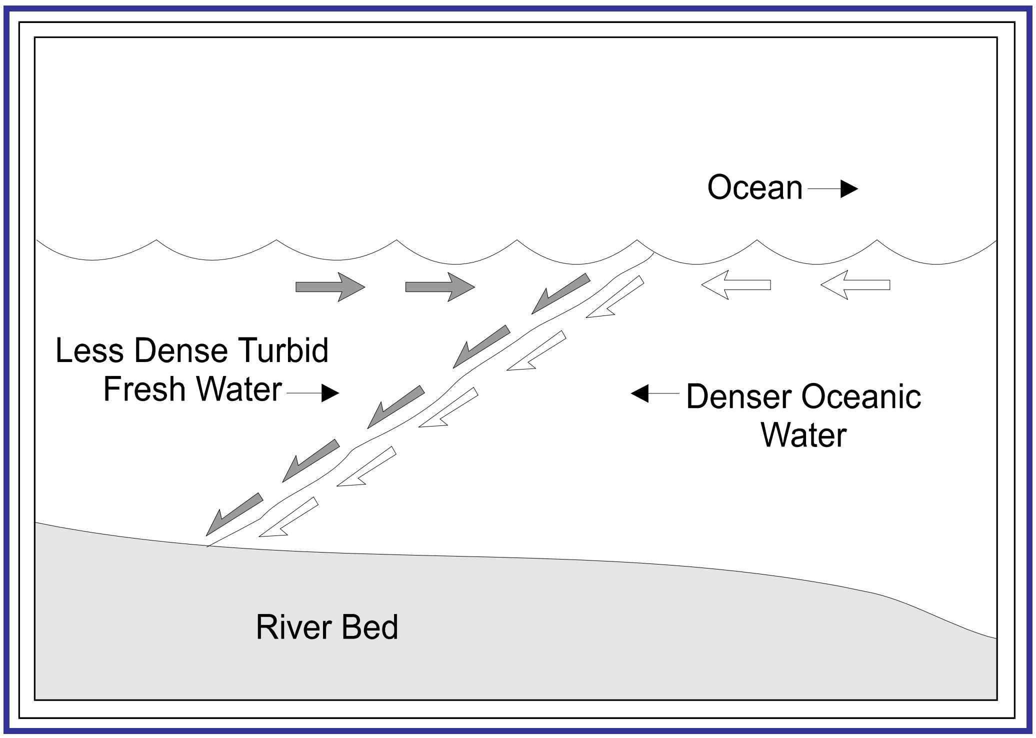


- Tidal inlets have distinctive ebb-and flood-tidal current patterns.

Density Fronts

- Where different water waves meet (e.g., fresh water flow from a river meets saline nearshore ocean water), a distinctive density front may be a barrier to the movement of oil on the water surface (Murray, 1982; Murray and Owens, 1988).
- In estuaries and bays this mixing zone (density front) moves seaward with the ebb tides and landward with the flood tides.
- These density fronts are very common around the Mississippi Delta and were observed on many occasions on DWH.

"Classic" Salt Wedge Estuary (CHS, 1983)



1.1.5. Geomorphology

Coastal landforms are not fixed, but continually change by the work of moving water and other agents as material is deposited or eroded. The constant, dynamic conditions of shorelines must be considered in any attempt to predict the fate of stranded oil.

- Rates of shoreline change are variable and depend on coastal processes and the geology of the region. Characteristics that determine the degree to which the coastal processes affect the shoreline include:
  - slope,
  - susceptibility of materials to erosion (resistance),
  - fluvial input,
  - sediment availability,
  - prevailing longshore transport direction,
  - presence of vegetation,
- The relief of the interior land mass generally governs the size of river drainage basins and the supply of sediments to the coasts:
  - river basins on high mountain coasts are generally small and sediment inputs are low;
  - large drainage basins combined with active terrestrial weathering processes produce high sediment yields to the coasts.
- The amount of sediment supplied by fluvial input is also dependant upon the precipitation amount and may be seasonal (i.e., spring runoff from snow melt).
- Where sediments are supplied directly by rivers or by marine erosion of unconsolidated or unresistant cliffs, sedimentary deposits such as beaches, tidal flats, and/or deltas frequently characterize the coastal zone.
- The longshore transport of sediments may be limited by the presence of headlands or embayments; the transport systems are compartmentalized and the free exchange of sediment from one compartment to another is not possible.
- On coasts where longshore transport is uninterrupted by bedrock outcrops, movement of material is limited only by the presence of estuaries or inlets; if sufficient sediments are supplied, even these obstacles may be crossed.

1.2. Ecology and Cultural Resources

A shoreline or region may be characterized by any number of ecologically or culturally important resources.

- Wildlife
  - birds; seabirds and waterfowl for nesting, breeding, and migration, colonial nesting birds, raptors, wading and shorebirds
  - mammals; manatees,, seals, whales, dolphins, porpoises, sea lions, sea otters
  - fish; exploited on both commercial and recreational basis; salmon, herring, commercial groundfish
  - amphibians and reptiles; frogs, turtles, alligators, water snakes (especially in wetland areas)
  - invertebrates; sea scallop, crab, shrimp, squid, octopus
  - intertidal organisms; shellfish, seaweed, benthic invertebrates
  - shore associated mammals; river otters, mink, deer, bears
- National Parks or regional parks (including underwater parks), nature reserves or wilderness areas.
- Environmentally Sensitive Areas or areas of ecological significance (e.g., wetlands, dune formations, marine plants)
- Recreational and tourism areas
- Marine transportation industry
- Water Intakes
- Commercial, sport, or subsistence fisheries and aquaculture sites
- Significant Cultural Resources

  — relating to aboriginal occupation and land-use practices along the shorelines,

  — many may be undocumented or unknown, such as:
  - Paleontological sites (archaeological interest)
  - Historic occupation sites (campsites, villages, fishing stations, trade posts, military and naval establishments)
  - Pictographs (rock paintings, usually on rocks or cliffs over water)
  - Stone structures
  - Underwater shipwrecks
- Best Management Practices (BMPs) may be defined through Sections 7 and 106

1.3. Shoreline Types and Coastal Character

The character of the shore zone and the fate and persistence of stranded oil are primarily a function of the

- ❖ SHORELINE PROCESSES, and the
- ❖ SUBSTRATE MATERIALS.

For oil spill response studies, it is important to distinguish between:

- ❖ the *SHORELINE TYPE* of the intertidal (foreshore) or swash zone;
    - < this is *where the oil becomes stranded* and where the treatment or cleanup activities take place.

and

- ❖ the *COASTAL CHARACTER*, which refers to the form of the shore zone as a whole and includes the area inland and seaward of the intertidal zone;
    - < this is *where operations activities to implement the treatment or cleanup take place,* and defines access constraints to the foreshore (intertidal) and backshore (supratidal) zones.

The coastal character or landform (beach, cliff, marsh, etc.) may be a useful descriptor of the regional setting, but the substrate materials or shoreline type control the behavior and persistence of stranded oil.

Coastal processes
act on the
substrate or material (shoreline type)
that is provided by the
regional geology of the coastal zone
to develop the
form of the shoreline (coastal character).

1.3.1. Shoreline Types for Oil Spill Response

The basic parameter in defining shoreline type is the *MATERIAL* that is present at the shoreline (in the intertidal or foreshore zone); this parameter involves two components:

1) the presence or absence of sediments in the shore zone, and
2) the character of the substrate materials.

∈ The presence or absence of sediments is a key factor as this will determine whether oil is stranded on the surface of a substrate or can penetrate and/or be buried.

- ❖ SOLID SHORELINES, such as bedrock outcrops or man-made sea walls, are stable and impermeable.
- ❖ UNCONSOLIDATED SHORELINES, such as beaches and deltas, are mobile and permeable.

∉ Within these two fundamental shoreline types, further subdivision is based on the *character of the substrate materials*.

Solid and Unconsolidated Materials of the Shore Zone

SOLID MATERIALS		UNCONSOLIDATED MATERIALS	
Bedrock:	- resistant	Inorganic:*	- silt/clay
	- unresistant		- mud
			- sand
Anthropogenic:	- concrete		- pebble
	- metal		- cobble
	- pilings		- boulder
	- wood	Organic:	- wetland
			- marsh
Beach Rock			- mangrove
			- corals
			- peat
			- shell hash **
			- swamp
			- vegetated shore
		Anthropogenic:	- concrete forms **
			- debris/logs
			- riprap**
			- rubble**

* = sediments
** these would have a size component equal to that used for inorganic materials

Solid and Unconsolidated COASTAL CHARACTER Forms

SOLID FORMS

Anthropomorphic:
- bulkhead
- dolphin
- dyke
- breakwater
- jetty
- marina
- seawall
- revetment
- wharf

Cliff:
- vertical
- steep
- inclined
- beveled
- terraced
- sea stack

Platform:
- horizontal
- terraced

Reef

UNCONSOLIDATED FORMS

Anthropomorphic:
- dock/pier
- dyke
- breakwater
- fill
- marina
- midden
- sea wall

Beach:
- attached
- barrier
- spit

Delta:
- bird-foot
- fan/ single channel
- fan/multi-channel
- lobate

Dune:
- bare
- vegetated

Channel:
- creek bank
- levee
- river bank
- tidal

Flats:
- delta
- tidal
- boulder barricade

Marsh:
- fringing
- meadow

Mangrove:

Scree/Talus

Coastal Oil Spill Vulnerability

Feature	Residence Time of Oil	USCG Ranking	NOAA Ranking
Exposed rocky shores	Days to weeks	1	1
Wave-cut platforms	Days to weeks	2	2
Fine sand beaches	Days to weeks	3	4
Coarse-sand beaches	Months	4	No rank given
Exposed sandy tidal flats	Months	5	7
Sand and gravel beaches	Years	6	5
Gravel beaches	Years	7	6
Sheltered rocky shores	Years	8	8
Tidal mud flats	Years	9	9
Marshes and lagoons	10 years	10	10

Part 2 Oil Fate and Behaviour

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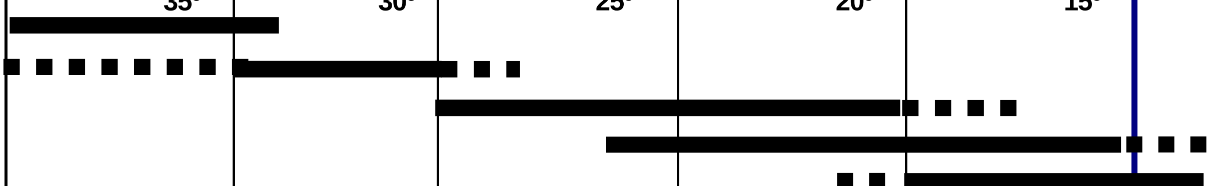
Part 2 Oil Fate and Behaviour

2.1. *Oil Types*

Crude or refined oils vary considerably in their physical and chemical character.

		STICKY OR NON-STICKY			
	Low Pour Point Volatile Oils	**Low Viscosity < 15 CST**	**Medium Viscosity 15 - 50 CST**	**High Viscosity > 50 CST**	**Semi-solid or Solid**
API GRAVITY RANGES	**40°** **35°**	**30°**	**25°**	**20°**	**15°**
PRODUCTS	▪ Avgas 80/100 ▪ Gasoline ▪ Kerosene ▪ Naptha ▪ No. 1 Fuels ▪ Solvents	▪ Diesel ▪ No. 2 Fuel ▪ Heating Oils ▪ Gas Turbine Fuel ▪ Marine Diesel	▪ No. 4 Fuel ▪ Lube Oil	▪ Bunker B, C ▪ No. 5, 6 Fuel ▪ Marine Fuel Oil ▪ *Weathered Medium Viscosity Fuels*	▪ Asphalt ▪ *Weathered High Viscosity Fuels*
CRUDES	▪ Sable Is. ▪ Scotian Light	▪ Alberta ▪ Brent ▪ West Texas	▪ Alaskan North Slope ▪ South Louisiana ▪ *Weathered Low Viscosity Crudes*	▪ San Joaquin Valley ▪ Venezuela ▪ *Weathered Medium Viscosity Crudes*	▪ *Weathered Medium or High Viscosity Crudes*

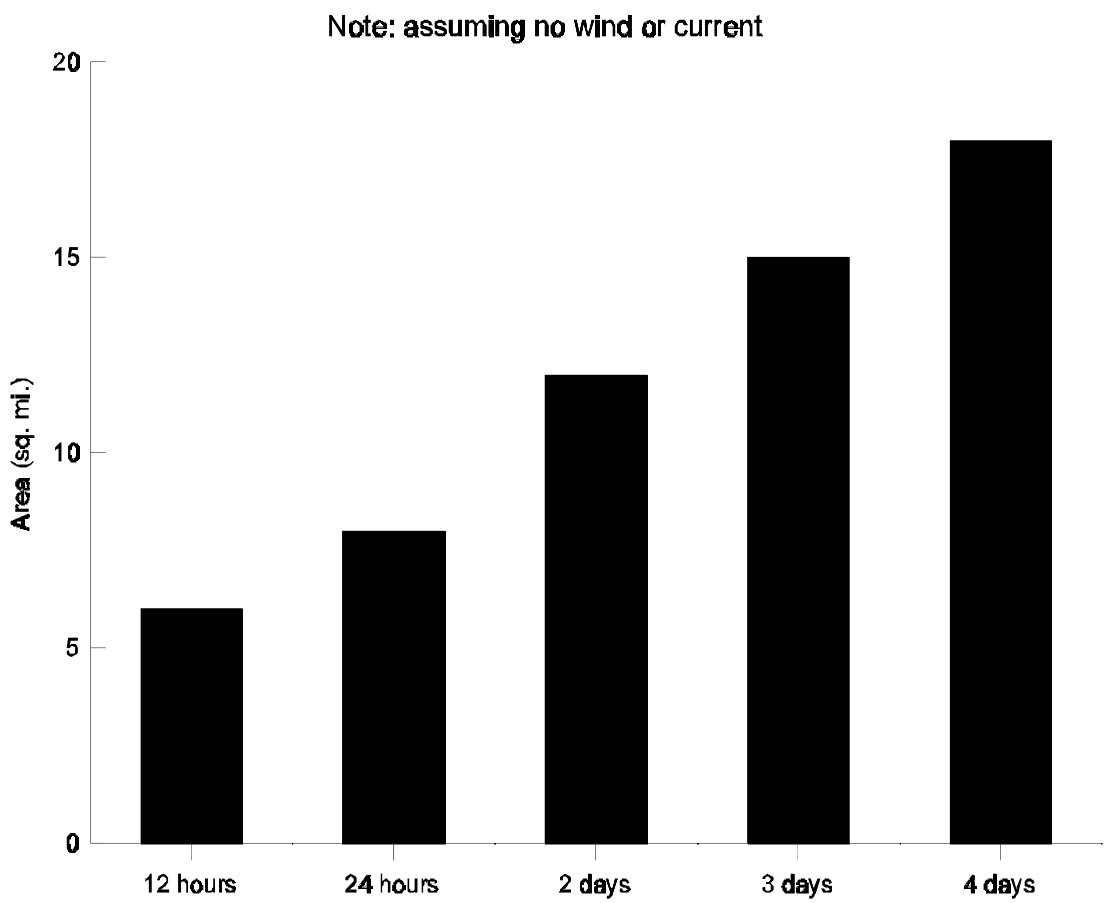


(from Owens and Taylor, 1993)

2.2. The Fate of Spilled Oil — Oil Movement

- Spilled oil spreads on the water surface due to gravity effects (as illustrated below) and is transported by currents and winds.
- For large spills, *TRAJECTORY MODELS* may be used to estimate slick movements. A local knowledge of currents may help to estimate general movement patterns.
  - for an oil slick classification system, see Allen,1997.

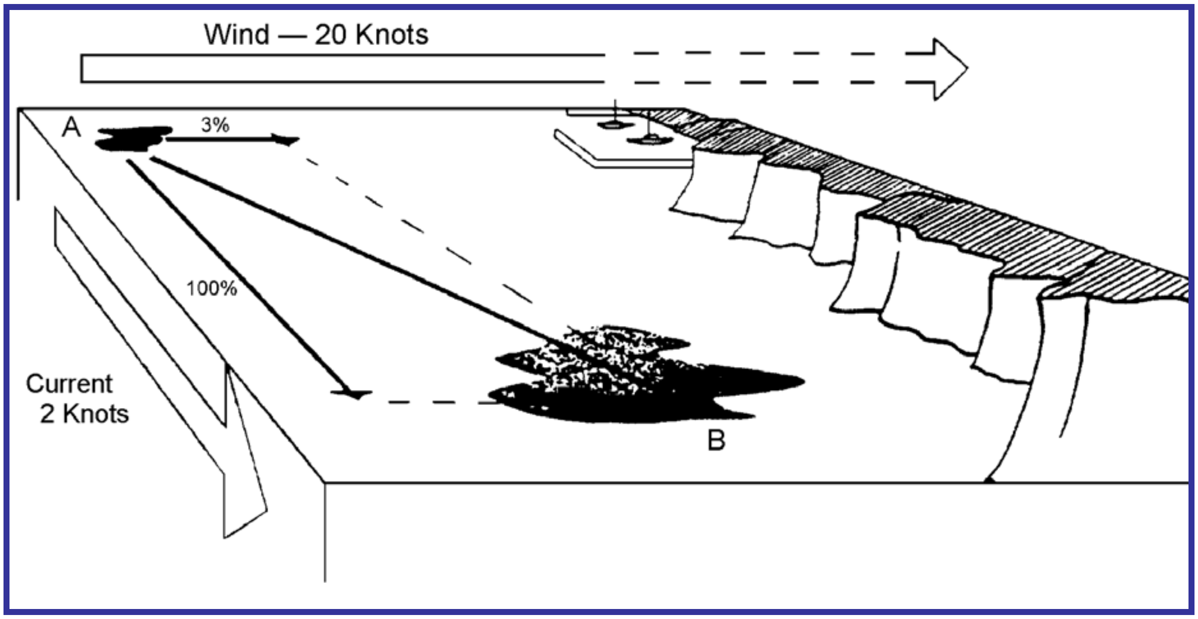
Spread of an "Exxon Valdez"-Sized Oil Spill



2.2.1. Oil Movement — Simple Trajectory Analysis

Surface currents dominate spill movement unless there are no currents or the winds are very strong.

- An oil slick will move at about the same speed as the surface current and at about 3% of the wind speed (illustrated below).



(adapted from ITOPF, 1987)

Wind Velocity km/hr	3% of Wind Velocity	=	Metres/Second	=	Knots
25	0.75 km/hr	=	0.21 m/s	=	0.41 kts
50	1.5 km/hr	=	0.42 m/s	=	0.82 kts
75	2.25 km/hr	=	0.62 m/s	=	1.215 kts

Trajectory Uncertainty

- Oil drifts at between 1 to 6 % of the wind speed.
- Strong winds typically are “gusty.”
- Timing is the most uncertain element of weather forecasting.

2.2.2. River Flow

- Generally in one direction (downstream), currents usually dominate.
- Varies locally — back eddies, whirlpools, etc.
- Spread also variable in time and space.
- Current speeds are lower at the banks and the bottom (friction), surface and center water moves faster (causes oil to spread rapidly and there may be considerable mixing behind leading edge of oil plume).
- If river or channel narrows, then surface current speed increases. Currents may be strong (>50 cm/sec) in river sections where flow is constricted.
- If river widens, then speed decreases.
- Wakes from both large vessels and small boat traffic *CAN CAUSE STRONG WAVE ACTION* (wave heights >1 m) at the shore.
- *WINDS* are important in a river or canal as they can drive a slick against one bank, keeping the lee shore oil free.
- Near the mouth, rivers may be subject to *TIDAL REVERSALS*.
- 3-D distribution for most oil types in rivers.

Oil Transport in Rivers

- Currents (sheer) usually dominate.
- Wind is generally a minor effect.
- Wind may determine which riverbank is oiled as oil moves downstream.

2.2.3. Nearshore Currents

Coastal currents are very important in controlling the movement of oil near the shoreline.

- Coastal boundary currents can:

  (a) trap or contain oil close to a shore (Murray and Owens, 1988):

    - *Ixtoc*, Gulf of Mexico, 1979;
    - *Amoco Cadiz,* Brittany, France, 1978;
    - *Nestucca,* NW USA and Vancouver Island, British Columbia, 1988-1990;
    - *Exxon Valdez,* Alaska, 1989;
    - Kuwait, 1991; or can

  (b) keep oil away from a shore:

    - *Alvenus*, Gulf of Mexico, 1984;
    - *Kharg V*, Morocco, 1990;
    - *Mega Borg*, Gulf of Mexico, 1990.

- Fresh or brackish water outflow from a river can deflect oil away from a river mouth or estuary:

    - Chevron, Mississippi River, 1970;
    - DWH, Gulf of Mexico, 2010.

- Density fronts are associated with coastal boundary currents, fresh water outflow, or other ocean and nearshore currents.

2.3. The Fate of Spilled Oil — Weathering

WEATHERING — the set of physical and chemical processes that change the compounds of the spilled oil.

Primary Weathering Processes

- Processes that are initially important include:
  - spreading
  - dispersion
  - evaporation
  - dissolution+
  - emulsification
- Processes that are more important in the later stages of weathering and usually determine the ultimate fate of the spilled oil include:
  - oxidation+
  - biodegradation
  - sinking and/or sedimentation+
- All of the 8 processes are interactive.

(+ these *processes usually are of lesser importance than the others)*

Weathering Rates

- Depend on:
  - oil type
    - – physical properties such as viscosity and pour point, and
    - – chemical properties such as wax content
  - amount of oil spilled
  - weather and sea state conditions
  - location (whether oil stays at sea or is stranded)
- NON-PERSISTENT OILS
  - weather naturally and rapidly — usually do not involve a cleanup response.
- PERSISTENT OILS

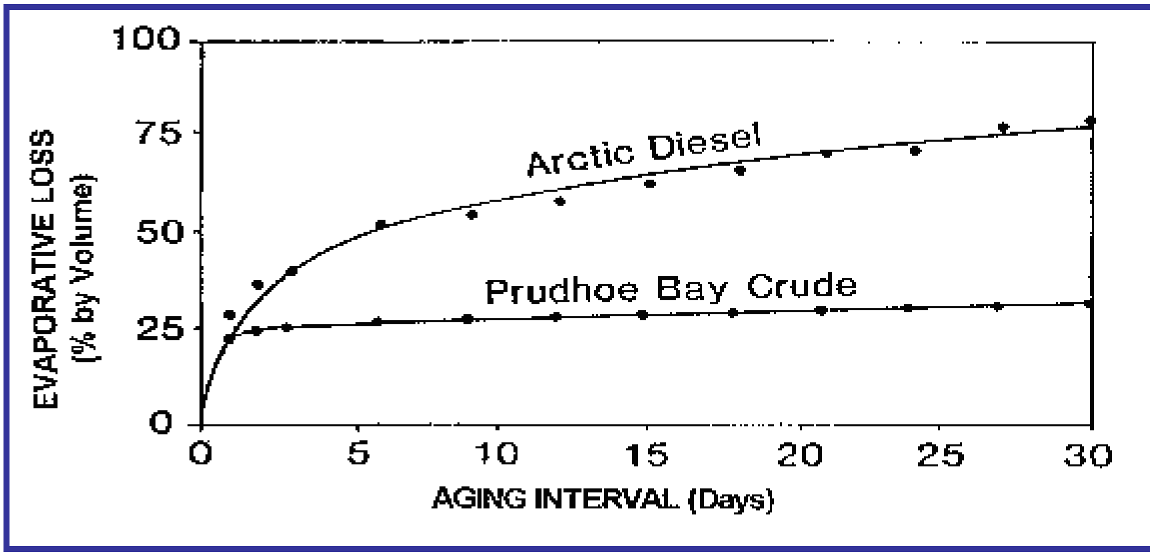
- break and weather more slowly and often require a cleanup response (includes most crude oils, see table on page 2-3).

Persistence of Stranded Oil

EVAPORATION is usually the most important weathering process in the first days immediately following a spill.

Evaporation of Two Oil Types at 0ºC and a Wind Speed of 18 km/hr

(from ABSORB, 1981)



Approximate Evaporation for Various Classes of Oil

(ITOPF, 1987)

Oil Type	12-Hour Evaporation*	48-Hour Evaporation	Total Fraction Evaporated
Group 1 (Gasoline)	50 – 100%	100%	100%
Group 2 (Diesel)	10 – 40%	25 – 80%	100%
Group 3 (Medium Crude)	5 – 15%	10 – 25%	35%
Group 4 (Heavy Oils)	1 – 3%	5 – 10%	15%
Group 5 (Low API)	0 – 2%	1 – 5%	10%

(*) Lower limits are for 5ºC and the upper limit for 30ºC and a moderate wind speed of 5 m/sec.

2.3.1. Emulsification

An emulsion is usually a *WATER-IN-OIL* mixture, but can be an *OIL-IN-WATER* mixture.

- Either way, the process of emulsification results in:
    - an increase in the volume of oil, and
    - the alteration of the properties of the spilled oil.
- The process is a function of the oil type and the available mixing energy (usually wave action at sea for marine spills).
- Oil is difficult to emulsify if the ambient water temperature is >10°C below the pour point.
- *EMULSION STABILITY* in crude oils is largely dependent on the oil types:
    - for example, ANSC (Exxon Valdez spill — Alaska 1989) forms a stable emulsion whether fresh or weathered; whereas, unweathered Gulfaks oil (Braer spill — Shetland 1995) formed a temporary oil-in-water emulsion,
    - light crudes (e.g., North Sea Brent) tend to form temporary or unstable emulsions,
    - water-in-oil emulsions often are referred to as "(chocolate) mousse".
- Emulsion affects the *ADHESION PROPERTIES* of oil:
    - this dramatically affects the on-water recovery options, and
    - an oil-in-water emulsion likely will not stick to shore zone materials.

2.3.2. Persistence

The persistence of oil stranded on the shoreline is dependent on:

∈ the character of the oil,

∉ the physical character of the shoreline, and

∠ shoreline processes.

The following tables show increasing persistence (top to bottom) for various oil and shoreline characteristics.

<u>Expected Persistence</u>

Days/Weeks

▼

Decades

OIL CHARACTERISTICS

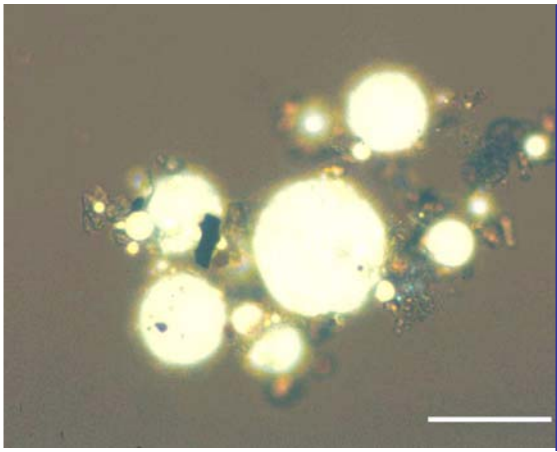
INCREASING PERSISTENCE	Types of Oil	Thickness of Oil on Shore Surface	Depth of Oil Penetration
▼	Light Volatile ▼ Tarry	Very Thin (<1.0 cm) ▼ Thick (>10.0 cm)	All Oil Exposed on Shore Surface ▼ All Oil Buried Below Beach Surface

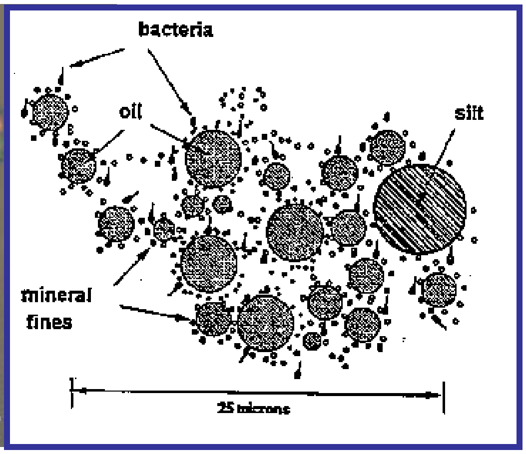
SHORELINE CHARACTERISTICS

Fetch	Prevailing Winds	Coastal Exposure	Offshore Ice	Wave Energy Level at Shoreline
Long (> 200 km) ▼ Short (> 50 km)	Onshore ▼ Offshore	Straight (open) ▼ Indented (sheltered)	Absent ▼ Present	High Energy Levels: Exposed Coast ▼ Low Energy Levels: Totally Sheltered

2.3.3. Natural Degradation (Weathering) by Fine Particle – Oil Interaction

- ❖ Following the 1989 Prince William Sound *Exxon Valdez* spill, researchers found that a key factor in the natural removal of residual stranded oil was fine particle (clay) and oil interaction (Bragg and Yang, 1995; Jahns *et al.*, 1992).
- ❖ This process can be used to explain why and how oil is removed naturally from surface and subsurface sediments in areas where natural wave energy levels are too low to physically or mechanically abrade residual oil.
- ❖ These initial studies were then extended to include oil samples from other sites in arctic, temperate, and tropical coastal environments (Owens, Bragg, and Humphrey, 1994).





The scale of fine particle and oil interaction - 25 microns is equal to 0.001 mm or one-thousandth of an inch (from Bragg and Yang, 1995)

Fine Particle — Oil Interaction

- Oil can be broken down or weathered, in place, into its component parts in the absence of mechanical wave energy.
- This can occur by a number of surface interaction processes, one of which is clay-oil flocculation (Bragg and Owens, 1995; Bragg and Yang, 1995).
- Once small particles have been generated, they are more available for biodegradation (Bragg *et al.*, 1994; Lee *et al.*, 1997).

- Although the scale of the processes and the size of the particles is very small (see diagram on previous page), the process is very evident when watched under the microscope.
- The factors that control or affect the rates of natural oil removal by this process are not well understood. Laboratory tests (Bragg and Owens, 1995) and field observations (Owens *et al.*, 1994) show that, even after many (22+) years, very viscous oils can be continuously weathered by this process, albeit at relatively slow rates. The tests also show that the processes can occur in inland waters (such as the Great Lakes).
- It is believed, but unproven, that these processes will eventually remove and break down all residual stranded oil, except in a few unusual circumstances. This explains why so little oil remains from the thousands of miles of shoreline that have been oiled over the years.
- Oil may remain if it is:

  (a) *above water level limits* — stranded above the higher high-water mark and so not in contact with water, or

  (b) *semi-solid* or has a solid/semi-solid (asphalt) "skin" — so that the forces of cohesion are too strong and prevent small particles from breaking away from the oil surface.

Conclusion:

❖ We have known for many years that oiled shorelines will clean rapidly in the presence of wave action (high mechanical energy levels).

❖ We now know why and how oil can be cleaned in low wave-energy environments in the absence of mechanical wave energy.

2.4. Where Oil Is Stranded

- On sheltered coasts with small waves, most of the oil will be deposited as a thin band in the middle to upper intertidal zone (in the zone of wave action).
- If washed ashore during periods of storm-wave activity, oil can be carried farther up a beach and deposited in the supratidal zone (above the limit of most wave action); this oil is stranded and will not be affected by waves until the next period of high water levels.
- On impermeable surfaces (bedrock, solid man-made structures), oil remains on the surface.
- On permeable shores (i.e., shores with sediments), subsurface oil can be present due to burial and/or penetration.

Factors That Affect Where Oil Is Located

When observing and documenting oil conditions and discussing treatment options, keep the following in mind:

Type of Shoreline + Tidal Stage or Water Level + Wave Conditions

Control

Where the Oil is Deposited on the Shoreline

Example
- On sheltered shorelines, oil is usually deposited as a band in the mid- to upper-intertidal zone with a sharply defined upper limit at the high tide line.

Wave Energy + Sediment Transport Cycle

Control

Whether Oil is Buried or

Naturally Washed from the Beach

Example
- The potential for rapid burial or erosion is greater on fine-grained beaches as less energy is required for sediment transport.

Sediment Type + Degree of Sorting + Viscosity of the Oil

Control

Rate and Depth of Oil Penetration

Example ◆ Weathered or emulsified high viscosity oil tends to remain on the surface of fine-grained beaches and of poorly sorted substrates.

2.4.1. Rivers

❖ Key factor is river stage (rising or falling water level) — this controls whether stream banks are oiled or if can expect over-bank flooding and oiling.

Changes in river stage result from:

- the interplay between inputs (precipitation, run-off, groundwater) and outputs (evaporation, transpiration, consumptive uses, and outflow),
- the regulation of the flow by man (dams),
- the effects of wind-generated storm surges and seiches (wind set-up and set-down),
- In winter, ice retardation and ice jams in rivers may affect water levels by reducing flow; aquatic growth during summer may have a similar effect.

❖ These runoff variations change the water level and may strand oil on the shoreline at different levels.

- For example, falling water levels may strand oil so that it will not refloat, which removes it as a secondary source for remobilization but may leave a persistent shoreline cleanup problem.
- Rising water levels may wash off beached oil and reintroduce floating oil or may cover up or bury oil that is adhered to sediment or vegetation.
- High water levels may lead to greater oil contact with shore bank vegetation and may strand oil in small pools and eddies along the bank.
- Oil may be carried into flood plains during overbank flood stages, leaving potentially extensive areas of oiled vegetation and soils.

❖ In general, oil will tend to accumulate in areas of quiet water or eddies at the inside of river bends on a meandering river or stream, or in other pools where velocities are slower.

❖ Pools of oil may also accumulate behind log or debris jams.

❖ For any oil that enters a river, irrespective of flow velocities or water levels, some of the oil will end up on the riverbanks.

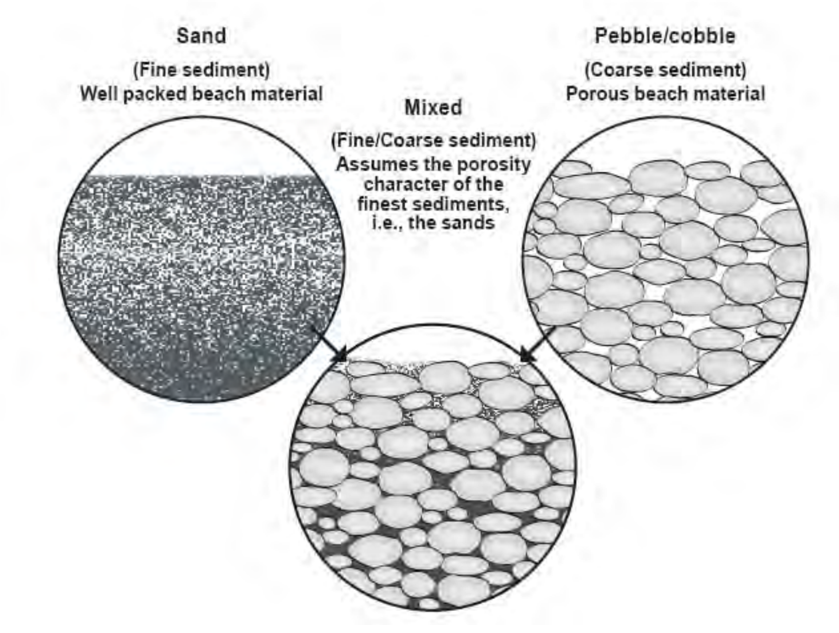
❖ In faster flowing conditions, the geographic spread and the affected area would be greater than under slower flow conditions, although local concentrations of oil may be greater for slower streams.

2.5. Oil Burial, Penetration, and Retention

Stranded oil can be *BURIED* or *ERODED* by the normal movement of beach sediments as they are redistributed by the action of waves and winds.

Oil may penetrate below the surface of a beach, depending on the size of the sediment and the viscosity of the oil. Only light oils (e.g., a diesel) can penetrate a sand or mixed sand-gravel beach, whereas, all but the more viscous oils can easily penetrate into a pebble-cobble beach.

- ❖ In principle, oil more easily penetrates coarse sediments (pebbles/ cobbles) than fine sediments (sands/granules) due to:
  - fewer grain-grain contacts/m3 (see table on following page), and
  - larger void spaces between grains.
- ❖ Beaches composed of *mixed sands, pebbles, and cobbles* are sometimes referred to as "gravel beaches". The surface layer often has predominantly coarse sediments with increasing amounts of sand in the subsurface.
- ❖ On the mixed-sediment beaches, the coarser fractions (pebbles and cobbles) are infilled with the finer sands so that these beaches are *permeable only for some medium oils and all light oils*, and they have a *dynamic, mobile* surface layer.



(from Owens, 1996)

- ❖ From an oil fate and persistence perspective (for example, in terms of penetration of oils), this mixed-sediment beach type is similar to a sand beach, but, for response operations (in terms of bearing capacity and cleanup techniques (Section 6)), this beach type is more like a pebble-cobble beach.

Oil Penetration — Retention

- *PENETRATION* is the amount of oil that enters sediment and the depth of oiling. *RETENTION* is the amount of oil that remains in the substrate after remobilization (natural flushing).
- Oil is more easily removed by water flushing from coarse sediments due to:
  - fewer grain-grain contacts/m^3, and
  - the larger surface area per unit volume of finer sediments.
- More oil can penetrate coarse sediments, but if the oil can penetrate the finer sediments then it is likely that more oil will be retained in those finer sediments.
- No single parameter controls oil penetration or retention. A combination of oil properties, such as adhesion and viscosity, and sediment properties, in particular grain size and sorting, affect penetration and retention of oil in sediment.
- The long-term retention of subsurface oil in sediments is strongly determined by the initial oiling.

	SEDIMENT CHARACTERISTICS					OIL RETENTION (l/m^3)			
	Mean Grain Size (mm)	Minimum Porosity (%)	Clasts per m^3	Surface Area (m^2/m^3)	Grain-to-Grain Contacts (#/m^3)	Bunker C		ANSC	
						Unweathered		22% Weathered	
						2ºC	15ºC	2ºC	15ºC
Coarse Sand	0.75	36	10^8	2000	6^9	*	*	*	*
Very Coarse Sand	1.7	36	2^8	1700	10^8	*	*	*	115
Granules	3.4	37	3^7	1500	2^8	*	*	*	65
Small Pebble	6.7	35	10^5	400	8^6	*	*	75	5
Medium Pebble	14.5	36	2^5	200	10^5	*	50	30	5
Large Pebble	22	39	7^4	150	3^5	100	70	15	0
Very Large Pebble	43	40.5	10^3	100	6^4	80	5	10	0

* = limited penetration

(after Harper *et al.*, 1995)

Relative Values of Oil Penetration and Retention Potential for Various Shoreline Types

Shoreline	Wave Energy*	Oil Penetration*	Oil Retention*
Beaches			
Gravel/Cobble	M – H	M – H	L –- M
Sand/Gravel	L – H	L – H	L – M
Sand/Silt	L – M	L – M	L – M
Peat	L – M	L	L – H
Tidal Flats			
Mud	L	L	H
Sand/Silt	L	H	L
Vegetated Shores	L – M	L	M – H
Slumping Tundra Scarps	L – M	L	M – H

2.6. Oil on Shorelines

1) *Beaches*

- Mobile sediments
- Biota either mobile or deep burrowing
- Relatively few organisms
- Recovery usually rapid (<1 yr) if beach is open to wave action

2) Marshes

- Very productive environments
- Impact depends on degree of oiling: less damage if only fringes are oiled
- Recovery slower if interior areas are oiled
- Cleanup can delay recovery

3) Tidal Flats

- Rich communities of burrowing invertebrates and shore birds
- Oil not easily stranded
- BUT can fill burrows quickly
- Recovery can be slow (several years)

Part 3 Spill Management

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Part 3 Spill Management

3.1. Decision Process

Spill Response Management

- Base Concept:

  Management by Objectives

- Integral part of the Incident Command System (ICS) for Emergency Response Management

Decision Concept

- Define: Objectives
- Develop: Strategy
- Select: Methods
- Evaluate: Feasibility

Spill Response

Concept	►	Application
A Management		**Operational**
Decision		**Response**
Process		**Action(s)**

Key Points:

- Response is one of the management functions
- Field actions (operations) are part of a managed response
- Appropriate and effective field actions are implemented in the context of the response objectives

Decision Process

1. Gather *INFORMATION* and assess the situation.
2. Define response *OBJECTIVE(S)*.
3. Develop *STRATEGIES* to meet the objectives.
4. Select appropriate *TECHNIQUE(S)* or method(s) to implement the strategy.
5. Evaluate the *FEASIBILITY* of the strategies and methods in view of the environmental conditions and the nature of the spill.
6. Prepare an action or response *PLAN*.
7. Obtain appropriate *APPROVALS, PERMISSION, or PERMITS*.
8. Implement the field *RESPONSE OPERATION*.

The decision process for Shoreline Response is described in detail in Sections 4 and 6. Examples of activities within each decision step for Shoreline Protection and Treatment/Cleanup are provided in those sections, respectively.

Minimum Regret

- NOAA uses this concept in trajectory modeling to place confidence limits around their spill path estimates (e.g., most likely affected area — potentially affected area).
- Also applies to any goals and objectives set by management.
- Focus on realistic objectives, both at regional and site-specific scales.
- Avoid promising things that are unlikely to be achieved or cannot be accomplished (i.e., containment and recovery of submerged oil; or, recovering at sea all of the oil that has been spilled).
- A "minimum regret strategy" is one that reduces the possibility of:
  a) having to say "sorry", or
  b) explaining why a goal was not achieved.

  - See Galt 1995 and Lehr *et al.*, 1995.

NOAA MASS Trajectory Analysis

Printed by: **Christopherson, Sharon** Wednesday, March 5, 1997 9:02:45 AM

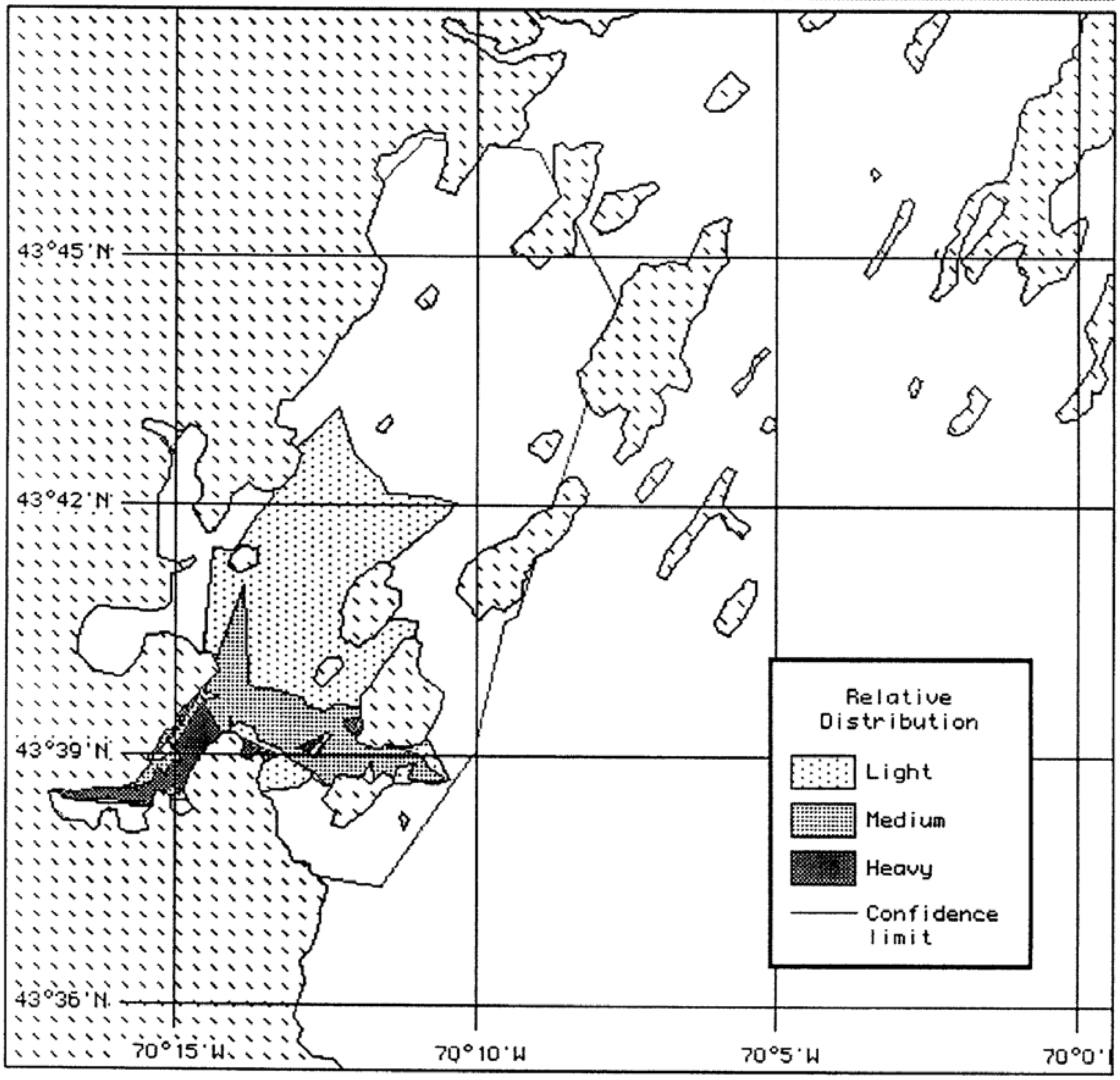
Title: **Portland.Traj 9/29-1830** Page 1 of 2

T/V Julie N Trajectory MASS Trajectory Analysis

Estimate for: 1830, 9/29/96

Prepared: 0911, 9/28/96 NOAA/HAZMAT/MASS (206) 526-6317

These estimates are based on the latest available information. Please refer to the trajectory analysis briefing and your Scientific Support Coordinator (SSC) for more complete information. This output shows estimated distributions of heavy, light, and medium concentrations as well as an outer confidence line. The confidence line is based on potential errors in the pollutant transport processes.



3.1.1. Major Players in the Decision Process

- **The Responsible Party (RP)**
  - Usually a private sector organization
  - Can be represented by lawyers or (for marine spills) ITOPF
  - Have a moral and legal responsibility
  - Typically focus on **practicality** and **cost effectiveness**
- **The Regulators ("Trustees")**
  - Federal and state agencies
  - Set the environmental standards for treatment or cleanup
  - Often quite practical and realistic and often take NEBA philosophy
  - Sometimes have conflicts of interest between responsible agencies
  - Typically an objective or scientific approach to treatment standards
- **Local Governments and Residents**
  - Represent the people who live in the affected area
  - May have zero tolerance treatment standards
  - Consider socioeconomic damages as well as amenity and aesthetic values
  - Often very subjective standards
- **The Public**
  - Politicians, the Media, NGO's
  - Not local people or organizations
  - Not part of the "team" and typically take a critical attitude rather than a supporting position
  - Usually take an emotional attitude
  - Often very non-technical standards

3.2. Sensitivity Analysis

The decision process requires input on:

a) where the oil will go, and

b) what is in the spill path, plus

c) an estimate of the effects of the oil on resources/activities at risk at the time of the spill (vulnerability) is required.

- "SENSITIVITY" is the response or reaction of a resource to the presence of oil.
- "VULNERABILITY" refers to the probability that a resource will be affected by an oil spill.

Shoreline Sensitivity

- One step in developing a response strategy (planning)
- Indices and maps generally simplistic and localized
- Often little consistency between sensitivity mapping systems
- Sensitive habitats may not be "Vulnerable" to oil (e.g., coral reefs, sea grass beds)

Perception is Reality!

- How an individual or group perceives a situation is their "reality".
- The general public uses emotional and media input in developing a perception of an oil spill and of its impact.
- Spill management must use technical support (science and technology) to develop accurate internal and external perceptions; those perceptions likely will be used to evaluate the "success" of the response operation.

Seasonality

Timing or seasonality is an important aspect of sensitivity and can affect the planning of cleanup operations.

- Timing of ecological/resource activities can —
  - cause an area to be assessed or treated before other areas (i.e., have a higher response priority), or
  - preclude operations in an area during a sensitive time period.

Environmental and Cultural Sensitive Resource Usage Periods — Prince William Sound and Gulf of Alaska (Owens, 1994)

Sensitive Resource	April	May	June	July	August	Sept.
SALMON						
— Stream — Out migration						
— Stream — Spawning						
— Fry Rearing Areas						
— Hatchery Releases						
— Commercial Fishing						
HERRING						
— Spawning and Fishing						
PINNIPEDS						
— Pupping						
— Molting						
BIRDS						
— Seabird Colonies						
— Bald Eagle Nests						
— Waterfowl/Shorebird Concentrations						
RECREATION						
— Campsites, Anchorages, Cabins, etc.						
MARICULTURE						
— Oyster Farms						
SUBSISTENCE AREAS						
ARCHAEOLOGICAL SITES						

Shaded area = times when intrusion should be limited or not occur

Summary of Shoreline Sensitivities

(adapted from Owens, Cramer, and Howes, 1992)

Shoreline Type/ Sensitive Feature	**Relative Sensitivity by Oil Class***				**Comments**
	Light, Volatile Oils	**Low Viscosity Oils**	**Medium Viscosity Oils**	**Very Viscous or Semi-solid**	
SHORE TYPE					
Exposed Bedrock	High	Moderate	Low	Low	Probability of persistence low; high biological value.
Sheltered Bedrock	High	Moderate	Low	Low	Probability of persistence high; high biological value.
Bedrock Platform	Moderate	Moderate	Moderate	Low	Probability of persistence low; high biological value.
Sand Beach	Moderate	Low	Low	Low	Low permeability except for light oils: low biological value.
Pebble/Cobble Beach	Low	Moderate	Moderate	Low	Probability of persistence generally high but varies depending upon oil class; low biological value, except in lower tidal zone (which usually has little oil deposition).
Mixed Sediment Beach	Moderate	Moderate	Low	Low	Low permeability except for light oils: low to moderate biological value.
Boulder/Cobble Beach	Moderate	High	High	Moderate	Probability of persistence high; low to moderate biological value.
Sand Flat	High	Moderate	Low	Low	Typically fine-grained sand tidal flats with migrating sand waves: exposed to winds, waves, and currents; probability of persistence generally low but varies depending upon oil class; moderate biological value.
Mud Flat	High	High	High	Moderate	Probability of persistence high; high biological value.
Marsh	High	High	High	Moderate	Probability of persistence high; high biological value.

Summary of Shoreline Sensitivities (continued)

Shoreline Type/ Sensitive Feature	Relative Sensitivity by Oil Class*				Comments
	Light, Volatile Oils	Low Viscosity Oils	Medium Viscosity Oils	Very Viscous or Semi-solid	
ECOLOGICAL FEATURE					
Mariculture Site	High	High	High	Moderate	Typically consist of clam-, oyster-, abalone-, and fish-rearing areas; sensitive all year long.
Anadromous Fish Stream	High	High	Moderate	Low	Typically sensitive during fry outmigration and spawning periods.
Pinniped/Mustelid Area	High	High	High	Low	Sea otters are particularly sensitive year-round, whereas others are less sensitive except during pupping and molting.
Spawning Ground	High	High	Moderate	Low	Sensitive during spawning periods.
Bird Rookeries or Colony	High	High	High	Low	If birds are migratory, the areas could be sensitive primarily during periods of occupation. If not, then the area would be sensitive year-round.
Wetland	High	High	High	Moderate	Sensitive year-round and especially during periods of migratory bird use.
Rare and Endangered Species	High	High	High	Moderate	Eagles, otters, whales, and other species: habitats are typically sensitive all year.
CULTURAL FEATURE					
Archaeological Site	Moderate	High	High	Moderate	Primarily sensitive to disruption or destruction by cleanup activities.
Historical Site	Moderate	Moderate	Moderate	Moderate	Primarily sensitive to disruption or destruction by cleanup activities.
Subsistence Use Area	Moderate	Moderate	Moderate	Low	Mainly sensitive only during periods of use, although food source may be affected for a longer time period.
HUMAN USE FEATURE					
Commercial Fishing Area	High	High	High	Moderate	Typically sensitive only during times of use; losses due to closure can be significant.
Sport Fishing Area	Moderate	Moderate	Moderate	Low	Typically sensitive only during times of use; very localized effect usually.
Boat Harbor/ Marina	Moderate	High	High	Low	Sensitive all year.
Recreation Area	Moderate	Moderate	Moderate	Low	Greatest sensitivity during periods of high use.
Residential Area	High	High	Moderate	Low	Sensitive all year, especially for the lighter, aromatic oils.
Commercial Waterfront	High	High	Moderate	Low	Sensitive all year, especially for the lighter, aromatic oils.

3.3. Response Priorities

Inputs to Decision(s) for Priorities

- Resources / activities at risk or oiled
- Access to affected areas / sites
- Availability of equipment / manpower
- Assessment of likely treatment effectiveness

Decision Trade-offs

A very vulnerable resource/activity may be at risk,

BUT...

If response operations are unlikely to be successful at protecting that resource/ activity,

THEN...

Consider deployment of resources to protect another (lower priority) resource/ activity where success IS likely.

Response/Priority Decision Constraints

- Availability of suitable resources
- Accessibility and trafficability
- Weather-marine conditions
- Timing of ecological / resource activities *

* these may control windows of opportunity

Response Priority Matrix

RESOURCE / ACTIVITY VALUE	RESPONSE EFFECTIVENESS: Good	Average	Poor
Very High	1	4	7
High	2	5	9
Moderate	3	6	11
Low	8	10	14
Very Low	12	13	15

Response/Priority Planning

Levels of Concern for Regional Strategic Response Planning

- **Absolute Concern:**

  threat to human health and/or safety.

- **Primary Concern:**

  countermeasure response necessary for all types of spills at any time of the year.

- **Primary Concern (seasonal)**:

  countermeasure response necessary at certain times of the year only.

- **Secondary Concern:**

  countermeasure response likely to be necessary at certain times of the year.

- **Tertiary Concern:**

  no known potentially serious biological or human activity disruptions:

  — countermeasure response probably not required.

3.4. Feasibility and Net Environmental Benefit

❖ Feasibility includes an evaluation of (1) the safety factors and (2) the practicality of achieving the objectives.

❖ Part of this *DECISION PROCESS* is to consider the proposed action(s) in terms of (3) the effects these activities will have on the area to be cleaned or treated.

❖ Any response action will have an effect either directly, by the protection or treatment actions themselves, or indirectly, by the associated support activities, on the shore zone or the adjacent backshore.

❖ The aim of a response is to mitigate the impact of the spilled oil and to accelerate natural recovery.

Recovery:

❖ The ecosystem is never static.

❖ After a damaging event, recovery has occurred when —

< approx. the same types of species —

< in the same relative numbers —

< use the habitat in a similar manner —

< when compared to the pre-spill conditions.

❖ Unlikely to return to the exact pre-spill status.

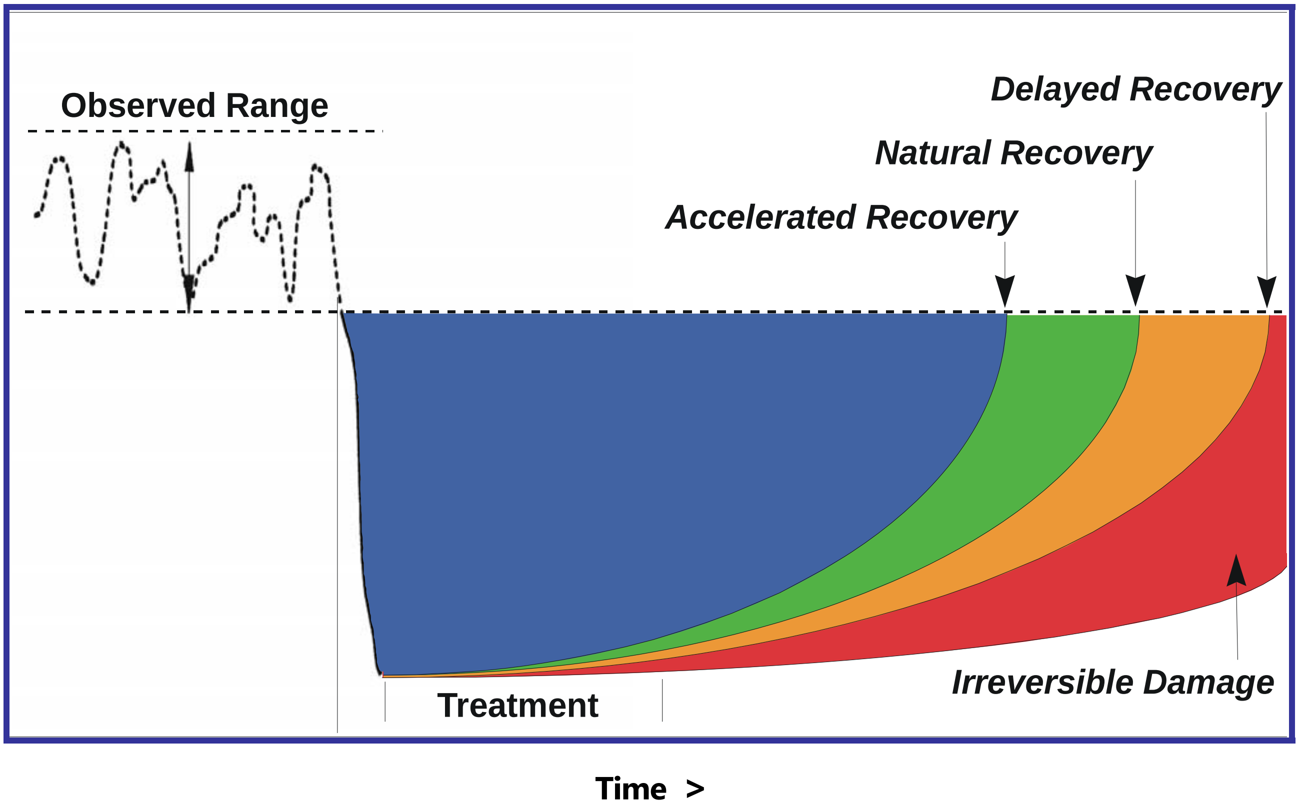
> A study (Sell *et al.*, 1995) found that, in most cases, on *ROCKY SHORES* and *SALT MARSHES*, cleanup did not promote ecological recovery — the exception being with large amounts of viscous oil.

❖ If the proposed actions likely would delay, rather than accelerate, that rate of recovery at a location, then the objective would not be met and alternate objectives and strategies would be considered (Baker, 1995, 1997).

> The concept is called ***NET ENVIRONMENTAL BENEFIT (N.E.B.)*** and was first used to evaluate a rock-washing proposal in 1990 after the *Exxon Valdez* spill in Alaska.

Net Environmental Benefit and Recovery

Net Environmental Benefit attempts to forecast accelerated, delayed, or irreversible damage.



Recovery

- **Accelerated Recovery**

conditions return to the same range in a shorter time span as a result of treatment

- **Delayed Recovery**

conditions take longer to return to the same range as a result of treatment

- **Irreversible Damage**

conditions will not return to the same range due to treatment or cleanup actions

Net Environmental Benefit and Recovery

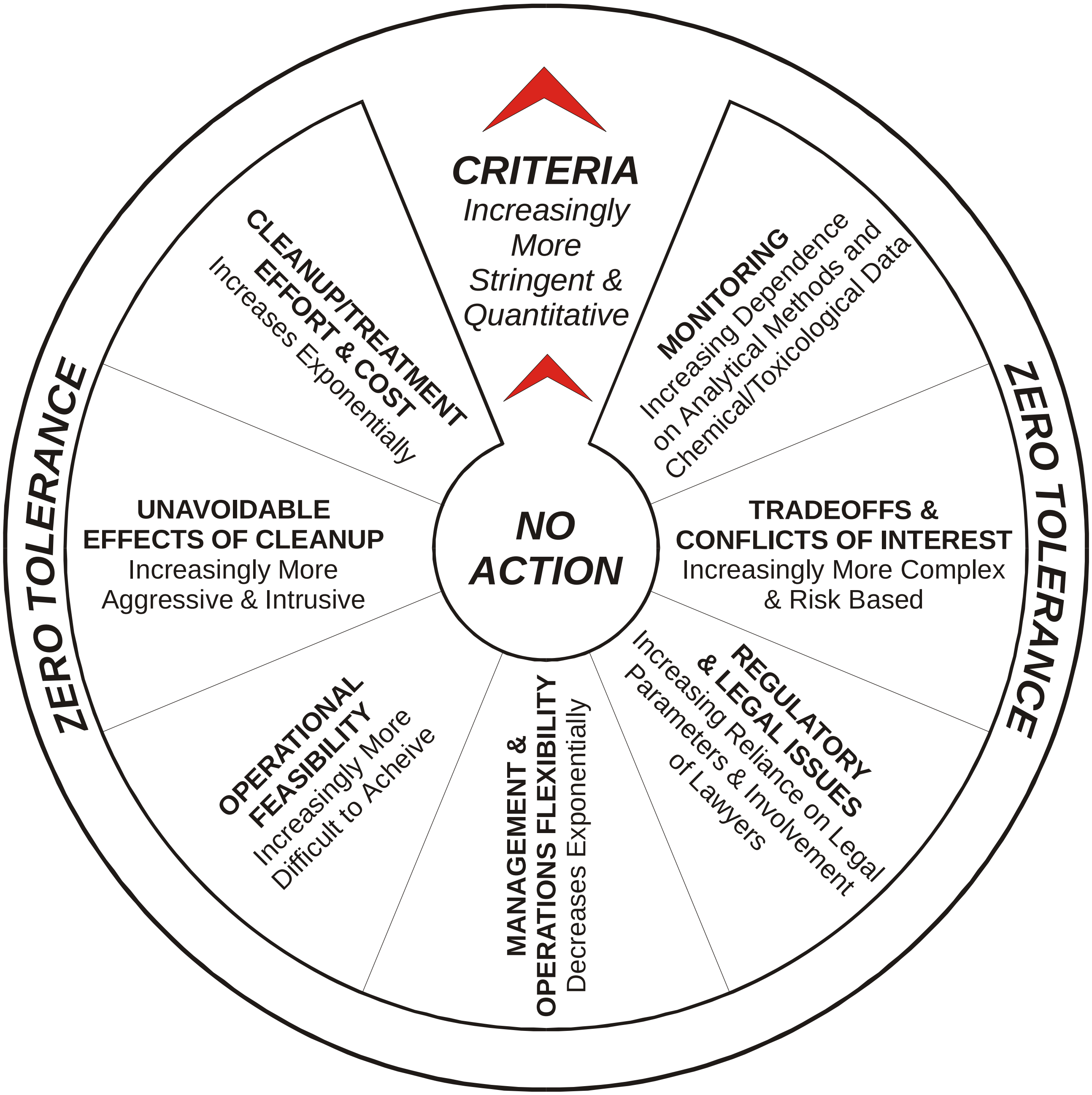
- The concept of net benefit also can be taken farther:
  - a level of treatment may accelerate recovery up to a point — beyond that point, further actions or attempts to remove more oil may begin to delay recovery.

Recovery "Rules of Thumb"

- As treatment level of effort increases:
  - oil removal efficiency DECREASES
  - damage to biota INCREASES
- i.e., the more energy it takes to remove the oil, the greater the degree of environmental intrusion
- Both diminishing economic and environmental returns

- Knowing at what point a positive benefit turns to a negative one is a key aspect of the feasibility evaluation.

Cleanup Standards Summary



3.5. When is Cleanup Completed ?

"Clean" is not a physical description, but an economic, legal, ethical *and* physical description.

How Clean
is
"Clean"
?

Shoreline probably was not
"Clean"
Before Spill
– Nor –
Will it be After Treatment.

Response/Cleanup ends when all responsible parties agree that:

- Sufficient appropriate treatment has been completed
- Further activities may cause a *Negative* **Net Environmental Benefit (N.E.B.)**

For a discussion of treatment criteria and standards, see:

Michel, J., and Benggio, B., 1999. Guidelines for selecting appropriate cleanup endpoints at oil spills. *Proc. 1999 Oil Spill Conference*, Seattlle, WA.

— and —

Owens, E.H., and Sergy, G.A., 2003. Treatment Criteria and End-Point Standards for Oiled Shorelines and Riverbanks. Environment Canada Technical Report EE-171, Ottawa Ontario. 45 pp. and 2008 IOSC Proceedings.

3.5.1. METHODS for Assessing Completion of Shoreline Treatment or Cleanup

- **Qualitative Field Observation**
- **Quantitative Field Measurements**
- **Analytical Measurements**
- **Interpretive Assessments**

1) Qualitative Field Observation — Methods

- Describes oil presence, character or behavior on the shoreline
- Visual observations
- Ground-level camera / videotape images
- Aerial observations, photography or videotape images

1) Qualitative Field Observation — Examples

- Presence of oil (tar balls, tar patties
- Presence of oiled debris or vegetation stranded on a shore that could affect wildlife
- Presence of oiled sand that produces rainbow sheen
- Presence of mobile or liquid oil
- Presence of oil that could be remobilized
- Presence of recoverable floating oil

2) Quantitative Field Measurements — Methods

- Based on visual observations and measurements on the quantity of oil, e.g. %, distribution, size, thickness
- Mapping or surveying with standard terminology to obtain a systematic database (SCAT)

2) Quantitative Field Measurements — Examples

- Presence of 100% surface oil patches >3-mm thick, and 50x50 cm across
- Presence of >20% surface oil cover >10-m long, >1-m wide, and >3-mm thick
- Presence of liquid oil patches >1-m diameter that could be remobilized
- Presence of 30% coat
- Presence of 5% stain
- Presence of 30% of vegetation stems with weathered oil or stains
- Presence of 10% of vegetation stems with unweathered (fresh or sticky) oil

3) Analytical Measurements — Methods

1) Chemical
2) Toxicological
3) Organoleptic

3) Analytical Measurements — Chemical Examples

- Specific pre-defined concentration of individual constituents or compounds (e.g., 0.002 mgl-1 of benzene in water sample: 500 ppm hydrocarbons in a water or sediment sample: <100 ppm tph at a 500-foot interval on a sand beach)
- US EPA and state primary maximum contaminant levels (pMCL) for BTEX

3) Analytical Measurements — Toxicological Examples

- 96-hour LC50, LL50 and TLm's for local fish species
- Chronic EC 20 value for BTEX, naphthalene and gasoline range hydrocarbons
- Acute to Chronic toxicity ratios for local fish species spawning habitat
- Acute to Chronic toxicity ratios for non-critical habitats
- US EPA limits for toxicity characteristic leaching procedure for benzene (TCLP-benzene) and metals

3) Analytical Measurements — Organoleptic Examples

- "Oil odor" in beach sediments
- Shellfish taint test

4) Interpretive Assessment — Methods

- Evaluation of the broader system – including environmental, social, economic and/or cultural factors
- Multi-factor synthesis using qualitative, quantitative and/or descriptive indicators

4) Interpretive Assessment — Examples

- Is the remaining oil likely to have an unacceptable ecological, aesthetic, recreational, or economic impact ?
- Will further oil removal cause environmental damage (NEB approach)?
- Are the costs of further cleanup or treatment excessive with respect to the threat or benefit ?

3.5.2. Example of "Sign-Off" Procedure

(from M/V Kure Spill, Humboldt Bay, CA, November, 1997)

Procedures for Completion of Unified Command Shoreline Treatment Operations

Shoreline Inspection

All oiled shorelines will be inspected using agreed upon cleanup guidelines. The Unified Command inspection team will be comprised of representatives of the Federal On-Scene Coordinator (FOSC), the California Dept. of Fish and Game, the appropriate landowner trustees, and the Responsible Party. The representatives assigned to the inspection team must have authority to either continue or discontinue shoreline treatment. Inspection team members should also be SCAT qualified and preferable have participated in SCAT for this incident. Continuity of team members is to be maintained to the extent possible in order to facilitate consistency and efficiency.

Inspection Phase I

Following notification by the Operations Chief that shoreline segments have been cleaned to the degree recommended by the Unified Command, the inspection team will evaluate segments to determine whether they satisfy agreed upon cleanup guidelines. The inspection team must reach consensus that no further cleanup is necessary.

Inspection Phase II

After a period of approximately six weeks (first week of January, 1998), the inspection team will re-inspect the shoreline to determine if there is agreement that the segments require no further treatment. If consensus is not reached, additional cleanup operations and a schedule for subsequent inspection will be specified.

Cleanup Re-initiation

If additional oil is discovered or if future conditions change such that further cleanup actions are necessary, cleanup operations will be re-initiated as recommended to the Responsible Party by the U.C. Coast Guard or California Dept. of Fish and Game.

Criteria for Completion of Shoreline Treatment

Shoreline Inspection Guidelines (Humboldt Bay Oil Spill, November 1997)

The shoreline inspection team will determine when each shoreline segment has been cleaned to a reasonable* degree, based on minimizing risk of impact to the environment and preventing human contact with the spilled oil. The following guidelines provide criteria for assessing shoreline status.

Water Surface
No recoverable floating oil should remain on the water surface.

Sand Beaches
The shoreline should be free of liquid oil. Tarballs, tar patties, oiled stranded eelgrass wrack, and oiled debris that could contaminate wildlife should be removed — to the extent removal using reasonable cleanup techniques is feasible. Oil stain on sand that does not produce rainbow sheen may be allowed to weather and degrade naturally.

Marshes
Marsh vegetation should be free of oil that could contact and contaminate wildlife. Oil that is not likely to affect wildlife may be allowed to weather and degrade naturally.

Riprap and Seawalls
Oil riprap and seawalls should be free of bulk oil except for oil stain (defined as a thin layer that cannot be scraped off using a fingernail), which may be allowed to weather and degrade naturally.

* *Reasonable*, for the purposes of these shoreline inspections, is defined as when further shoreline treatment would not yield a net environmental benefit.

3.6. Guidelines for the Selection of Treatment Standards and Cleanup Endpoints for Oiled Shorelines

These guidelines are intended to provide direction and assistance in the selection of treatment criteria and end-point standards for oiled shorelines and riverbanks (Owens and Sergy, 2003b). The guidelines provide an overview of some basic concepts, principles, rules of thumb, and examples that may be of assistance in the decision process.

Purpose of End-Point Standards

Primary Reasons

1. Assist the spill management team in the selection of the treatment objectives and treatment techniques for a specified area before the response operation begins;
2. Provide operations with a clear objective or target so that they can tailor their activities towards a known point of completion; and
3. Provide an inspection team with treatment criteria and standards upon which to evaluate the results of the treatment activities and to reach closure.

Secondary Reasons or Benefits

1. Facilitate a recognition and assessment of all of the various environmental, social, and economic factors that are important and that should be considered in the shoreline treatment or cleanup decision process and in the selection of response options that are appropriate and practical.
2. Facilitate recognition of concerns within, and attempt to create a consensus between, various responsible parties and stakeholders.

The Basic Decision Process

The process begins before the shoreline or riverbank treatment operation plans are developed, as the level of operational effort cannot be calculated without knowledge of the completion standard(s).

STEP 1. Divide the impacted shoreline or river into segments[a] based on information on the physical and ecological character of the area and on the oiling conditions.

STEP 2. Define the issues and objectives that will drive the selection of treatment criteria and treatment end-point standards for each segment.

STEP 3. Select the treatment standards for each segment.

STEP 4. Ensure that Operations understand the issue(s), the treatment objectives, and the end point standard for each segment.

STEP 5. Ensure that Operations agree that the criteria or standard are appropriate and practical and that they can be achieved

STEP 6. Consider that more than one set of standards or end points may be appropriate within one segment based on the use of a number of sequential treatment actions or methods.

STEP 7. Consider a phased completion approach with a first inspection and a later revisit to ensure that the required or expected conditions are achieved and/or maintained.

End-Point Guidelines

- Assume that different criteria and standards will apply to different segments.
- There may be more than one set of treatment criteria and standards within one shoreline segment, or during different response phases for a segment.
- Individual standards and endpoints, even the same ones, can be applied to different environmental components, e.g., to water, vegetation, sediments, surface and subsurface, intertidal and subtidal.
- There is no uniform or standard approach that can be applied universally. Treatment criteria or standards typically vary from one spill to another, depending on the unique features of the incident, and typically also vary within a single response operation as impacts and risks often are not uniform within the affected area.
- One end point or standard may be the trigger for further treatment in one segment and the standard for completion in another.
- Even with a clearly defined standard, a judgment call may be required from the spill management team.

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[a] Segment: A distinct alongshore section of shoreline or river that can be used as operational unit. Segments are relatively homogeneous in terms of physical features and sediment type and are bounded by prominent geological or operational features, or by changes in shoreline type, substrate type, or oiling condition. See Owens and Sergy (2000a) for more information.

Part 4 Resource Protection

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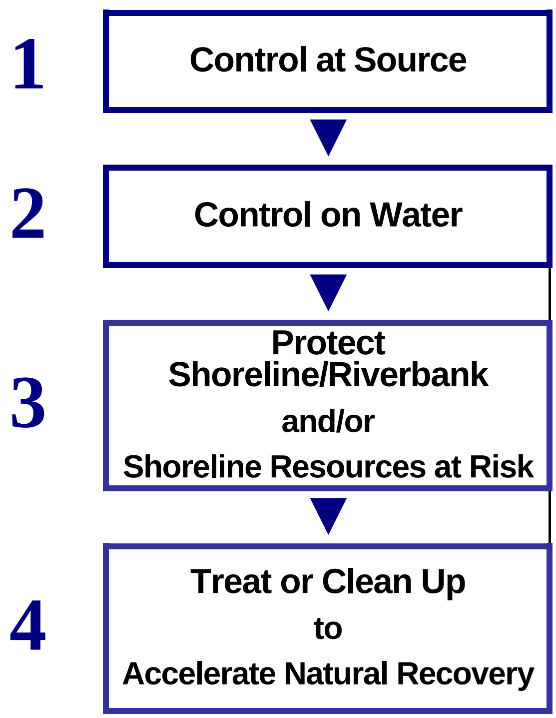
Part 4 Resource Protection

4.1. Introduction

Protection or Treatment operations are the fallback positions during a spill response after source control and/or control on water.

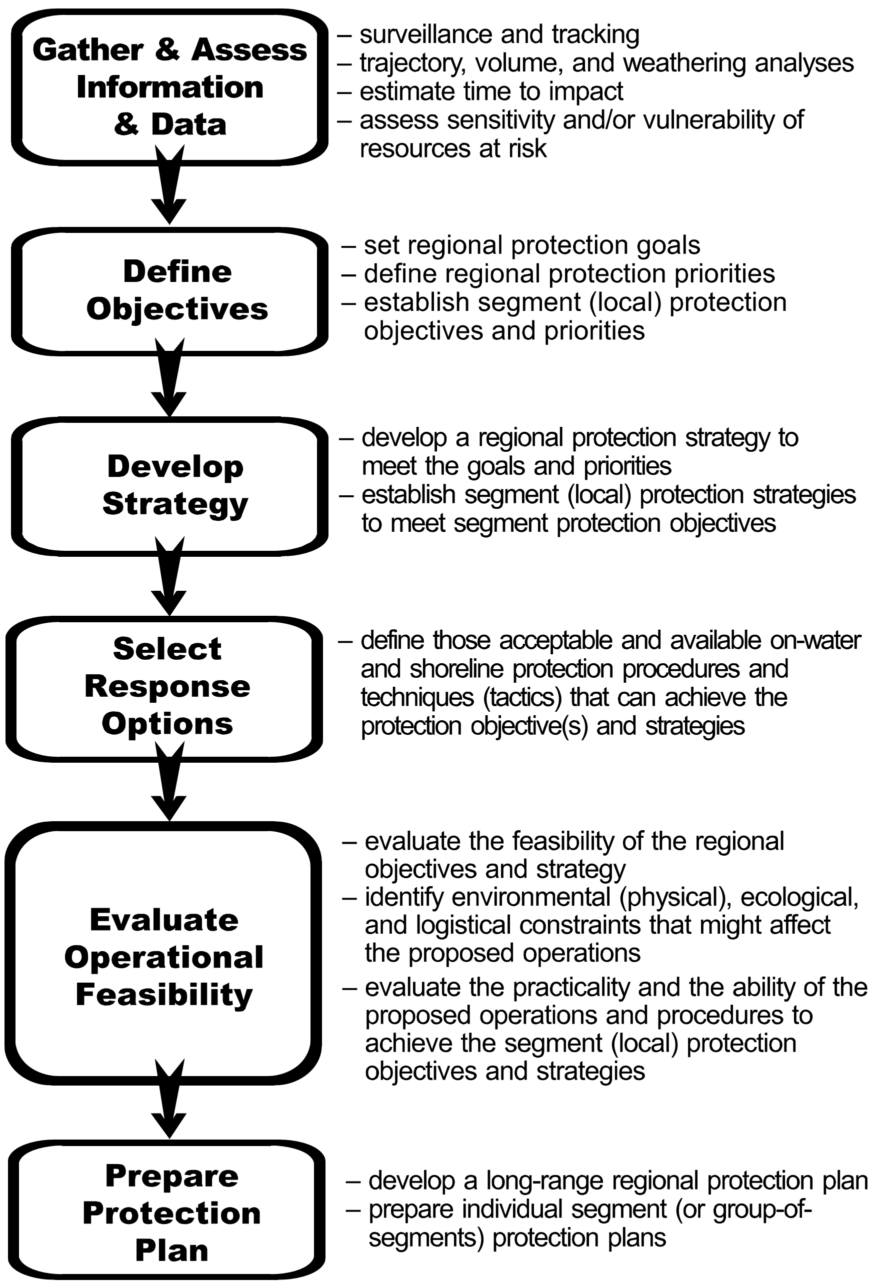


(Owens, 1996)

- The *OBJECTIVE* of a *spill response* is to ***minimize further impacts to the environment and public health***.
- The *OBJECTIVES* of *on-water containment and recovery* (either control at source or control on water) are to ***minimize the spreading of the oil and to minimize the affected area***.
- The *OBJECTIVE* of *protection actions* is to ***prevent or minimize the contact between the oil and a resource or resources at risk in the spill path***.
- The *OBJECTIVE* of *shoreline treatment* is to ***accelerate the recovery of oiled shorelines and riverbanks***.

4.2. Protection Decision Process

Management by objectives is achieved by a decision process that follows a sequence of steps (from Owens, 1996):



Objectives

Protection is defined as those response activities that take place at or near the shoreline or riverbank, rather than on open water.

The *OBJECTIVES* of response actions for the protection of a shoreline or riverbank can include:

- ❑ prevent contact between oil and the shore/riverbank or a resource at risk in the shore/riverbank,
- ❑ minimize the degree of contact between oil and the shore/riverbank or a resource at risk at the shore/riverbank,
- ? prevent the movement of oil alongshore, or downstream into adjacent shore-zone areas or adjacent resources at risk,
- ? contain stranded oil at the shoreline or riverbank,
- ? prevent the movement of oil downstream or into an inlet or channel
- avoid causing more damage in responding to the spill than the oil would cause alone,
- use available resources in a safe, efficient, and effective manner,
- minimize the generation and handling of waste materials.

SELECT ONE OF THE FIRST TWO OBJECTIVES (□) to define the urgency or importance of a protection operation for the segment. Then identify which of the next three (**?**) also might apply to the segment.

- The last three objectives (•) are generic and apply to *all* response operations.

Strategies

The protection objectives can be achieved by the development of a number of specific *OPERATIONAL STRATEGIES*, which include:

- altering the direction of movement of the oil on the water,
- containing and recovering oil on the water prior to shoreline or sensitive area impact,
- preventing the movement of oil landward in a channel during a flooding tide,
- trapping or containing and collecting oil at the shoreline,
- preventing oil being washed over a beach into a lagoon or backshore area,
- preventing stranded oil from remobilizing to affect adjacent shoreline areas,
- removing shoreline debris before the oil is washed ashore.

Strategies for Rivers

- always thinking ahead — downstream!
- factoring time and distance to identify defensive positions (ahead of the oil),
- containing and recovering oil prior to sensitive area impact,
- altering the direction of movement of the oil on the water (diverting toward the opposite bank or towards the center of the river, etc.),
- diverting or deflecting oil into low-flow sections for entrapment and collection,
- considering rising or falling water level,
- preventing oil being washed over the riverbank (overbank flooding),
- preventing stranded oil from remobilizing to affect adjacent downstream areas,
- removing shoreline debris and vegetation before the oil reaches the area.

Strategies \ Objectives	Prevent contact	Minimize degree of contact	Prevent alongshore movement of oil	Contain stranded oil at shoreline	Prevent oil transport into inlet, channel
Contain/recover oil on water	✓	✓	✓		✓
Alter direction of oil on water	✓	✓	✓		✓
Prevent oil movement in channel(s)		✓	✓		✓
Trap or contain & collect oil at shoreline			✓	✓	✓
Prevent remobilization			✓	✓	✓
Prevent overwash into backshore/lagoon		✓		✓	
Pre-impact debris removal			✓	✓	

(Owens, 1996)

Feasibility

The *FEASIBILITY* of a selected shoreline protection strategy is considered in the context of environmental constraints, both physical and ecological, that may affect the likely success of a proposed activity.

Examples of constraints to be evaluated include:

- is access by water affected by rocks, debris, vegetation, man-made structures, etc.,
- is there direct backshore access to the shore/riverbank,
- what is the channel width (widths greater than 150 to 300 meters will generally preclude using booms to completely contain oil floating in the waterway, particularly if strong currents are present),
- is the shoreline exposed to storm or wave or high boat wake action,
- are strong currents (>0.5 m/s) usually present in the area,
- is winter ice likely to be a factor on the water or the shore.

4.3. Protection Options

The *PROTECTION METHODS* or response actions that can be used to implement these strategies include:

- ***On Water***
  - Containment Booming and Recovery of Oil
  - Redirection and Recovery of Oil
    - Away from the Shore or Riverbank (recovery optional)
    - Towards the Shore or Riverbank
  - Exclusion Booming
  - Control or Recovery of Submerged Oil
- ***At the Shoreline or Riverbank***
  - Recovery of Oil
    - Shore-seal or River Boom
    - Barrier, Berm, or Sump
  - Exclusion of Oil
    - Contact Barrier
    - Channel Boom, Barrier, or Dam

(Owens, 1995)

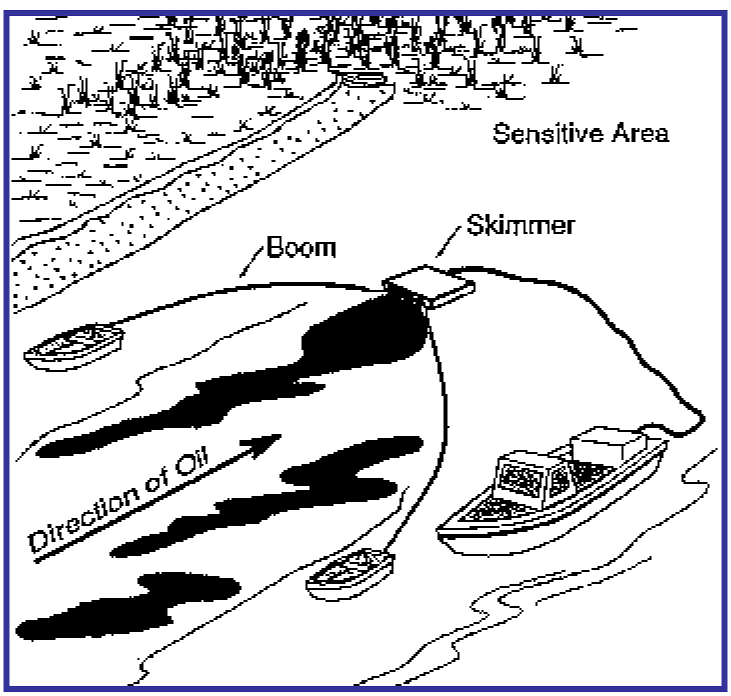
Protection usually involves a combination of two or more strategies and methods. Booms are rarely used singly, and two or multiple booms usually are necessary to contain, redirect, or exclude oil.

Strategies	Methods: On-Water – Nearshore containment and recovery	Nearshore **redirection** away from shore/recovery	Nearshore **redirection** towards shore/recovery	Nearshore **exclusion** booming	Methods: On Land – Shoreline boom containment/**recovery**	Shoreline barriers or berms/sumps & **recovery**	**Contact** barriers	**Exclusion** shoreline boom or barrier/recovery
Contain/recover oil on water	✓	✓		✓				
Alter direction of oil on water	✓	✓	✓	✓	✓		✓	✓
Prevent oil movement in channel(s)	✓	✓	✓	✓				✓
Trap or contain & collect oil at shoreline			✓		✓	✓		
Prevent remobilization						✓		
Prevent overwash into backshore/lagoon		✓			✓	✓		✓
Pre-impact debris removal			✓		✓	✓		✓

(Owens, 1996)

Nearshore (on-water) containment of oil.

(from Owens, 1995)



Decision Guide for Inland Water Containment Techniques

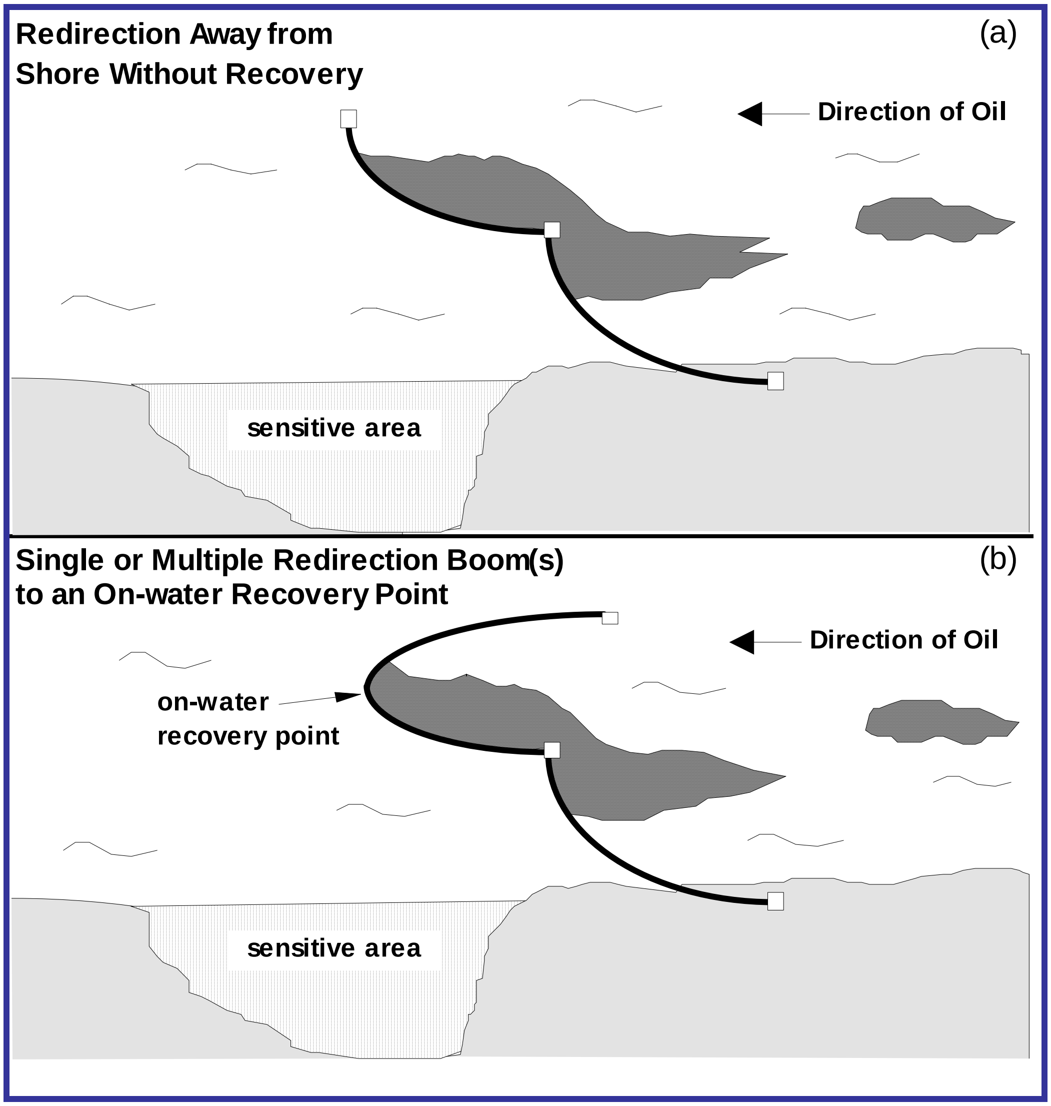
(modified from Exxon, 2002)

Water Body		Current Speed	Technique
Rivers or Large Streams greater than ½ meter deep	Water Current Speed	Less than 0.5 m/s (1 knot)	Containment Booming or Exclusion Booming
		Between0.5 and 1 m/s (1 and 2 knots)	Single Diversion Boom
		Greater than 1 m/s (2 knots)*	Multiple Cascading Diversion or Fast Current Booms
Small Streams less than 10 meters wide and greater than ½ meter deep	Water Current Speed	Less than 0.5 m/s (1 knot)	Sorbent Barrier, Containment Booming, Berms, or Dams
		Between 0.5 and 1 m/s (1 and 2 knots)	Single Diversion Boom, Berms, or Dams
		Greater than 1 m/s (2 knots)*	Multiple Cascading Diversion Booms, fast Currents Booms, Berms or Dams
Shallow Rivers or Streams less than ½ meter deep			Barriers, Berms or Dams on Stream Bed

* If current speed exceeds 3 knots, booming should be attempted at an alternate location where currents are slower.

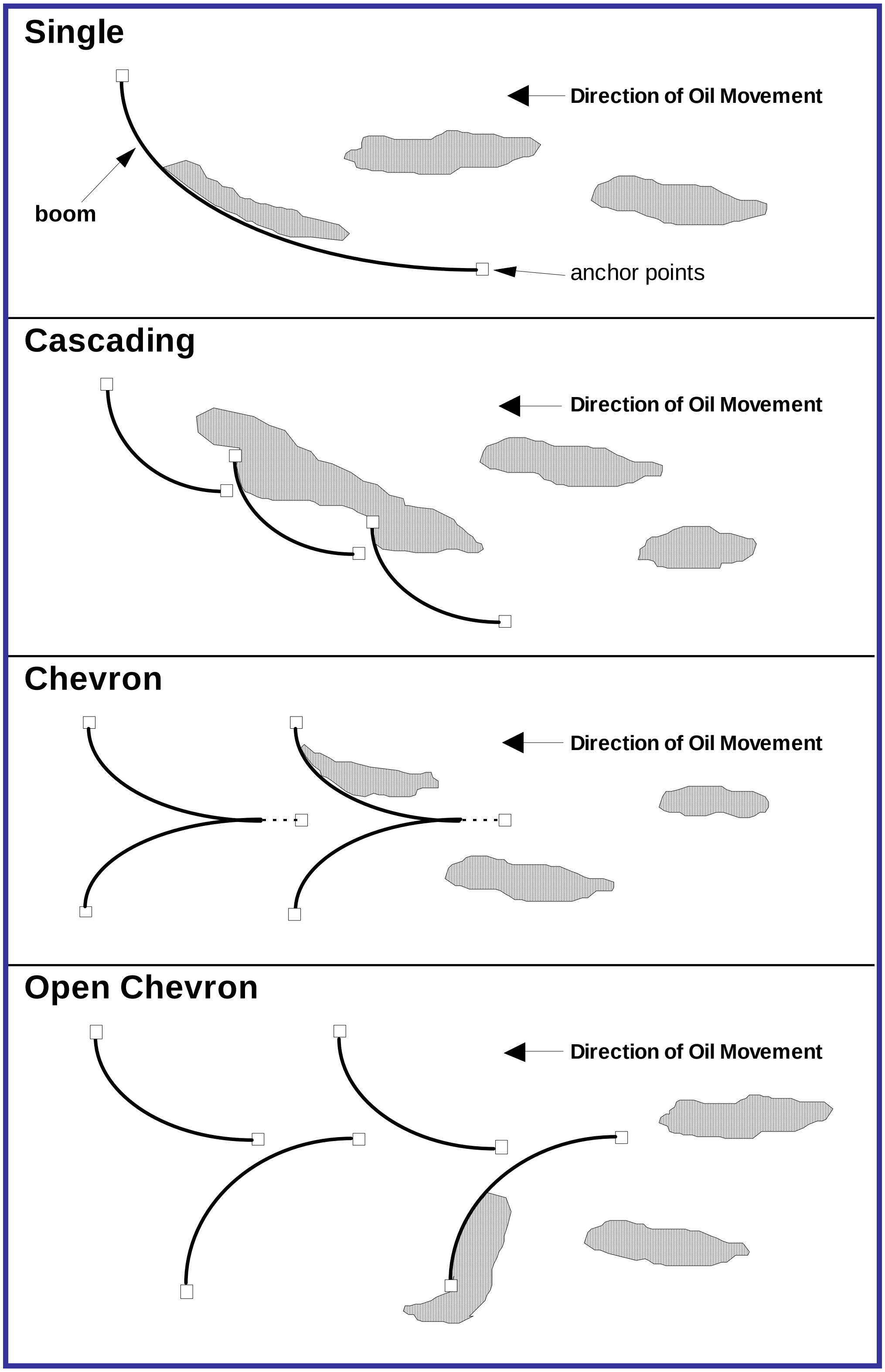
Redirection Booms

(from Owens, 1996)



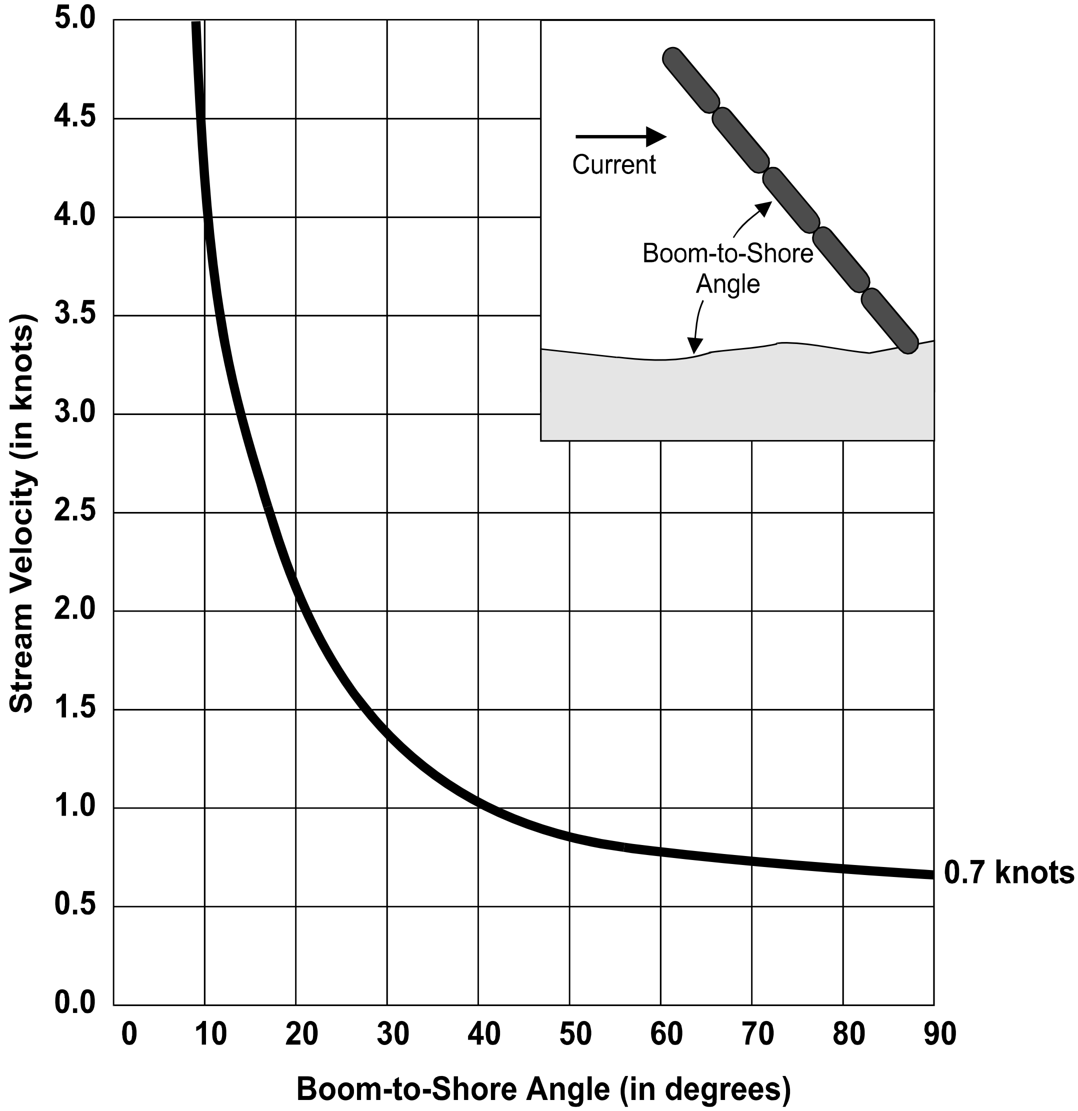
On-water redirection boom configurations.

(from Owens, 1996)

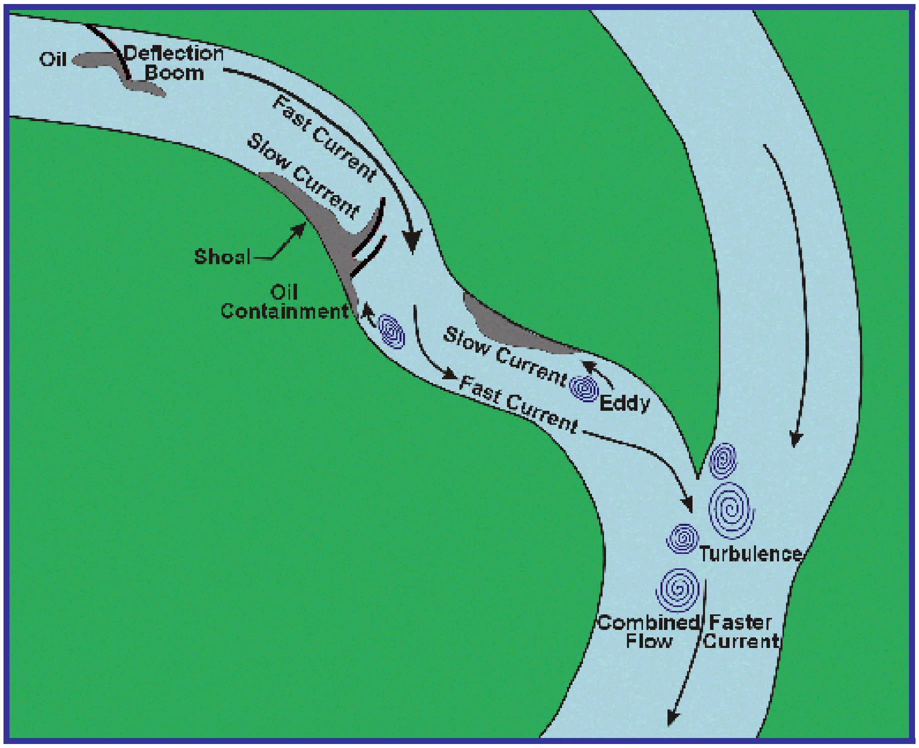


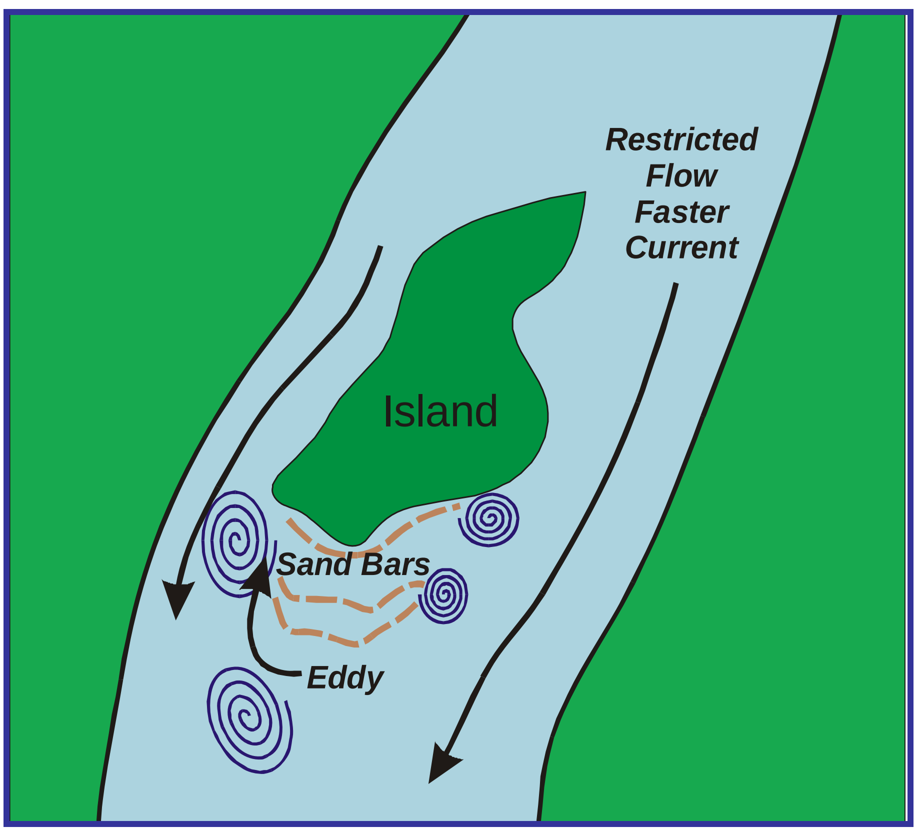
Shoreline boom deployment angles for on-water redirection booming.

(after CCG, 1995)



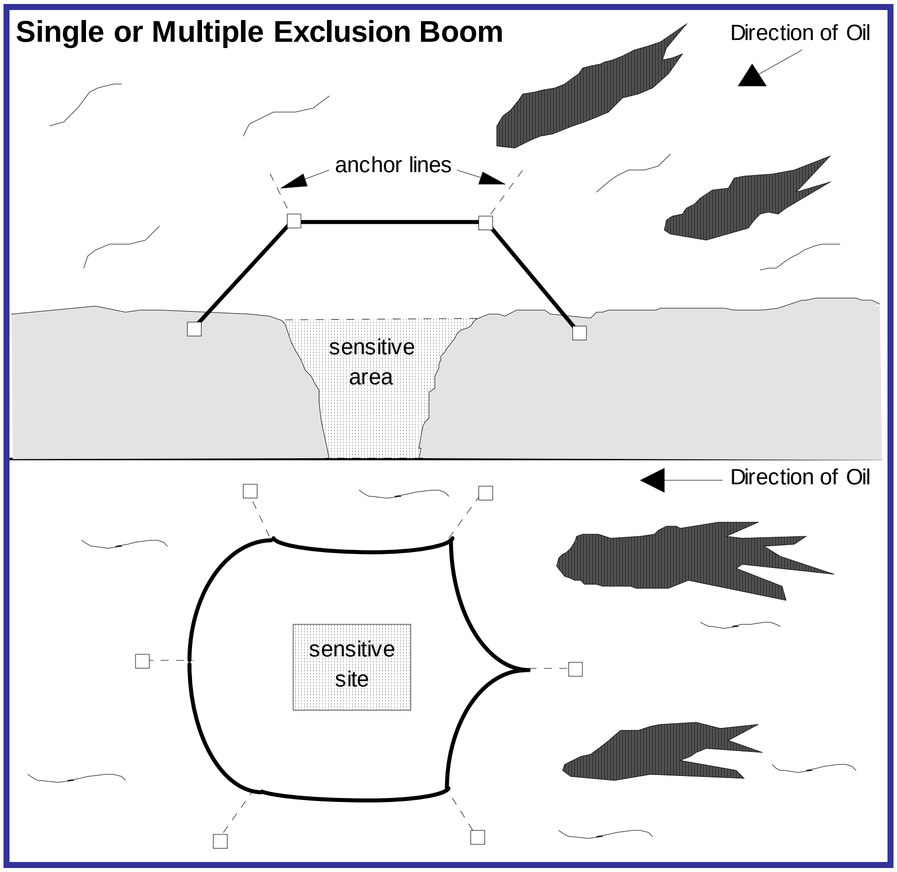
Typical river flow patterns and boom deployments. (after Hansen and Coe, 2001)





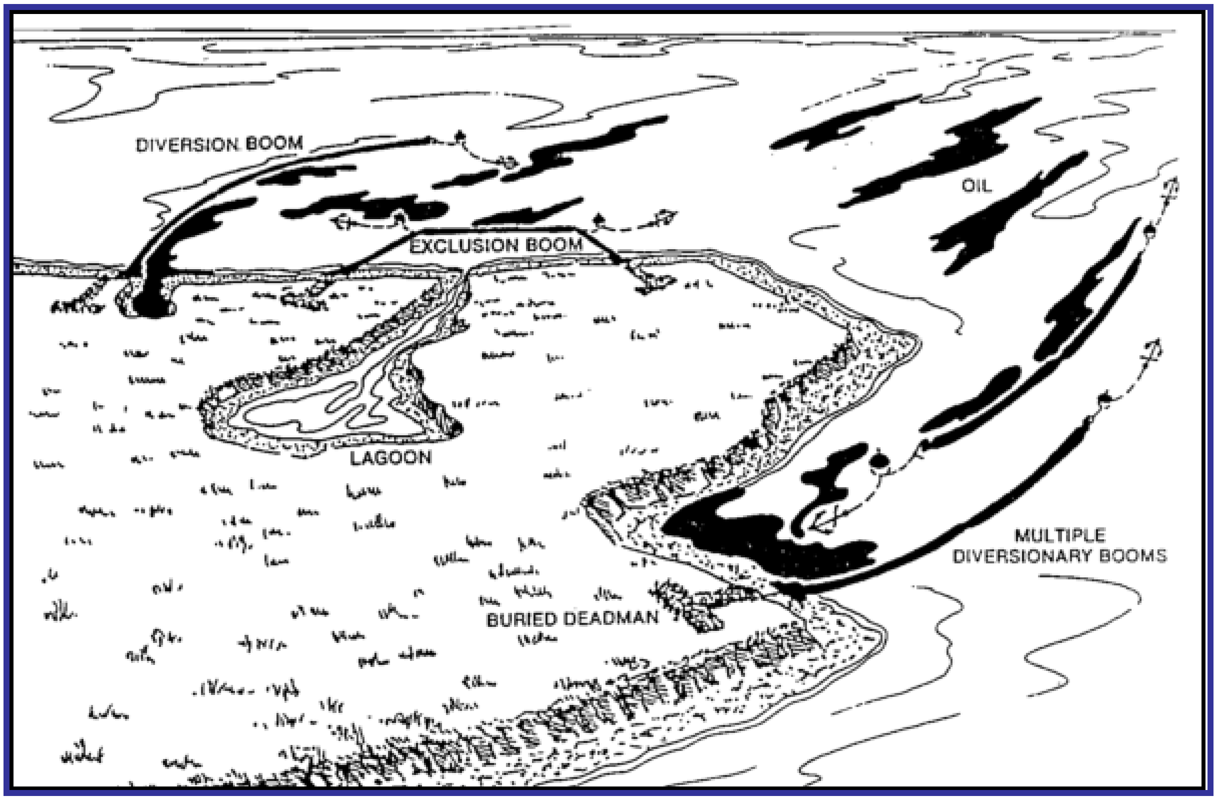
Exclusion Booms

(from Owens, 1996)



Examples of redirection and exclusion boom deployment.

(from Oil Industry Task Group, 1984)



Sawmill Bay deployment plan.

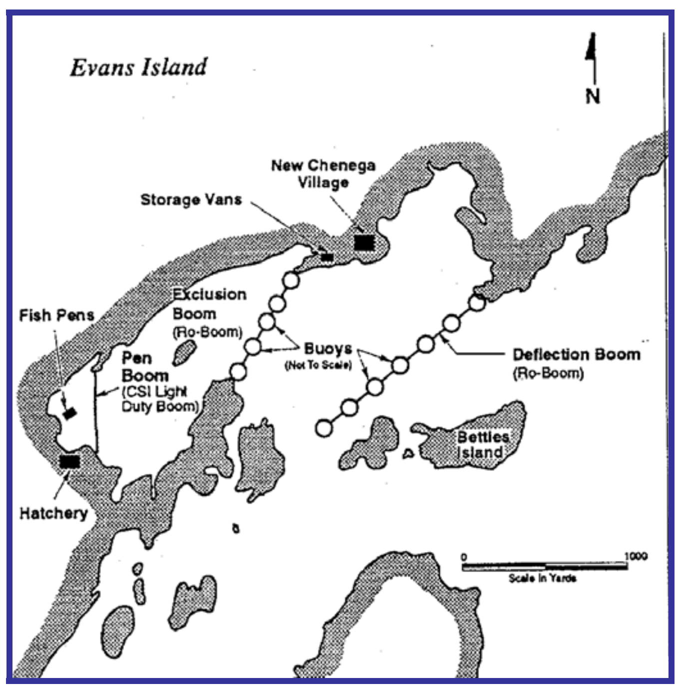
Three lines of protection against oil spills:

(1) deflection boom (1st line of protection),

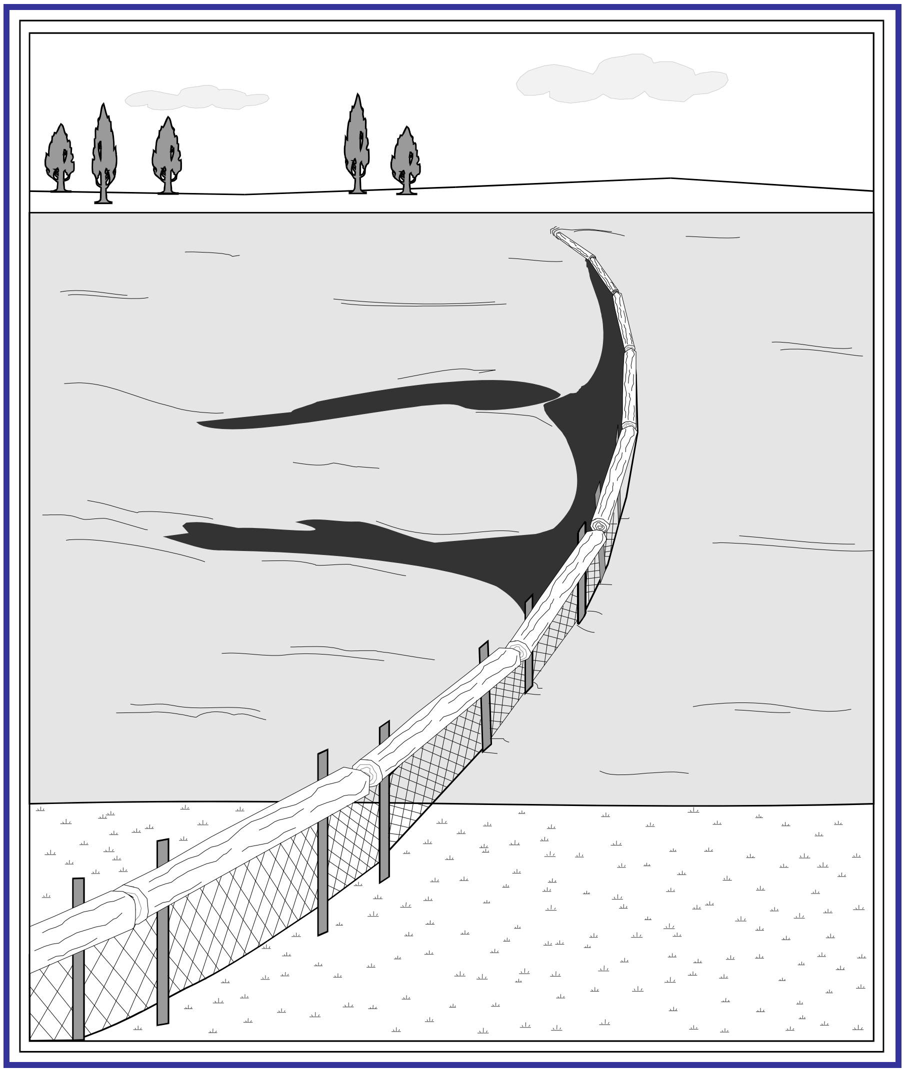
(2) exclusion boom (2nd line of protection), and

(3) pen boom (3rd line of protection)

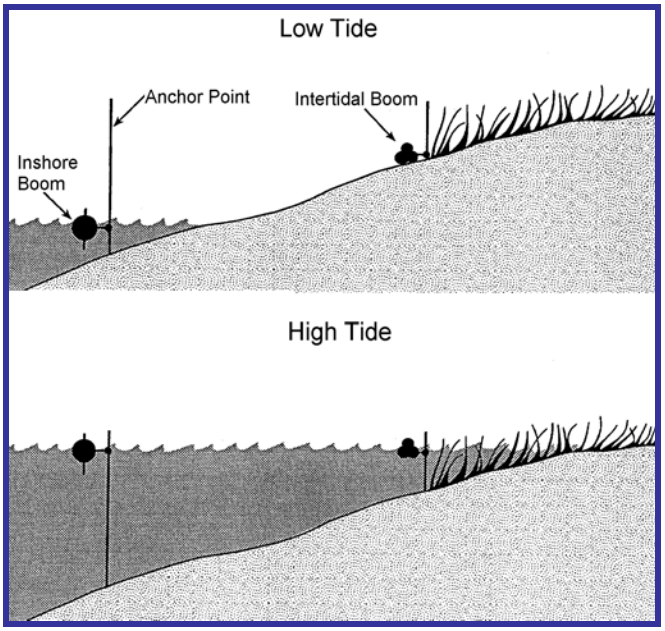
(Sawmill Bay in Prince William Sound, Alaska; from PWS Tanker Plan, 1994)

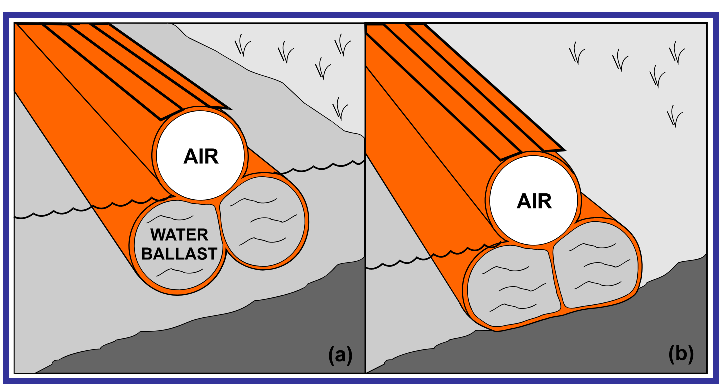


Improvised redirection boom made from logs, rope, wire. (after ITOPF, 1987)



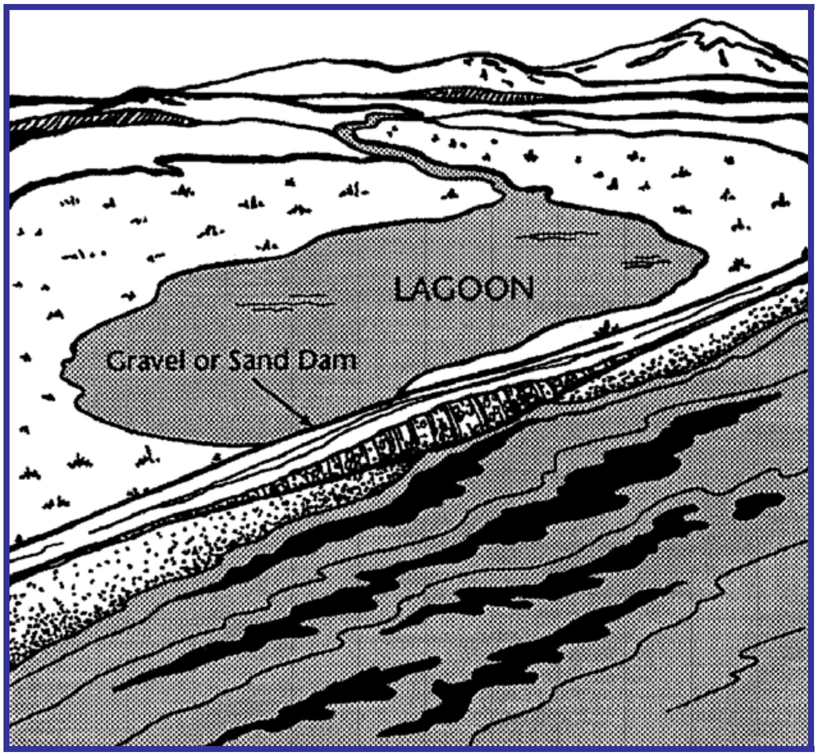
Shoreline or Intertidal Booms



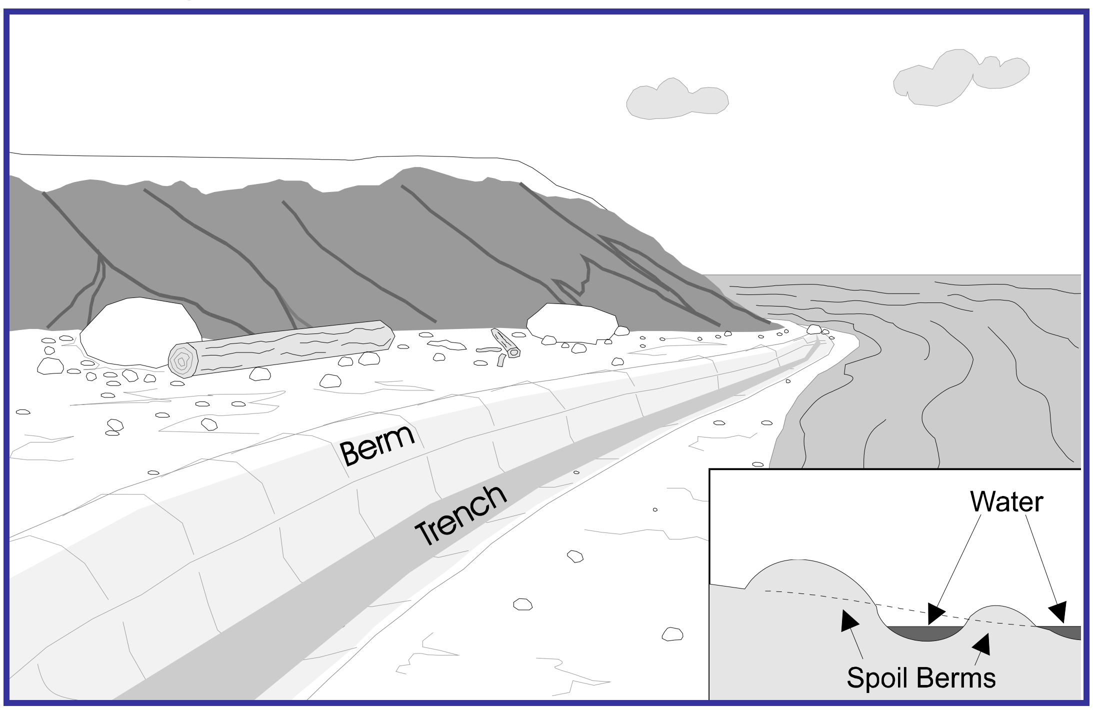


(from Owens, 1996)

Exclusion dam. (after ABSORB, 1981)

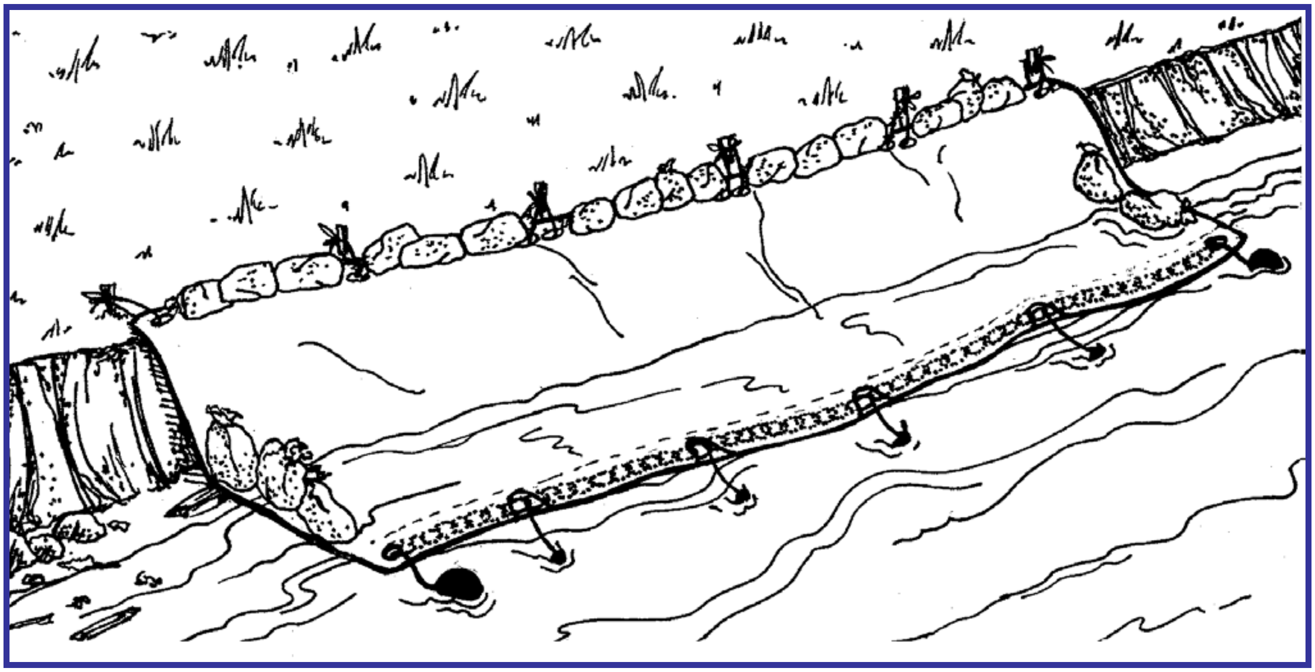


Berm along shoreline.



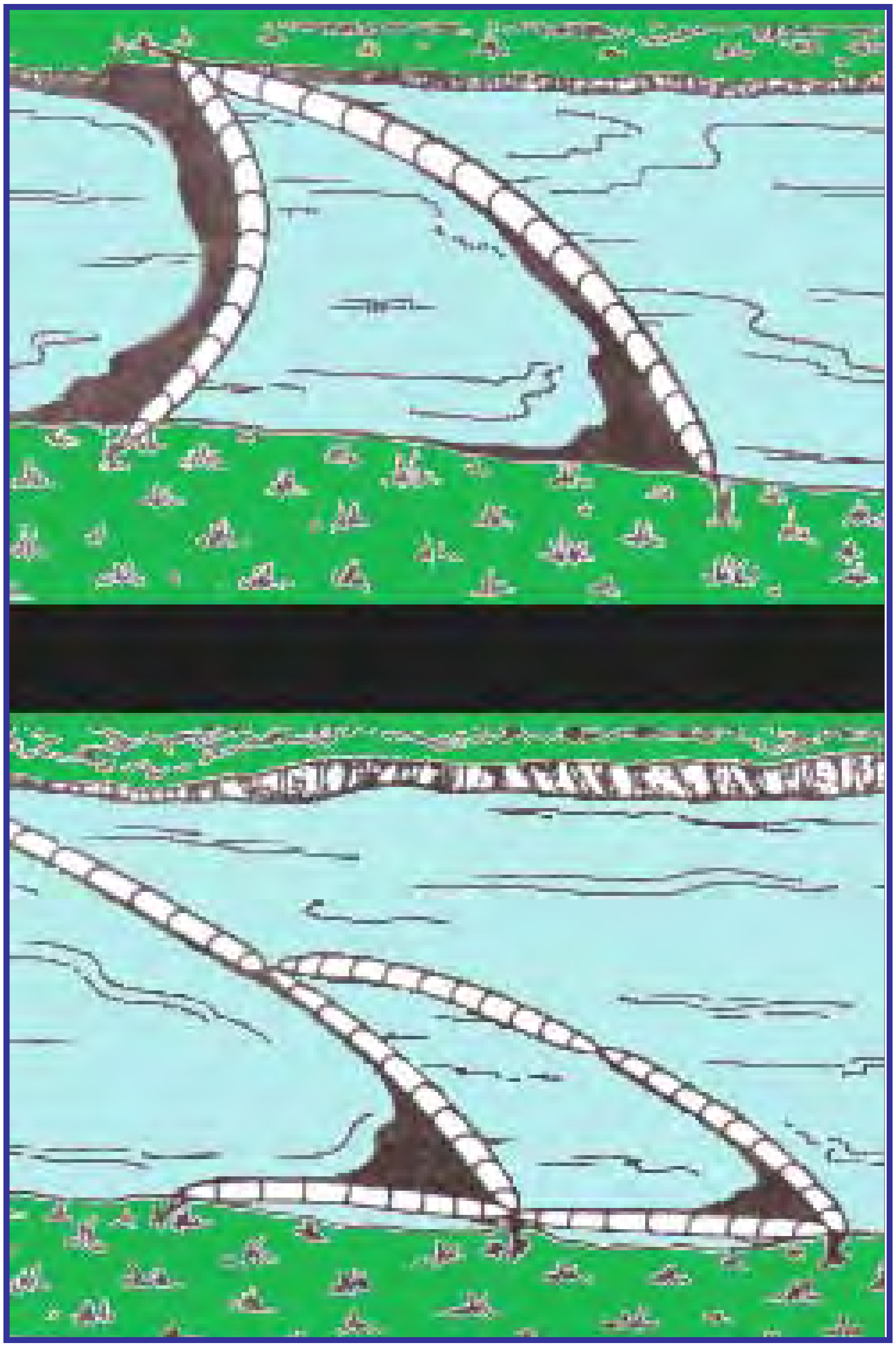
(from Owens, 1996)

Geotextile (Contact) Barriers



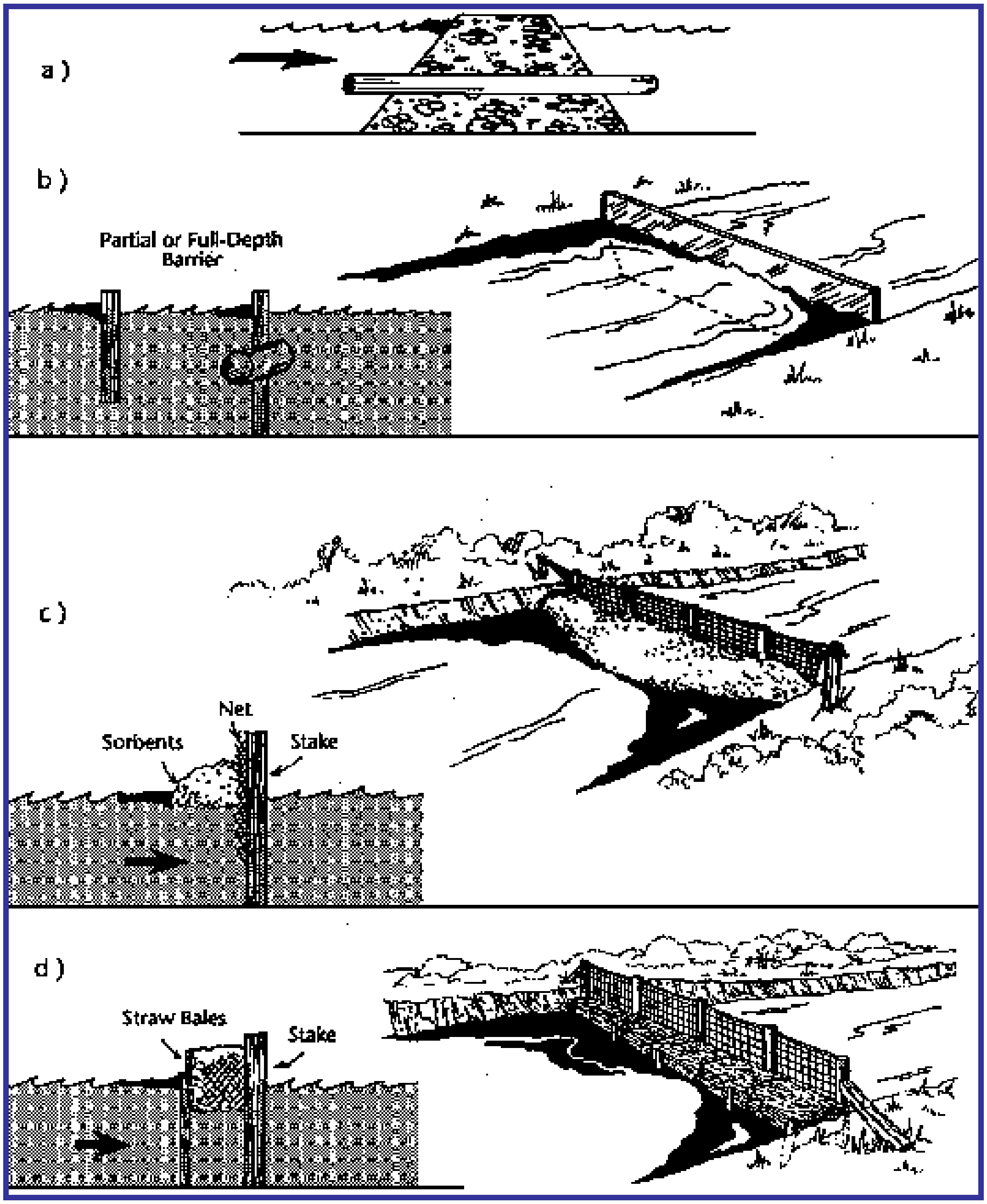
Channel Boom Strategies

(Owens, 1996)



Channel Barriers

(after CONCAWE, 1983)



Protection Technique Summary Tables

Protection Technique	Description	Limitations	Potential Environmental Effects
ON-WATER BOOMING			
Containment	Boom is deployed in nearshore waters in a "J" or "U" shape in front of the oncoming slick. The ends of the boom are anchored by work boats or drogues and the oil is contained within the "U", or the ends can be brought together to encircle the oil for recovery.	High winds Swells > 2 m Currents > 1.0 m/s Breaking waves > 50 cm	No significant effects.
Recovery-Skimming	Portable skimmers are placed within containment booms in the area of heaviest oil concentration. On-water, self-propelled skimmers work back and forth along the leading edge of a windrow; booms may be deployed from the front of a skimmer in a "V" configuration to increase sweep width.	High winds Swells > 2 m Currents > 1.0 m/s Breaking waves > 50 cm	No significant effects.
Redirection Away	Single or multiple booms are deployed from the shoreline at an angle away from the approaching slick and anchored or held in place with a work boat. Oil is deflected away from the shoreline where it may be contained for recovery.	Currents > 1.0 m/s Breaking waves > 50 cm	Minor disturbance to substrate at shoreline anchor points. Could affect unprotected downstream areas.
Redirection Towards	Single or multiple booms are deployed from the shoreline at an angle towards the approaching slick and anchored or held in place with a work boat. Oil is diverted towards the shoreline for recovery.	Currents > 1.0 m/s Breaking waves > 50cm	Minor disturbance to substrate at shoreline anchor points. Can cause heavy shoreline oiling at down-stream end of boom (collection point).
Exclusion	Boom is deployed across or around sensitive areas and anchored in place. Approaching oil is deflected or contained by boom.	Currents > 0.5 m/s Breaking waves > 50 cm Water depth > 20 m	Minor disturbance to substrate at shoreline anchor points.
ONSHORE BARRIERS			
Intertidal/ Shoreline Boom	Boom can be deployed across or along the shore/riverbank, on the beach or in the water, to contain oil. Designed for use where the water level will change. Water-filled chambers provide a seal as the boom grounds and a skirt when afloat. Can prevent remobilization of stranded oil.	Currents > 0.5 m/s Breaking waves > 50 cm	Minor disturbance to substrate at anchor points. Can cause heavy oiling if oil concentrated by the booming strategy.
Barriers, Berms	A berm is constructed along the shore/riverbank. The berm should be covered with plastic or geotextile sheeting to minimize wave erosion and oil penetration or burial.	Breaking waves > 25 cm Strong currents	Disturbs upper 50 – 60 cm of foreshore zone.
Sumps and Trenches	Dug by machinery to contain and collect oil for recovery as it is washed ashore. Prevents or minimizes remobilization of stranded oil. Likely would have to be lined to prevent penetration or mixing of oil and sediment by wave action.	Breaking waves > 25 cm Coarse sediments (cobble and boulders)	Disturbance of the substrate and, if not lined, greater oil penetration.
Geotextiles	A roll of geotextile, plastic sheeting, or other impermeable material is spread along the bottom of the splash zone and fastened in place to protect logs or other materials from oil splash or spray or to prevent oil penetration into riprap or boulder, cobble, pebble beaches.	Breaking waves > 25 cm Strong alongshore currents Low-sloped shorelines	No significant effects.
Boom Filter or Sorbent Exclusion Barrier	A barrier is constructed by installing two parallel lines of stakes across a channel, fastening wire mesh to the stakes, and filling the space between with loose sorbents.	Currents > 0.5 m/s Waves > 25 cm	Minor disturbance of inlet or channel substrate.
Solid Exclusion Barriers	A dam is constructed across a channel, inlet, or culvert where there is a limited flow, using local soil or beach sediments, sandbags, or wood sheeting to seal the opening and exclude oil from entering the area.	Water outflow Waves > 25 cm	Disturbs channel substrate and adds suspended sediments to water. Can be harmful to landward biota.

4.4. Protection Expectations

Despite best efforts, it is rarely possible to contain and remove much of the spilled oil from the water surface.

Nearshore / Offshore Operations

(1) Do not expect off / in / nearshore operations to prevent shoreline oiling.

(2) Oil will end up on the shore (in most cases) despite our best efforts.

The following table, based on operational experiences in the published literature, is a fair indicator of what can be expected from offshore and nearshore operations

Recovery of Spilled Oil From a Nearshore Spill

0 – 10%	Normal
10 – 25%	Exceptional
25 – 50%	It happens from time to time with small spills in sheltered waters
> 50%	Does not happen on the open sea

- Therefore, planning for shoreline protection and shoreline cleanup should begin even if the oil is still on the water and away from the shoreline, to prevent a last-minute operation to protect resources at risk.

Shoreline Protection "Rules of Thumb"

Protection Strategies

- Protection is a defensive strategy for resources at risk in the anticipated spill path.
- Think ahead, it may be already too late to protect a resource at risk.
- Be specific and define whether the protection goal is to "*prevent contact between the oil and the resource at risk*" or "*minimize the degree of contact*" — this will make a big difference to the level of effort and the degree of commitment by Planning and Operations.
- Protection by exclusion booming can be effective in sheltered areas; on open coasts, redirection (deflection – diversion) may be the only feasible protection strategy.
- Do not promise to keep oil away from an area or a location if it not feasible or practical to do so; this will avoid disappointment and loss of credibility.

Protection Priorities

- *PAY ATTENTION TO LOCAL SENSITIVITIES AND PRIORITIES* — generic sensitivities (e.g., marshes and wetlands — ESI 10s) may not be the same as local priorities; in the 1993 Tampa Bay spill, the local population considered the tourist sand beaches a much higher priority than the back-bay mangroves (which they considered to be "weeds that had grown on dredge-spoil piles and messed up the boating")
- The oil is in the "backyard" of the local inhabitants, it is their land, riverbank, or shore that will be oiled and their resources or activities that will be affected — usually, we are outsiders and often do not immediately recognize their concerns or priorities.
- Area Contingency Plans (ACPs), Geographic Response Plans (GRPs), or similar regional response plans, do not necessarily reflect local concerns or priorities.
- *Sensitivity* and *Vulnerability* are two different concepts: a resource may be sensitive to oil but not vulnerable, and vice versa.

4.5. On-Water Response Guidelines

Booms and Boom Selection

Operating Environment Constraints

- ❖ wave height and wave steepness
- ❖ surface current strength
- ❖ winds
- ❖ visibility and darkness
- ❖ water depth (inshore)

Operational Factors

- ❖ oil encounter rate
- ❖ oil thickness
- ❖ debris

Boom Failure

- ❖ ENTRAINMENT — water flow too strong
- ❖ DRAINAGE — too much oil
- ❖ SPLASH OVER — wave height too high
- ❖ SUBMERGENCE — water flow too strong
- ❖ PLANING — winds and currents too strong

"Rules of Thumb"

- ❖ Booms work for most oil types and large or small oil volumes.
- ❖ Containment is most effective when the booms can be accurately directed towards the oil; a boat usually is not a good place from which to locate the oil.
- ❖ Booms almost always leak, even under the best of circumstances.
- ❖ A boom is only as good as the crew that deploys and controls it.
- ❖ Booms are not a static piece of equipment, they require constant attention.
- ❖ Offshore containment costs can be high per barrel
(but still considerably less than shoreline cleanup and resource damages).

- Shoreline (or "tidal") booms work well at the shore and on riverbanks.

Skimmers and Skimmer Selection

- Mechanical recovery in rivers might be possible in areas where oil naturally accumulates or is easily diverted to a collection area with booming techniques. Such areas, e.g. back eddy and quiet water embayments, are common in meandering rivers or streams.
- They can also occur where a narrow channel widens or a river turns in an oxbow and currents are reduced. In some cases, such areas are also created during a spill by earthmoving equipment where the advantages of creating an oil collection point outweigh the disturbances caused by altering the terrain.

Operating Environment Constraints

- wave height
- surface current strength

Operational Factors

- oil encounter rate
- oil type (viscosity and adhesion properties)
- oil thickness
- debris

"Rules of Thumb"

- Different skimmers work for different oil types.
- Skimmers do not like rough waters or strong currents.
- Oil recovery rate equals total volume recovered less the amount of water.
- Oil recovery cannot exceed storage capacity.
- Offshore containment and recovery costs can be high per barrel (but still considerably less than shoreline cleanup and resource damages).

Mechanical Containment and Recovery

- The success of containment and recovery is primarily a function of (not in any order):
  - a) the type and volume of spilled oil
  - b) the size of the area over which the oil has spread
  - c) the sea and weather conditions
  - d) operator experience and skill.
  - e) the accuracy with which the equipment can be deployed in terms of the location and movement of the oil.
- The last item is probably the most important. Without good direction from the air, a recovery team likely will have a low efficiency and recovery potential.
- There are many different types of equipment and each has been designed for different applications.
- “Booms leak”.
- Skimmers like calm water.
- On-water recovery rates generally are less than 10% of the spill volume — so for nearshore spills, expect the coast to be oiled.

In-Situ Burning "Rules of Thumb"

- Burn when you can: limited window of opportunity.
- Know which way the wind is blowing and find out about the forecasted winds.
- Air emissions (usually) are not an HSE issue; fire and smoke only look bad.
- Burning does not preclude other actions taking place concurrently (i.e., containment and recovery).
- Any boom can be a "fire boom" — it may be only a one-time use though
- Burning is the simplest method and can be the most effective method for oil removal from a water surface: may be as much as 90% oil removal
- Be safe; think what will happen as soon as the oil is ignited — it will happen fast!

Dispersant Application "Rules of Thumb"

- Disperse when you can: limited window of opportunity.
- Dispersion can be a very effective method for oil removal from a water surface.
- Environmental effects of chemical dispersion are much lower than the effects of oil on the shoreline.
- Dispersion does not preclude other actions taking place concurrently (i.e., containment and recovery, in-situ burning).
- Aerial spraying can cover very large areas (tens of acres per minute): figure out how much area can be covered with one load and the transit times to re-load to estimate how long it will take to cover all of the target oil.

4.6. Submerged or Sunken Oil

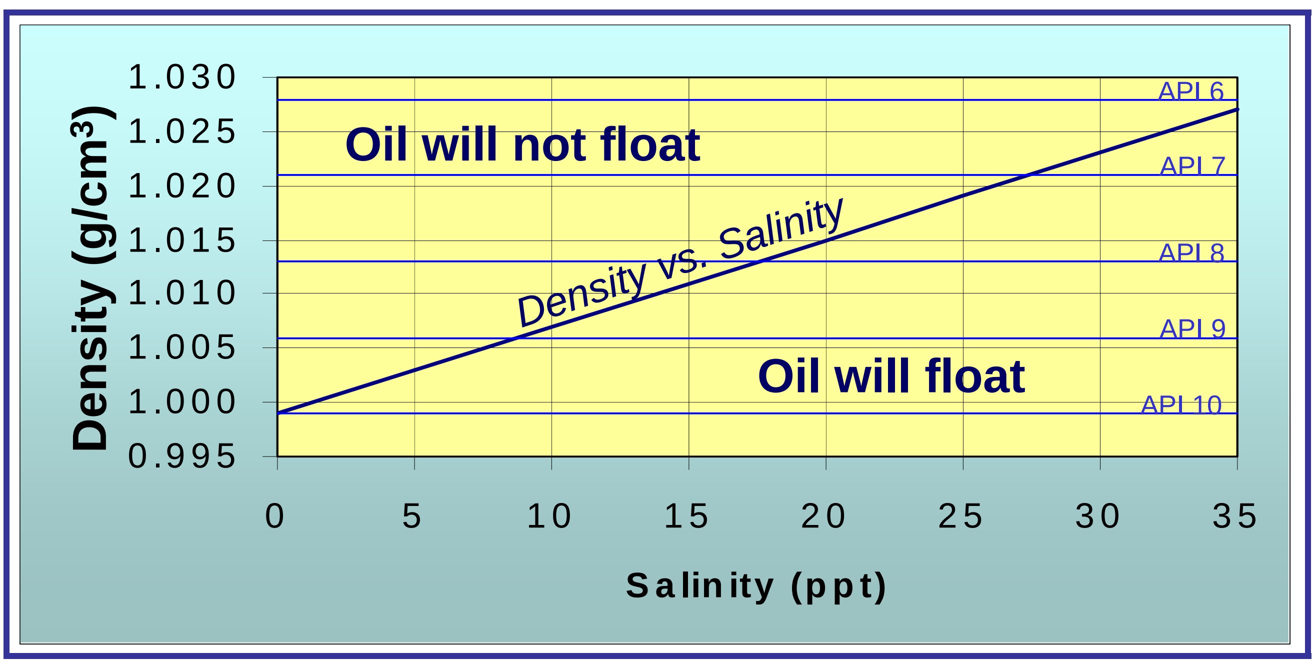
- *SUBMERGED OIL* is defined as oil that is below the water surface and is in the water column, whereas
- *SUNKEN OIL* is defined as oil that has been deposited on the floor of the sea, lake, or river.

Character

- *DENSITY* determines if a substance will float, remain in suspension, or sink in still water.
- *SOLUBILITY* determines if a substance will dissolve or partially dissolve.
- a *MIXER* dissolves (slowly or rapidly) and is irreversibly changed.
- a *SUSPENSION or SINKER* may dissolve (slowly) and retains all of part of its physiochemical character.

Density vs. Salinity

(after Galt)



Assessment of Submerged or Sunken Oil

- Can the oil be accurately located ?
- How long will it likely stay there ?
- Is the oil likely to move, be eroded or be buried ?
- What are the environmental effects of the submerged or sunken oil ?

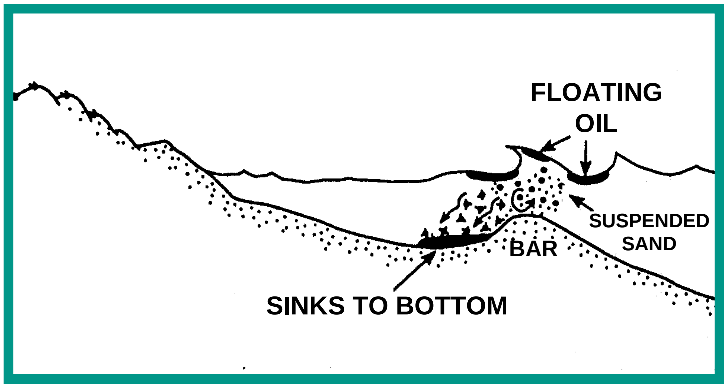
Possible Objectives (pick only one)

- Allow to weather and disperse naturally
- Contain and recover all of the oil
- Contain/recover as much oil as practical and safe

Submerged or Sunken Oil

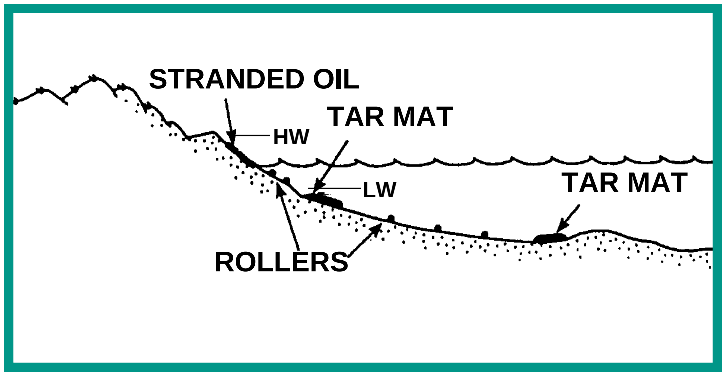
Oil can sink in the shore zone as the buoyancy is altered by mixing with suspended sediments or beach materials, so that the oil becomes more dense than the nearshore waters (Michel and Galt, 1995).

- Oil initially floats – mixes with suspended sand in breaker zone, then sinks.



- Oil initially floats – strands on beach – oil and sediment are mixed by wave action, then eroded and transported to nearshore bottom

(Michel *et al.*, 1995).



Assessment Guide

(Castle *et al*., 1995)

Oil is:	Depth is:	
Near Neutral Buoyancy (oil suspended in water column) ▶	0–20m ± ▶	▪ Visual (Aircraft) ▪ Photobathymetric Techniques
	0–30m ± ▶	▪ Visual (Diver)
	No depth restriction ▶	▪ Sonar ▪ Visual (Television, ROV) ▪ Water Column Sampling – Water Samples – Mid-Water Trawls ▪ In-Situ Detectors
Negative Buoyancy (sinks to bottom) ▶	0–20m ± ▶	▪ Visual (Aircraft) ▪ Photobathymetric Techniques
	0–30 ± ▶	▪ Visual (Diver)
	No depth restriction ▶	▪ Geophysical ▪ Sonar ▪ Side-Scan Sonar ▪ Enhanced Acoustic ▪ Grab Samples ▪ Bottom Trawls ▪ Visual (Television, ROV) ▪ *In-Situ* Detectors

Containment Guide

(Castle *et al*., 1995)

Oil is:	Depth is:	
Near Neutral Buoyancy (oil suspended in water column) ▶	0–2m ± ▶	▪ Physical Barrier
	0–3m ± ▶	▪ Silt Curtain
	Maximum working depth not established ▶	▪ Pneumatic Curtain ▪ Contain Onshore
Negative Buoyancy (sinks to bottom) ▶	0–2m ± ▶	▪ Physical Barrier
	No depth restriction ▶	▪ Allow to collect in natural or artificial depression ▪ Contain Onshore

Recovery Guide

(Castle et al., 1995)

Oil is:	Depth is:	
Near Neutral Buoyancy (oil suspended in water column) ►	0–2m ± ►	▪ Permeable Barriers ▪ Manual Recovery
	Working depth variable ►	▪ Mid-Water Trawls ▪ Pump/Decant Systems ▪ Recover Onshore
Negative Buoyancy (sinks to bottom) ►	**Oil is:**	**Depth is:**
	Pumpable ►	0–5m ± Mud Cat 0–15m ± Dustpan/Cutterhead Dredge 0–20m ± Hopper Dredge 0–30m ± Hand held Dredge 0–40m ± Oozer Dredge Working Depths Variable: Vacuum Systems, Progressive Cavity Pumps, Air Lift Pumps, Combination Systems
	Not Pumpable ►	**Depth is:** 0–5m ± Mud Cat 0–15m ± Cutterhead Dredge 0–30m ± Manual – Divers Working Depths Variable: Bottom Trawls, Clamshells, Robotic Systems

Floating vs Sinking Oil

- Pay particular attention to this issue if (a) the oil has, or weathers to, a density close to that of the water, and (b) there are mixed water masses (e.g., fresh-water and sea-water lens in an estuary).
- Oils with a density near 1.0 may rise and sink as water temperature or water density (salinity) change — changes in oil temperature are not a factor.

Containment & Recovery Variables

SURFACE OIL	SUBMERGED OIL	SUNKEN OIL
Visible	"Hidden"	"Hidden"
Variable horizontal location	***Variable*** horizontal location	***Fixed*** horizontal location
Fixed vertical location	***Variable*** vertical location	***Fixed*** vertical location
Surface winds and currents identifiable and predictable to a degree.	Subsurface currents and density changes generally not known, hard to predict.	Bottom currents and density changes generally not known, hard to predict.
Concentrated in slick(s) or in small droplets	Concentrated in slick(s) or in small droplets	Usually would be concentrated

Detection and Tracking

1. ROVs
2. Water-penetrating remote sensing
3. Trajectory models

— *NONE are very effective or efficient*

- It is very difficult (usually impossible) to detect and track oil below the water surface.
- It is very difficult to see with the naked eye.
- Underwater "trajectory analyses" are a "shot in the dark".

Containment, Protection and Recovery

There are only a very few situations (calm environments and shallow waters) when containment, protection, and recovery are feasible.

- ❖ Do not expect open-ocean containment and recovery actions to be successful.
- ❖ Recovery that involves pumping techniques also involves large volumes of water.

Protection Priorities include:

- ❖ water intakes
- ❖ aquaculture sites
- ❖ mid-depth – bottom fisheries (include crab, lobster pots, etc.)
- ❖ tidal inlets, oxbows, bayous, etc.

Boom

"Standard Booms"

- — Draft usually 6 feet (2 m) or less

Specialized Booms

- — Deep-skirt booms (12-ft. (4-m) draft)
- — Silt curtains (generally 10-ft. (3-m) draft)
- — Nets
- — No theoretical depth limit for boom draft
  - • But how easy would it be to deploy a 30 ft. (10 m) curtain in flowing water?
- — Pneumatic barriers
- — Behave as surface booms
- — Entrainment, drainage will occur in the water column and on the bottom

Factors that Aid an Operation

- Shallow water
- Sheltered conditions (waves, currents, and winds)
- Limited and stationary distribution or extent of the oil
- Nearby staging and decanting facilities
- Either pumpable oil for vacuum recovery or weathered asphalt-like oils for physical removal

Potential for Success will Decrease with...

- Water depth
- Currents strength
- Wave exposure
- Distance offshore
- Extent of the affected area
- API gravity of the oil (because of dispersal)
- Volume of recovered oily wastes

The State of the Art

❖ "There are no proven techniques for locating oil that is neutrally buoyant and suspended in the water column"

❖ "Containment and removal efforts for neutrally buoyant oil will likely be ineffective. No proven techniques exist for containing oil in the water column, or for removing oil from large volumes of water"

Michel *et al.*, — 1995 Int. Oil Spill Conf.

❖ "The scope for recovering sunken oil is severely limited"

Moller (ITOPF) — AMOP 1992

SO ? ? ?

What is really practical?

- Diversion booms
- Sorbent barrier

"Rules of Thumb"

- Expect the unexpected in terms of where the oil might go.
- Expect oil to enter the water column.
- Do not expect to predict the movement of, or detect, this submerged oil.
- Realistic control or recovery only is likely where the submerged or sunken oil can be accurately located and where recovery is a safe and practical operation.
- In most circumstances, despite some recent successes, it is not realistic to expect responders to contain or recover submerged or sunken oils.
- Do not be optimistic or promise results except in sheltered and shallow waters.
- The communication of reasonable expectations is almost as important as the development of practical, feasible, and safe response options.

Part 5 Shoreline Cleanup Assessment Technique (SCAT)

Table of Contents

Part 5 Shoreline Cleanup Assessment Technique (SCAT)

5.1. The Documentation of Oiled Shorelines

A clear and accurate understanding of the *nature and extent of the shoreline oiling* is key to developing a practical response strategy and to selecting appropriate cleanup options.

Objective

The primary purpose of SCAT (*Shoreline Cleanup Assessment Technique*) is to Provide:

❖ OPERATIONAL SUPPORT

Method

❖ Systematically Collect Real-time Data on Oil and Shoreline Conditions

(that is assessed by the Decision Makers in the Unified Command to)

❖ Develop an Appropriate Treatment (Cleanup) Program

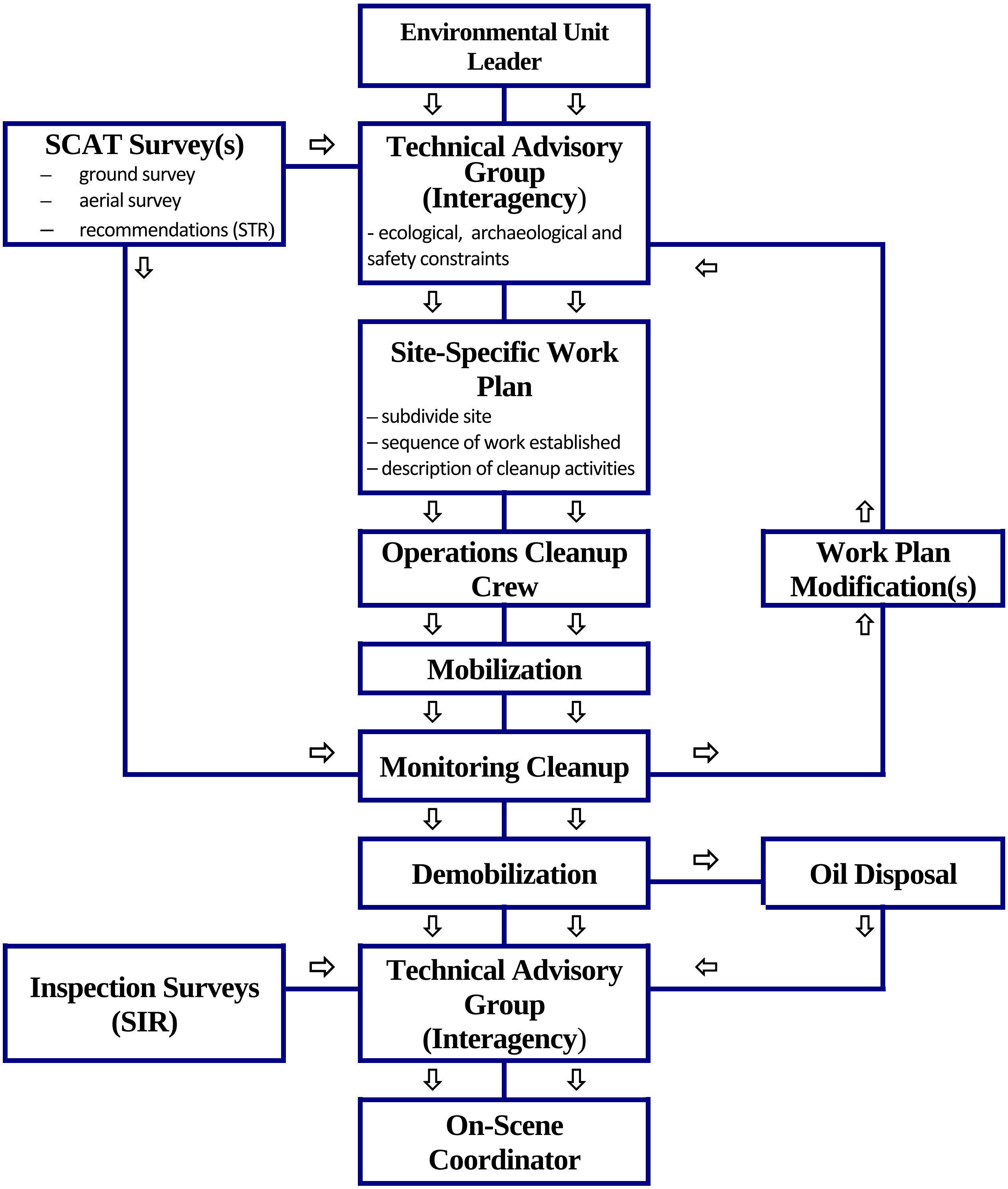
❖ The *OBJECTIVES* of the documentation phase are to:

- provide decision support for onshore response operations,
- systematically collect data on shoreline oiling conditions,
- identify and describe affected resources,
- cross check pre-existing information on environmental sensitivities or clarify observations from aerial surveys,
- identify and describe any constraints that may limit operations, and
- recommend appropriate treatment actions, if and where necessary, to meet the endpoint criteria.

❖ *PRIORITIES* for shoreline assessment surveys may be determined using information from aerial surveys and pre-existing sensitivity atlases and databases. Priority setting criteria include:

- degree of oiling,
- environmental resources/sensitivities,
- projected tidal and wind conditions, and
- available transportation and logistics.

Flowchart of Site-Specific Tactical Decision-Making Process



5.1.1. Shoreline Oiling Assessment Strategy

SCAT May Involve:

- o Aerial Reconnaissance Team
- o Aerial Videotape Recording (VTR) Team
- o Shoreline Assessment Team(s)
  - – *Geology/Oil*
  - – *Ecology*
  - – *Cultural Resources*
- o Inspection Team(s)

SCAT and NRDA

- ❖ SCAT is ***not*** NRDA.
- ❖ SCAT provides data to support Response Decisions and Operations — NRDA or similar impact assessment surveys assess damage and define compensation (not punitive) for "resource injuries".
- ❖ SCAT data may be used by the Responsible Party or Trustees, but
  - < SCAT is not initiated or driven by NRDA;
  - < if it were, data could be sequestered.

Government agencies, landowners or managers, and operations representatives can participate in the documentation process and in the development of recommended response options and constraints by participating in the assessment team surveys. This participation may minimize subsequent discussion on the degree and extent of oil conditions and recommended response options.

The SCAT process generates information for the decision process. The SCAT team does not decide on treatment or cleanup methods but can identify operational constraints, such as ecological sites, cultural resources, or access considerations.

Aerial Reconnaissance Survey

⇩

Identify Areas of Current
or Potential Impact

⇩	⇩
Establish Locations and Priorities for Aerial VTR Surveys	Operations Establishes Protection Priorities and Locations

Aerial VTR Survey

⇩

Document Shoreline
Oil Conditions
and Geomorphology

⇩	⇩
Establish Locations and Priorities for Ground Surveys	Operations Initiates Scoping and Planning for Cleanup

Ground Survey

⇩

Document Shoreline Oil
Conditions, Geology, Ecology,
Cultural Resources, and
Identify Constraints, Recommend Treatment Options

⇩	⇩
Establish Locations and Priorities for Long-term Monitoring	Operations Establishes Cleanup Locations and Priorities and Initiates Cleanup

Initial Phase — Aerial SCAT

For all but very small areas:

- Aerial observations/video provide the initial direction for operations
- Rapid data collection / turnaround
- Provides "Big Picture" — Scales the problem

Second Phase — Ground SCAT

- Ground surveys provide detailed information on shoreline oiling conditions to define where treatment is necessary to meet the end point criteria
- Just need to stay 2–3 days ahead of shoreline operations
- Do not need many teams: usually 4 to 5 maximum even on large spills (except a DWH scale response)
- Aerial surveys continue to provide "Big Picture"

Later Phases

- Post treatment ground surveys to support the inspection and "sign-off" process

Method

The Description of Shoreline Oiling Conditions

STEP 1: Divide the Coast into Segments (Section 5.1.2)

STEP 2: Describe Shoreline Character within Segment (Section 5.1.3)

STEP 3: Describe Surface Oil (Section 5.1.4)

a. **length** of oiled shore within segment

b. **width of** oiled band

c. **% distribution** of oil in band

[width + distribution = surface cover]

d. **thickness** of oil cover

[cover + thickness = surface oil category]

c. describe **oil character**

STEP 4: Describe Subsurface Oil (Section 5.1.5)

e. describe **relative oil concentration** and **subsurface oil character**

f. measure **thickness/depth of penetration** of oiled layer

[depth of penetration + relative oil concentration = subsurface oil category]

(Owens and Sergy, 2000)

The Five SCAT Principles

1. A systematic survey of all shorelines in the affected area
2. Division of the coast into segments
3. Use of a standard set of terms and definitions for documentation
4. A team of interagency personnel to represent land ownership, land use, management or trustee interests
5. Management and operational support that continues until all treatment activities and inspections have been completed.

SCAT Process — "Rules of Thumb"

- *Use an existing documentation form if that is appropriate*: generate a new form if existing forms are not appropriate.
- *Modify terms, definitions, forms at the outset*: try not to change terms and definitions midway through a project (can always add new terms or redefine terms in some cases).
- *SCAT can be labour-intensive and generate a large volume of data*, so be sensible and practical in designing field surveys: do not promise more than you can deliver and do not do more than is necessary.
- *Calibration* is an ongoing activity as personnel and as oiling conditions change.
- *Minimize personnel substitutions* and select team members who can stay with the program, or have a systematic schedule of alternates: people who see conditions change through time have a better perception of reality.
- Assign a *data manager* as soon as possible for anything other than a small response: field teams do not have time to complete their paper work, perform data entry and routine management tasks, as well as produce maps or reports unless the affected area is very small.
- *Have a data manager review field forms daily*: post-spill reconstruction of oiling conditions is tedious and usually inaccurate.

5.1.2. Shoreline Segmentation

Shoreline Segmentation

- A geo-reference system
- Used by SCAT to define:

  — Shoreline character

  — Oiling conditions
- Provides a systematic and uniform framework for documentation, planning, and response (*Operations*)

- ❖ The shoreline is divided into working units called *SEGMENTS* within which the shoreline character is relatively homogeneous in terms of physical features and sediment type.
- ❖ Each segment is given a unique location identifier and is surveyed.
- ❖ Segment boundaries can be either prominent geological features (headlands, streams, etc.), changes in shore/substrate types, or changes in oil conditions.
- ❖ Segments should consider jurisdictional, land management, administrative and/or political boundaries
- ❖ Segment lengths are small enough to obtain adequate resolution and detail on the distribution of oil, but not so small that too much data are generated. Most segments in oiled areas would be in the range of 0.2–2.0 km.
- ❖ Segments are numbered based on an alphanumeric numbering scheme with an alphabetical prefix (e.g., EI = Example Island) followed by a number based on an alongshore sequence (EI-14).

Segmentation

Existing segmentation may be available in the form of a *GIS database* or as part of a pre-spill planning exercise.

- Existing segmentation would need to be reviewed and compared to oiling conditions observed in the field to determine if the segmentation may need to be adapted to existing spill conditions.
- If oiling conditions vary significantly within the segment, segments could be subdivided; segment subdivisions can be identified by a suffix, e.g., EI-14 A, EI-14 B, etc.

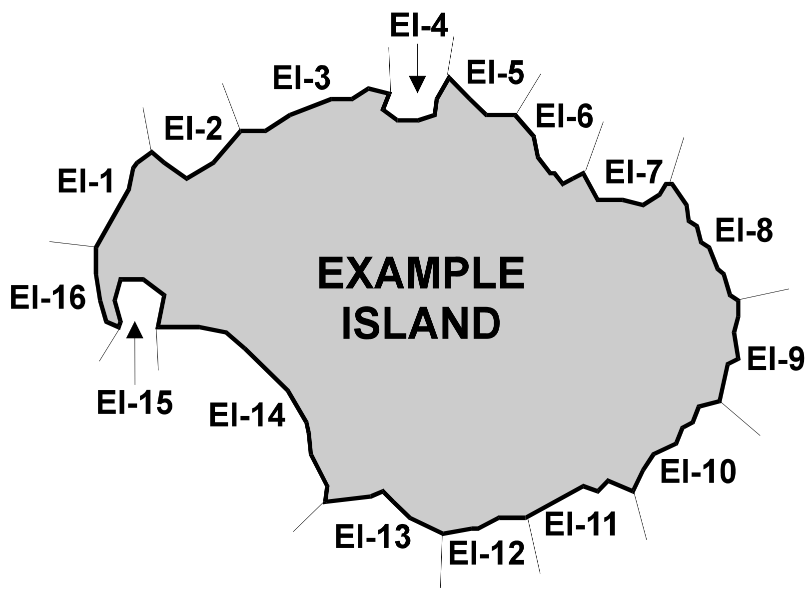
Exxon Valdez *Shoreline Assessment Programs* (adapted from Neff *et al*., 1995)

SURVEYED				OILING CATEGORY				
Year	Segments	Km Surveyed	Number of Subdivisions	Very Light	Narrow/ Light	Medium/ Moderate	Wide/ Heavy	Total Oiled
1989	550	1450	855	223	326	94	141	783
1990	493	1109	711	323	80	46	21	420
1991	305	386	432	68	15	12	0.1	96
1992	59	32	76	8.7	0.8	0.6	0.2	10

Segment "Rules of Thumb"

- The segment boundary should be at a change in the physical shoreline character, or where there is a change in oiling conditions even if the physical character is uniform (e.g., a long, straight sand beach).
- Do not use a river, stream, or inlet as a boundary, rather make the river or inlet a separate segment in itself.
- Make the segments operational units if possible, i.e., not too long nor too short.

Map showing shoreline segmentation for a hypothetical island shoreline.



5.1.3. The Description of Shoreline Character

Shoreline character affects the fate and persistence of stranded oil as well as access to the site and equipment constraints. During a survey, therefore, it is important to document the shoreline type and coastal character.

<u>Shoreline Types</u>

(1) An Oil Spill Can Affect:

- Intertidal or swash zone
- Supratidal or splash zone
  – therefore, base characterization on these zones **<u>(shoreline type)</u>**

(2) Operations Activities Take Place in Backshore and Nearshore Zones

– therefore, must also characterize area inland and seaward of the shoreline **<u>(coastal character)</u>**

The *COASTAL CHARACTER* describes the *form* of the various materials that result from *marine and coastal processes* (described in Part 1) that act to change the shape of the initial material.

<u>Coastal Character</u>

<u>Solid Forms</u>

Bedrock:
– cliff
– platform
– reef

Anthropomorphic:
– bulkhead
– revetment
– marina
– seawall

Ice

<u>Unconsolidated Forms</u>

Beach
Delta
Dune
Sand Barrier/Lagoon
Channel
Flats (mud, sand, tidal)
Scree/Talus
Low-lying Tundra
Tundra Cliff
Anthropomorphic:
– dock/pier
– fill

5.1.4. The Description of Stranded Surface Oil

- The description of the character and amount of oil stranded on a section of shoreline uses a standardized set of terms and definitions.
- Length of oiled shoreline is the least accurate method: the most useful descriptions include estimates of length, width, and distribution of oil.
- The tables and terminology on the following pages are a standardized approach that has been developed for Environment Canada and is applicable worldwide.

Methods Used to Describe Surface Oil Conditions (Environment Canada, 1992)

Length	**Presence or absence only**
Length – Width	**A measure of total oiled area**
Length – Width – Distribution	**Indicates oil cover** (equal to Equivalent Area — Owens *et al.*, 1987) *
Length – Width – Distribution – Thickness	**Estimates the amount of oil ****

* see Initial Surface Oil Cover Matrix (page 5-23)
** see Surface Oil Categorization Matrix (page 5-23)

Data Collection

- Data are collected on standardized *SHORELINE OILING SUMMARY (SOS) FORMS*;

  forms may be modified for various shoreline types (e.g., beach, marsh, tidal flat, river, stream, winter), regions, or study programs, as appropriate (see examples on pages 5-19 through 5-23).
- This documentation is supplemented with *sketch maps* (Section 5.2) and *photographs* (Section 5.3).
- A list of typical equipment needed during a field survey is included on pg. 5-17.

Typical Shoreline Oiling Summary Forms

- SOS Shoreline Oiling Summary Form (full or "short" form)
- WOS Wetlands Oiling Summary Form
- RBOS River Bank Oiling Summary Form
- SBOS Stream Bank Oiling Summary Form
- LSOS Lake Shoreline Oiling Summary Form
- TFOS Tidal Flat Oiling Summary Form
- MOS Mangrove Oiling Summary Form
- CROS Coral Reef Form
- TBS Tar Ball Oiling Summary Form

Forms adapted for COLD CLIMATE or ARCTIC regions

- Arctic Shoreline Oiling Summary (ASOS) Form
- "Short" ASOS Form for First Responders
- Winter Lake Shore Form
- Winter River Bank Oiling Summary (WRBOS) Form
- "Short" WRBOS Form for First Responders
- Winter Stream Bank Form
- Winter Tidal Flat Form
- Winter Tar Ball Form
- Winter Wetland Form

- The most recent versions may be downloaded from: http://www.shorelineSCAT.com
- Adjust forms as necessary for local environmental conditions (e.g. tidal range and oiled zone width categories)

Essential SCAT Data

General

- location, date, time, and segment code
- information on team members

Surface

- length and width of oiled section or subdivision described
- location of oil relative to tidal zones or lake/river levels
- distribution (percent surface coverage to nearest 5 or 10%)
- oil thickness
- oil character

Subsurface

- location and area (length and width) of penetrated or buried oil
- pit or trench locations and depths
- thickness of clean sediment on buried oil
- thickness of sediment to base of penetrated/buried oil

Field Sketch or Map

- scale, North arrow, GPS coordinates
- surface oil locations and characteristics (abbreviations)
- pit and trench locations
- access, staging, and safety or operational concerns
- photographs and/or video of the segment (optional)

SCAT Kit List — "SCAT Pack"

The Essentials:

- Forms — SOS, etc.; Sketch blanks (on waterproof paper)
- Waterproof Notebooks
- 2B Pencils or waterproof pens
- Clip board
- Camera and Film or Digital Memory Cards, extra Batteries; Photo Scale
- Map(s)

Optional:

- Range Finder
- Radios — Cellular Phone
- Compass — GPS (Global Positioning System)
- Shovel (folding)
- SCAT field guide or manual
- Other types of equipment would be necessary depending on the logistics, location, and duration of the surveys, including:
    - safety and survival equipment,
    - sampling equipment, if required, and
    - personal weather gear/PPE; raingear, gloves, boots, exposure suits.

SCAT Documentation — "Rules of Thumb"

- Remember that the role of the SCAT is to be the "eyes and ears" for the Planning and Operations teams. Record, on a form or in a field notebook, any and all information required to later recreate the character and location of the oil.
- Define practical segments, based on either the physical shore-zone character, oiling conditions, or operational units.
- Be more, rather than less detailed, and do not categorize (i.e., enter the actual value of ***15%*** for Distribution, not *Patchy*; enter the value *15 m* for Width of Oiled Band, not > *3 m*).
- Always make a sketch (or draw a map or on a map if you cannot sketch too well) to indicate important features and the location of the oil.
- If there is not a standard term or definition that fits an observed feature, define and describe the feature.
- Look around and identify advantages or constraints that might help or hinder the field cleanup crew.

Key Components of a SCAT Survey/Program

- Systematic data collection (i.e., forms)
- Identification of resources (physical, ecological, cultural, human use) affected by the oil and/or operations at the time of the spill
- Identification of factors that may assist or constrain operations
- Treatment recommendations

- In the US, Canada and elsewhere, SCAT has been in use for over 20 years and has been applied successfully to spills on the coast, in rivers, and for tar ball oiling conditions.
- The SCAT process is an integral part of Environment Canada procedures and is included in most Oil Spill Contingency Plans. Agencies will expect the Responsible Party to initiate a SCAT program, or likely they will do it themselves.

Shoreline Oiling Summary (SOS) Form (with Supplemental Form)

MARINE TEMPERATE (SOS) FORM (ver. 13Feb13) **Incident:**______________________________________ **Page**______ **of** ______

1.GENERAL INFORMATION	**Date** (dd/mmm/yyyy)	**Time** (24h standard/daylight) _____:_____ to _____:_____	Tide Height (m) Low:________ High:_________ (H / M / L) - (R / F /LS / HS)
Segment ID:	**Segment Name:**		
Ops Zone:	**Survey Type:**	**STR:**	

Survey By: Foot __ ATV__ Boat__ Helicopter__ Other ______________ | Weather: Sun / Clouds / Fog / Rain / Snow / Windy / Calm

2. SURVEY TEAM	Name	Organization	Name	Organization
Team Number				

3. SEGMENT	Total Length: meters	Length Surveyed: meters	Datum:

Survey Start GPS:	WP:	LAT: .	LONG: .
Survey End GPS:	WP:	LAT: .	LONG: .

4a. SHORELINE TYPE : *Indicate only ONE Primary(dominant) type and ALL Secondary types. CIRCLE those OILED*

BEDROCK: Cliff_____ Ramp_____ Platform_____
MAN-MADE: Solid______ Permeable______
Description:_______________________________________
ESI Shoreline Type (primary) _____ (secondary) _____

Sediment BEACH: Sand____ Mixed____ Pebble/Cobble____ Boulder_____
Sediment FLAT: Mud____ Sand ___ Mixed___ Pebble/Cobble/Boulder____
WETLAND:_____ Description:____
OTHER:______________________________ *If snow and ice use Winter SOS*

4b. COASTAL/BACKSHORE CHARACTER *Indicate only ONE Primary (P) and ANY Secondary (S) types.*

Cliff/Hill:____ ht._____ m. | Flat/Lowland:____ Beach:____ Dune:____ Inlet/Channel:____ Delta:____ Lagoon:____ Marsh/Wetland:____
Sloped: > (5^o) (15^o) (30^o) | Man-Made: ___.________________ Primary Substrate type:________ Forested / Vegetated - _________

5. OPERATIONAL FEATURES	Oiled Debris? Yes / No	Type:	Amount: (bags/trucks)

Direct backshore access? Yes / No | Alongshore access from next segment? Yes / No | Suitable for backshore staging? Yes / No
Access Description / Restrictions: | Current Dominated Channel? Yes / No

6. OILING DESCRIPTION: *Use letters A-Z, Indicate 100% overlapping oil zones in different tidal zones by numbering them (e.g. A1, A2)*

Zone ID	WP # Start	WP # End	Substrate Type(s) or ESI Code	Tidal Zone				Oil Cover: Area		Distribution		Size		Oil Thickness					Oil Character							
				LI	MI	UI	SU	Length (m)	Width (m)	Dist % (> 1) or	Number per unit area	Avg Size (cm)	Large Size (cm)	TO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO

7. SUBSURFACE OILING CONDITIONS: *Format: Indicate Zone ID in Pit #, e.g., A-1, B-2, B-3, (use only number if not in zone e.g. 4 , 5)*

Pit #	WP #	Substrate Type Surface/Subsurface	Tidal Zone				Pit Depth (cm)	Oiled Interval (cm-cm)	Subsurface Oil Character								Water Table (cm)	Sheen Color B,R,S,N	Clean Below Yes / No
			LI	MI	UI	SU			AP	OP	PP	OR	OF	TR	NO	%			
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											

8. COMMENTS: Cleanup Recommendations; Ecological/Recreational/Cultural/Economic Issues; Wildlife Observations; Other Descriptions

**Use supplemental river SOS form for additional oiling zones, pits, and comments/sketches.*

Sketch / Map: Yes / No Photos/Video: Yes / No Numbers: (-) Photographer Name:

MARINE TEMPERATE (SOS-2) FORM (ver. 13Feb13) **Incident:**____ **Page**______ **of** ______

1.GENERAL INFORMATION		**Date** (dd/mmm/yyyy)	**Time** (24h standard/daylight) _____:_____ to _____:_____	Tide Height (m)
Segment ID:		**Segment Name:**		Low:________ High:_________
Ops Zone:	**Team #**	**Survey Type:**	**STR:**	(H / M / L) - (R / F /LS / HS)
Survey By: Foot __ ATV__ Boat__ Helicopter__ Other _______________			Weather: Sun / Clouds / Fog / Rain / Snow / Windy / Calm	

6. OILING DESCRIPTION: *Use letters A-Z, Indicate 100% overlapping oil zones in different tidal zones by numbering them (e.g. A1, A2)*

Zone ID	WP # Start	WP # End	Substrate Type(s) or ESI Code	Tidal Zone				Oil Cover						Oil Thickness					Oil Character							
								Area		Distribution		Size														
				LI	MI	UI	SU	Length (m)	Width (m)	Dist % (> 1) or	Number per unit area	Avg Size (cm)	Large Size (cm)	TO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO

7. SUBSURFACE OILING CONDITIONS: *Format: Indicate Zone ID in Pit #, e.g., A-1, B-2, B-3, (use only number if not in zone e.g. 4 , 5)*

Pit #	WP #	Substrate Type Surface/Subsurface	Tidal Zone				Pit Depth (cm)	Oiled Interval (cm-cm)	Subsurface Oil Character								Water Table (cm)	Sheen Color B,R,S,N	Clean Below Yes / No
			LI	MI	UI	SU			AP	OP	PP	OR	OF	TR	NO	%			
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											
		/						-											

8. COMMENTS: Cleanup Recommendations; Ecological/Recreational/Cultural/Economic Issues; Wildlife Observations; Other Descriptions

**Use supplemental river SOS form for additional oiling zones, pits, and comments/sketches.*

Sketch / Map: Yes / No Photos/Video: Yes / No Numbers: (-) Photographer Name:

Surface Oiling Definitions (Box 6 on SOS Form)

A five-fold rating has been developed for describing surface oil conditions on the shoreline.

These conditions are:

HEAVY	*VERY LIGHT*
MODERATE	*NO OIL*
LIGHT	

Two steps are involved in the ground survey assessment of surface oiling.

STEP ONE:

Determine Width of Oil Band and Distribution of Oil According to the Following Criteria:

Oil Width *(**for MICROTIDAL ENVIRONMENTS – such as the Gulf of Mexico**)*

– Represents the average width of the oiled area or band in the shoreline segment. If multiple bands or areas occur across shore, width represents the sum of their widths.

WIDE	**> 2 m**
MEDIUM	**> 1 to 2 m**
NARROW	**0.3 to 1 m**
VERY NARROW	**<0.3 m**

Note: enter exact width on form (e.g., 1.5 m) and avoid category break values (0.3 m, 1 m, and 2 m).

Oil Distribution (DIST)

– Represents the percent of the surface within a band or area covered by oil. In the event of multiple bands, distribution refers to the term that best represents the oil conditions for the segment.

***TRACE* (TR)**	**<1%**
***SPORADIC* (SP)**	**1 – 10%**
***PATCHY* (PT)**	**11 – 50%**
***BROKEN* (BR)**	**51 – 90%**
***CONTINUOUS* (CN)**	**91 – 100%**

Note: enter exact percentage (e.g., 60%) and avoid category break values (1%, 10%, 50%, and 90%).

The above two parameters are combined in the Initial Surface Oil Cover Matrix (see page 5-23) to determine the Initial Surface Oil Cover category.

STEP TWO:

Determine Oil Thickness According to the Following Criteria:

Oil Thickness

– Refers to the average or dominant oil thickness within a band or area.

TO ***POOLED OR THICK OIL*** – generally consists of fresh oil or mousse accumulations >1.0 cm thick: record actual thickness.

CV ***COVER*** – >1.0 cm and <0.1 cm thick.

CT ***COAT*** – >0.1 cm and >0.01 cm thick coating, can be scratched off with fingernail on coarse sediments or bedrock.

ST ***STAIN*** – <0.01 cm; cannot be scratched off easily on coarse sediments/bedrock

FL ***FILM*** – transparent or translucent film or sheen.

The thickness is combined with the Surface Oil Cover (result of STEP ONE) in the Surface Oil Categorization Matrix (page 5-23) to determine the Surface Oil Category.

Surface Oiling Definitions (Box 6 Continued)

Further assessment of the oil is made by noting the character and elevation (location) of the oil within the shore or riverbank zone.

Oil Character/Debris Type

FR ***FRESH*** — unweathered, low viscosity oil.

MS ***MOUSSE*** — emulsified oil (oil and water mixture) existing as patches or accumulations, or within interstitial spaces.

TB ***TAR BALLS or MOUSSE PATTIES*** — discrete balls or patties on a beach or adhered to rock or coarse-sediment shoreline. Diameters are generally <10 cm and 10 cm to 1.0 m, respectively.

TC ***TAR*** — weathered coat or cover (see Oil Thickness) of tarry, almost solid consistency.

SR ***SURFACE OIL RESIDUE*** — Consists of non-cohesive, oiled, surface sediments, either as continuous patches or in coarse-sediment interstices.

AP ***ASPHALT PAVEMENT*** — cohesive mixture of oil and sediments.

NO ***NO OIL*** observed.

DB ***DEBRIS*** — can consist of logs, vegetation, rubbish or general debris; includes spill response items (sorbents, boom, snares):
LG = ***logs***
VG = ***vegetation***
RB = ***rubbish, garbage*** (man-made materials)

Shore Zones (note in boxes 6 & 7 on form for surface and subsurface oil)

SU ***SUPRATIDAL ZONE*** — the area above the mean high tide that only occasionally experiences wave activity, as during a storm event. Also known as the splash zone or backshore.

UI ***UPPER INTERTIDAL ZONE*** — the upper approximate one third of the intertidal zone (foreshore).

MI ***UPPER INTERTIDAL ZONE*** — the middle approximate one third of the intertidal zone (foreshore).

LI ***LOWER INTERTIDAL ZONE*** — the lower approximate one third of the intertidal zone (foreshore).

Riverbank Zones

OB **Over Bank** — *flood zone*

UB **Upper Bank** — *under water during bank full stage*

LB **Lower Bank** — *exposed only during low flow stage*

MS **Mid-Stream** — *shoal or bar separated from river bank*

Initial Surface Oil Cover Matrix

(Environment Canada, 1992)

Oil Distribution		Width of Oiled Area			
		Wide	Medium	Narrow	Very Narrow
Oil Distribution	Continuous 91 – 100%	Heavy	Heavy	Moderate	Light
	Broken 51 – 90%	Heavy	Heavy	Moderate	Light
	Patchy 11 – 50%	Moderate	Moderate	Light	Very Light
	Sporadic 1 – 10%	Light	Light	Very Light	Very Light
	Trace < 1%	Very Light	Very Light	Very Light	Very Light

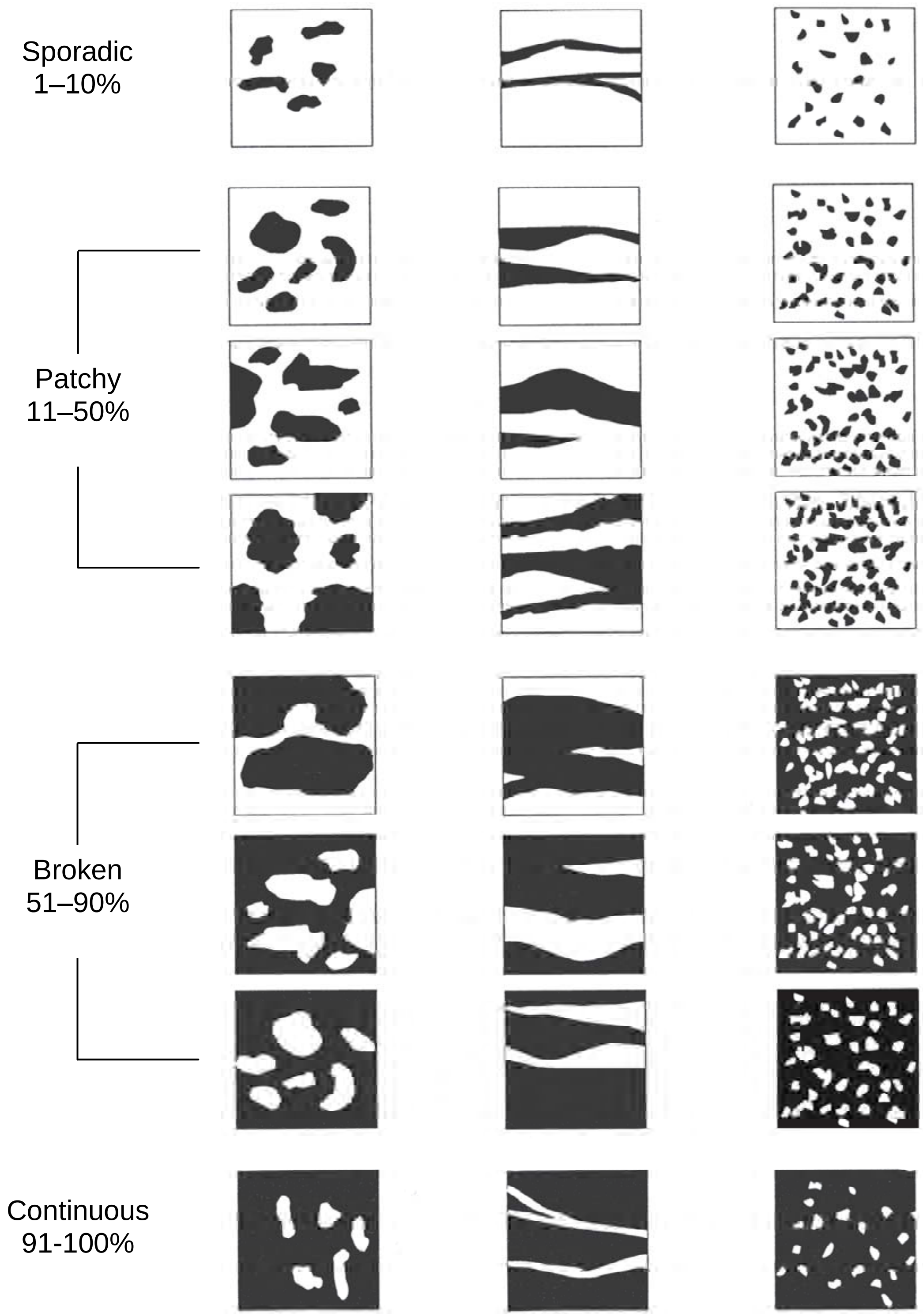
Surface Oil Categorization Matrix

(Environment Canada, 1992)

Average Thickness		Initial Categorization of Surface Oil			
		Heavy	Moderate	Light	Very Light
Average Thickness	Thick or Pooled > 1 cm	Heavy	Heavy	Moderate	Light
	Cover 0.1 – 1.0 cm	Heavy	Heavy	Moderate	Light
	Coat 0.01 – 0.1 cm	Moderate	Moderate	Light	Very Light
	Stain/Film < 0.01 cm	Light	Light	Very Light	Very Light

Visual aid for estimating oil distribution percentages.

(Owens and Sergy, 1994)



Example of Oiling Classification Method for a Shoreline Segment

STEP 1

Width of oiled area: **0.5m** = narrow

\+ **Distribution** estimated at: **75%** = broken

Initial Surface Oil Cover Matrix Category : **Moderate**

	***Width of Oiled Areas*:**			
***Distribution*:**	**Wide**	**Medium**	**Narrow**	**Very Narrow**
Continuous	Heavy	Heavy	Moderate	Light
Broken	Heavy	Heavy	**Moderate**	Light
Patchy	Moderate	Moderate	Light	Very Light
Sporadic	Light	Light	Very Light	Very Light
Trace	Very Light	Very Light	Very Light	Very Light

□ Therefore, this shoreline has a **MODERATE** surface oil cover.

STEP 2

Initial Surface Oil Cover Matrix Category (from above) = **Moderate**

\+ Average oil **thickness:** **2 cm** = **thick**

Final Surface Oil Matrix Category ***Heavy***

***Average Thickness*:**	***Initial Surface Oiling Category*:**			
	Heavy	**Moderate**	**Light**	**Very Light**
Thick or Pooled	Heavy	**Heavy**	Moderate	Light
Cover	Heavy	Heavy	Moderate	Light
Coat	Moderate	Moderate	Light	Very Light
Stain/Film	Light	Light	Very Light	Very Light

□ This shoreline has a **HEAVY** amount of surface oil. This information can then be used, in part, to determine cleanup priorities and options.

Generalized Oil Volumes (for Microtidal Environments)

(*assume oil ~ 1 cm or 0.5 inch thick*)

- ***Heavy:*** > 15 liters/m^2 beach
  > 3 gallons/yd^2 beach

- ***Moderate:*** > 5 – 15 liters/m^2 beach
  1 – 3 gallons/yd^2 beach

- ***Light:*** > 0.5 – 5 liters/m^2 beach
  0.1 – 1 gallon/yd^2 beach

- ***Very Light:*** < 0.5 liters/m^2 beach
  < 0.1 gallon/yd^2 beach

5.1.5. The Description of Subsurface Oil

Subsurface Oil Definitions (Box 7 on SOS Form)

Sheen Color:

BR ***Brown***

RB ***Rainbow***

SV ***Silver***

NN ***None***

Subsurface Oil Character/Relative Oil Concentration:

— Refers to a qualitative description of the degree of oil-filled pore spaces.

AP ***ASPHALT PAVEMENT*** — cohesive mixture of weathered oil and sediment situated completely below a surface sediment layer(s) (thickness should be noted during observation).

OP ***OIL-FILLED PORES*** — pore spaces in the sediment matrix are completely filled with oil. Often characterized by oil flowing out of the sediments when disturbed.

PP ***PARTIALLY-FILLED PORES*** — pore spaces filled with oil, but generally does not flow out when exposed or disturbed.

OR/C ***OIL RESIDUE – COVER*** (>0.1 – 1.0 cm) **or *COAT*** (0.01 – 0.1 cm) of oil residue on sediments and/or some pore spaces partially filled with oil. Can be scratched off easily with fingernail on coarse sediments or bedrock.

OR/S ***OIL RESIDUE – STAIN*** (<0.01 cm) or film oil residue on the sediment surfaces. Non-cohesive. Cannot be scratched off easily on coarse sediments or bedrock.

TR ***TRACE*** — discontinuous film or spots of oil on sediments, or an odor or tackiness with no visible evidence of oil.

NO ***NO OIL*** — no visible or apparent evidence of oil.

Subsurface Oil Categorization

As for surface oil, a five-fold rating system has been developed for describing subsurface oil conditions. The terms are:

HEAVY
MODERATE
LIGHT
VERY LIGHT
NO OIL

Subsurface Oil Character/Relative Oil Concentration (defined on previous page) combines with *the Depth of Penetration or Thickness* of the buried oil lens in the Subsurface Oil Categorization Matrix to determine the Subsurface Oil Category.

Subsurface Oil Categorization Matrix (Environment Canada, 1992)

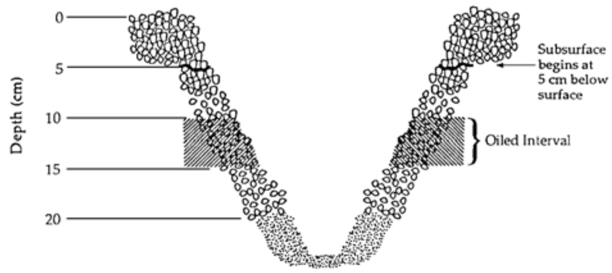
		Depth of Penetration or Thickness of Oil Lens			
		>30 cm	**21–30 cm**	**11–20 cm**	**0–10 cm**
Oil Concentration	**OP**	*Heavy*	*Heavy*	*Heavy*	*Moderate*
	PP	*Heavy*	*Moderate*	*Moderate*	*Light*
	OR	*Moderate*	*Moderate*	*Light*	*Light*
	TR	*Light*	*Very Light*	*Very Light*	*Very Light*

Subsurface Oil Definitions

Due to the problems associated with differentiating between what is considered surface and subsurface oil for oil character categories such as interstitial MS, surface SR, AP, subsurface OP and OR that begins at the surface, etc., the following definitions have been developed:

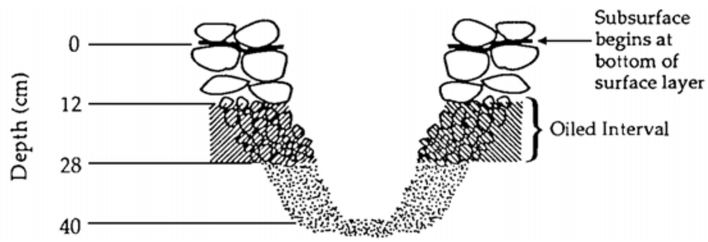
- Fine Sediments (Pebble, Gravel, Sand, Mud)

— If a pit were to reveal oiling in sand from the surface down to 20 cm, the upper 5 cm would be classified as surface oil and the remainder as subsurface. However, the oiled interval still would be shown as 0 to 20 cm.



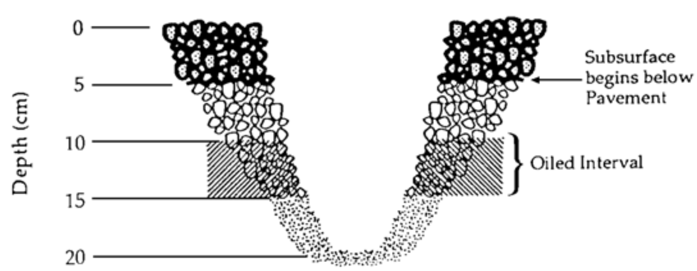
- Coarse Sediments (Cobble, Boulder)

— Subsurface begins where the top layer of cobbles or boulders contact the underlying layer of sediments.



- Asphalt Pavement

— Where AP exists on the surface, the subsurface begins at the bottom of the pavement.



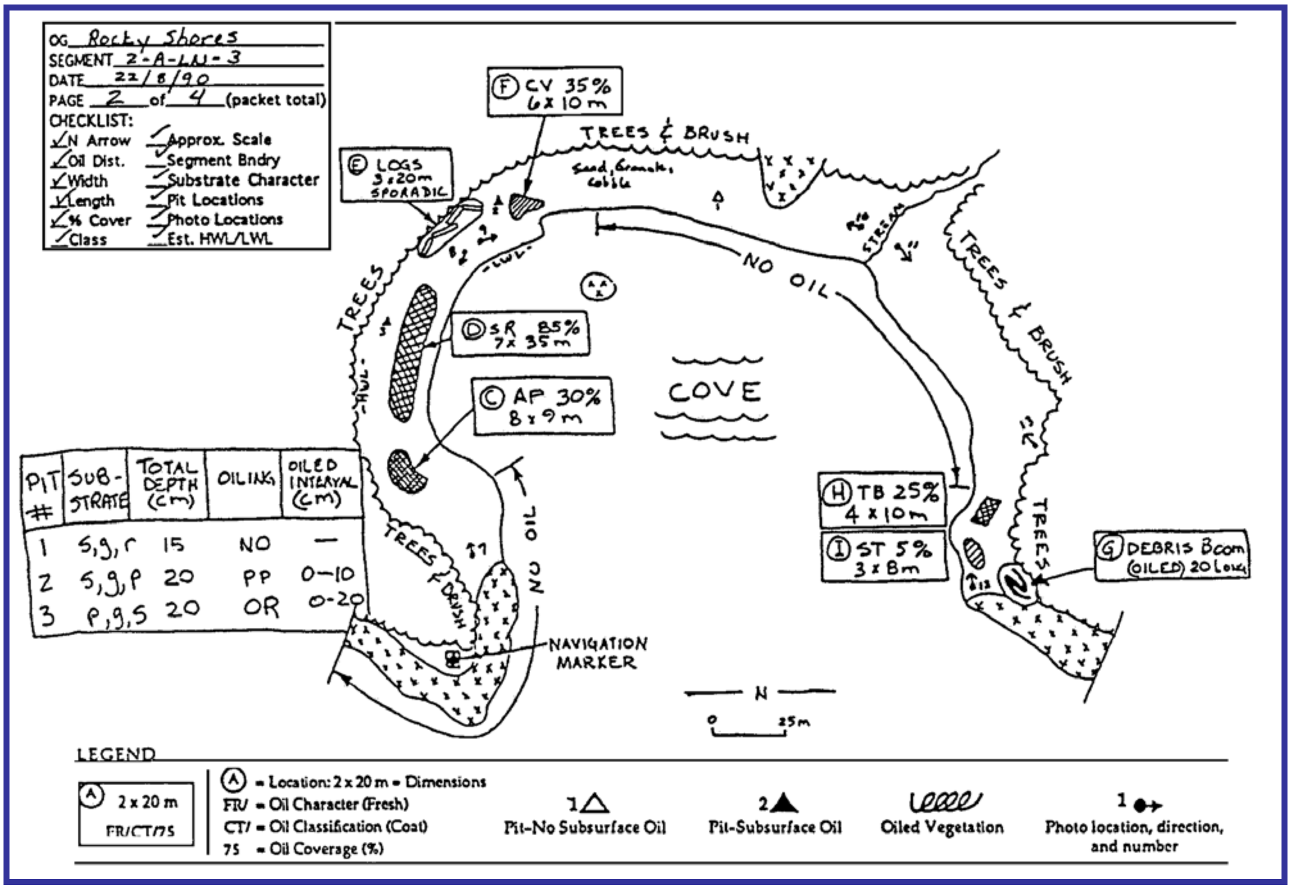
(after Environment Canada, 1992)

5.2. Sketch Maps

A sketch map is drawn for each segment to identify the physical layout of the shoreline, location of the oil, samples, pits, and photographs. The data shown on the sketch map are identified to correspond to the data on the SOS and other forms.

Aerial photos or small-scale maps can be photocopied or traced to create a base map for the sketches to enhance their accuracy and scale, and to provide consistency between the personnel providing sketch maps (geomorphologist, ecologist, archaeologist).

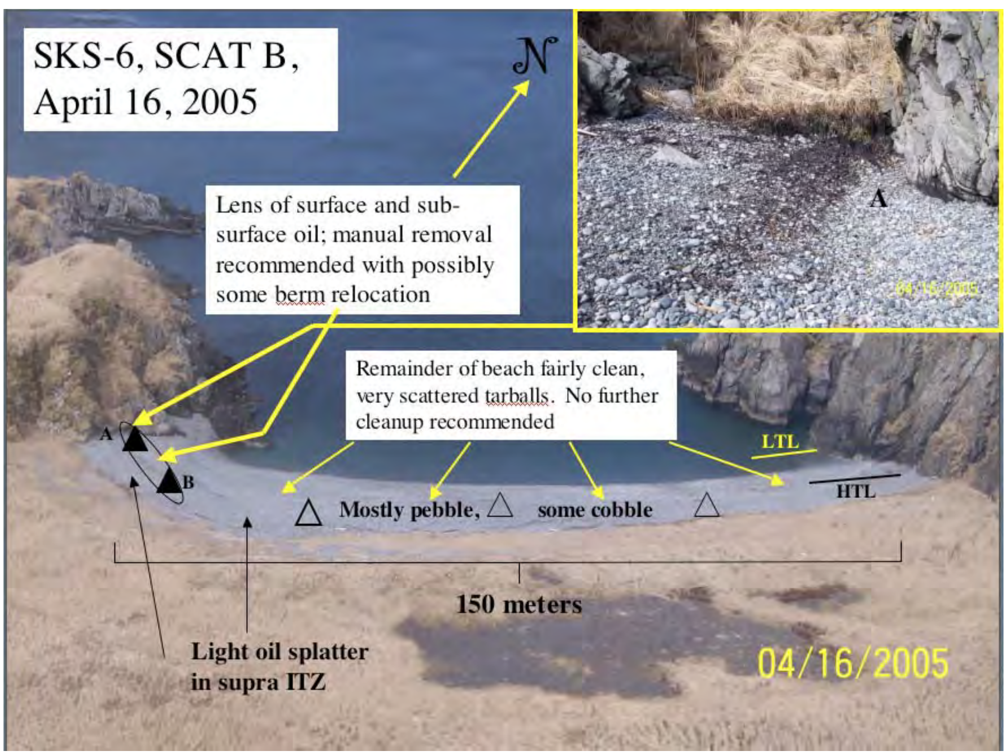
Shoreline oiling summary sketch map example.



5.3. Photo/VTR Documentation

Photographs and videotapes must be accurately documented and logged to avoid confusion about the location and subject matter; do not rely on memory as many segment locations look similar, especially in photographs.

- ❖ Maintain an accurate log of photographs and videotapes in the field or follow the georeferencing approach described in Appendix D.4. Note location and direction of photos on the sketch map (a circled number with an arrow works well — see sketch map legend (previous page)).
- ❖ Do not need a date stamp on the photo image as time/date are automatically recorded on digital cameras.
- ❖ As soon as return to the Command Post or SCAT base, download GPS and photos right away – keep all photos in a single location with files by date and initials of the photographer (e.g. 12Sept08-ABC)
- ❖ Photo Log : Ideally, set up a computer data base that logs photos by segment so that can pull out a time series from the same location – a critical part of the inspection phase of the response



see also Owens et al. 2008. *Proceedings International Oil Spill Conference,* Amer. Petr. Institute, Washington DC, 1193-1199.

5.4. STR and SIR Forms

(*see also Attachment C*)

5.4.1. Shoreline Treatment Recommendation (STR)

- A recent development to better support the management decision process, Planning and Operations has been the use of a SHORELINE TREATMENT RECOMMENDATION TRANSMITTAL (**STR**) form. These forms are completed by the SCAT teams to provide advice regarding treatment options that would be appropriate considering the degree of oiling, the treatment end points that apply to that segment, access considerations, and safety. This process was used on the M/V *Selandang Ayu* response in Alaska (December 2005) and on the M/V *Cosco Busan* response in San Francisco Bay (November 2007).
- The STR form is prepared by the SCAT team if, during the SCAT survey, the segment does not meet the Treatment Endpoint(s) for the shoreline type(s) present in that segment. If the segment has No Observed Oil (**NOO**) or conforms to the treatment endpoints, and therefore No Further Treatment (**NFT)** is required, then an STRT is not prepared.
- The completed STR form is reviewed and approved by the Historic Properties Specialist (HPS), the Environmental Unit Leader for environmental risk and environmental priority assignment, and the Unified Command (FOSC; SOSC; RPIC). Once approved by the UC, the form is forwarded to Operations via the EUL. The STR form is in effect a “work order” for the treatment of an oiled segment and can be included in the ICS-204.

INCIDENT NAME

Shoreline Treatment Recommendation **STR# ___**

Operational Permit to Work

Segment: Survey Date:

Start Latitude: **End Lat:**

Start Longitude: **End Long:** **Length (m): ________**

Shoreline Type: *Primary* ______________ *Secondary* ________________________________

Oiled Areas for Treatment:

Auto entry directly populated from data base of:
Zone: Shoreline Type, L x W, Oil % Dist, Oil Character, Oil Thickness, Oiling Category
e.g. Zone A: Salt marsh, 200 m x 1 m, 10% Fresh oil, pooled, Oiling Category: Heavy

Cleanup Recommendations:

(Use standard terms and definitions from a Word document or populate database with these standard statements)

Staging and/or Logistics Constraints/Waste Issues:

Ecological Concerns:

Cultural / Historical Concerns:

Safety Concerns:

Attachments: ☐ Segment Map ☐ Sketch ☐ SCAT Form ☐ Fact Sheet ☐ Other

Prepared by: ____________________ Date Prepared: ____________

	to SOSC	to Land Mgr	to SHPO	to EU Leader	to ________
Date					
Time					

Final Approval ___________ ____________ ____________ **Submitted to OPS** __________

State OSC Rep Federal OSC Rep EU Leader

** When Treatment is completed, send a Segment Completion Report to SCAT **

5.4.2. *Shoreline Inspection Report (SIR)*

- A formal inspection process is appropriate for shorelines where oil above the treatment end points was observed and for which an STR form was prepared. A Segment Inspection Report (**SIR**) form documents that a segment has been resurveyed by the SCAT team and that the treatment actions have reduced the oiling to a level that meets the Treatment Endpoints.
- After the Operations Division Supervisor or Shoreline Supervisor considers that cleanup in a segment has been completed, the segment is inspected by a SCAT team which (typically) is empowered to (a) determine that end point criteria have been met and (b) recommend to the UC that cleanup in that segment be terminated.
- Ideally, the Supervisor will provide advance notice so that an "informal" pre-inspection survey (Post-Treatment Assessment - **PTA**) can ensure that the endpoints will be met before the crews are deomobilized and before the formal inspection. This avoids the need to remobilize a crew that has been partially demobilized or has already moved on to another segment or area.
- There are four possible outcomes to the inspection: if the SCAT team determines that (1) no oil is present in the segment (**NOO**) or (2) that the cleanup has met the end-point criteria, so that No Further Treatment (**NFT**) is necessary, or (3) that oil has been observe and does not meet end point criteria but **NFT** is required as ***NEB is natural weathering .is expected to reduce the residual oil in the segment to meet end point criteria with an acceptably short time period.*** For these three cases, the members of the SCAT team who represent the UC sign an **SIR** form and forward this recommendation to the UC for approval.
- If a segment fails to meet the cleanup criteria and natural weathering to the end point criteria would not be expected to occur during an acceptable time period, by unanimous agreement among the UC representatives, the team (4) indicates on the SIR where work is required, what should be done to pass inspection, and sends the form to the SCAT Field Coordinator/Data Manager who forwards this to Operations via the EUL. One option at this point is to revise the original STR from rather than create a new one from scratch.

SEGMENT INSPECTION REPORT

INCIDENT NAME

LOCATION	Segment ID
Geographic Name	
Operations Division	

Date of Survey ______________

Time of Survey ______________

Tide Stage ______________

Weather ______________

Inspection Completed Along Entire Segment?

YES NO

SCAT Team ( ) Members

If no further treatment is required, each UC rep sign below:

Name		Signature
______________	RP rep	______________
______________	FOSC rep	______________
______________	SOSC rep	______________

Treatment Endpoint Criteria:

Is treatment or further treatment required? (circle one)

YES - define below specific treatment action(s) and specific locations within the segment where required. Provide sketches, maps, GPS coordinates to Ops

NO FURTHER TREATMENT required - each UC rep sign appropriate signature box above

Comments:

FOSC ______________ SOSC ______________ RP ______________

5.5. Data Base and Applications

Data Management

SCAT Information is Input into a
- Database, possibly for use with a
- Geographical Information System (GIS)

The scale of a field survey and the type of data sets that are collected are a function of the size of a spill and the operational needs of the response program. A small spill may require the collection of a only a few key parameters.

❖ Field information is transferred into a database system, such as a Geographical Information System (GIS). A form can be used for data entry.

❖ This information can be used interchangeably to track and evaluate, in a variety of ways, the impacts, treatment, and recovery of the affected areas.

The SCAT database can include:

< maps of shoreline oiling conditions,

< maps of the shoreline surveys,

< shoreline geomorphology,

< wave-exposure levels,

< sensitive areas and timing,

< species habitats and observations,

< ecological and cultural constraints,

< calculation and categorization of lengths of oiled shoreline,

< oil/sediment volume calculations (for cleanup/disposal),

< comparison of shoreline conditions through time,

< overlay of different related data (shoreline type, wave energy level, oil conditions) to predict the consequent behavior of oil,

< data displayed in tabular or graphic form,

< tracking of related response activities (date of segment assessment, cleanup approval date), and

< background information for comparison (other agency oiling surveys, ecological databases, and maps).

Data Management

- SCAT surveys can generate large volumes of data
- In almost all cases need a full-time SCAT Data Manager. Typically this a person who stays in the Command Post and who takes care of all data entry, managing the data files (hard copy and electronic), and generates summary information for the UC, Planning, and the EU Leader. Field teams rarely have time to reduce data or prepare maps
- QA/QC is important and should be carried out before observers forget what they saw !
- For more details see Lamarche 2007 – Shoreline Cleanup Assessment Technique Data Management Manual. Environment Canada, Ottawa, ON. (available at www.shorelinescat.com)

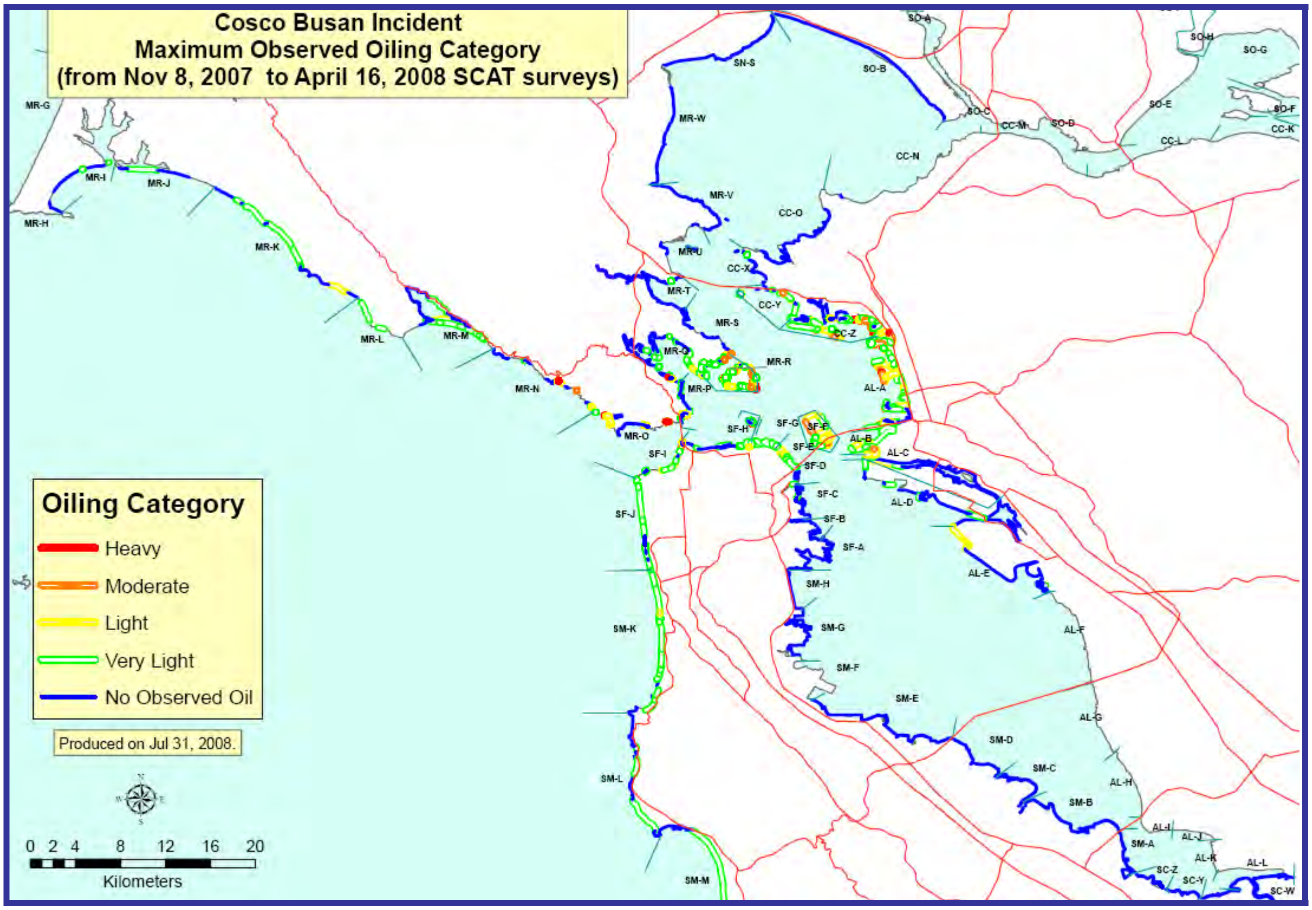
Example Oil Category/Volume by Segment Table

Cosco Busan Incident — *Oiling Summary by Shoreline Segment* — *Most Severe Oiling Conditions* — *(From Nov 8, 2007 to Apr 16, 2008 SCAT surveys)*

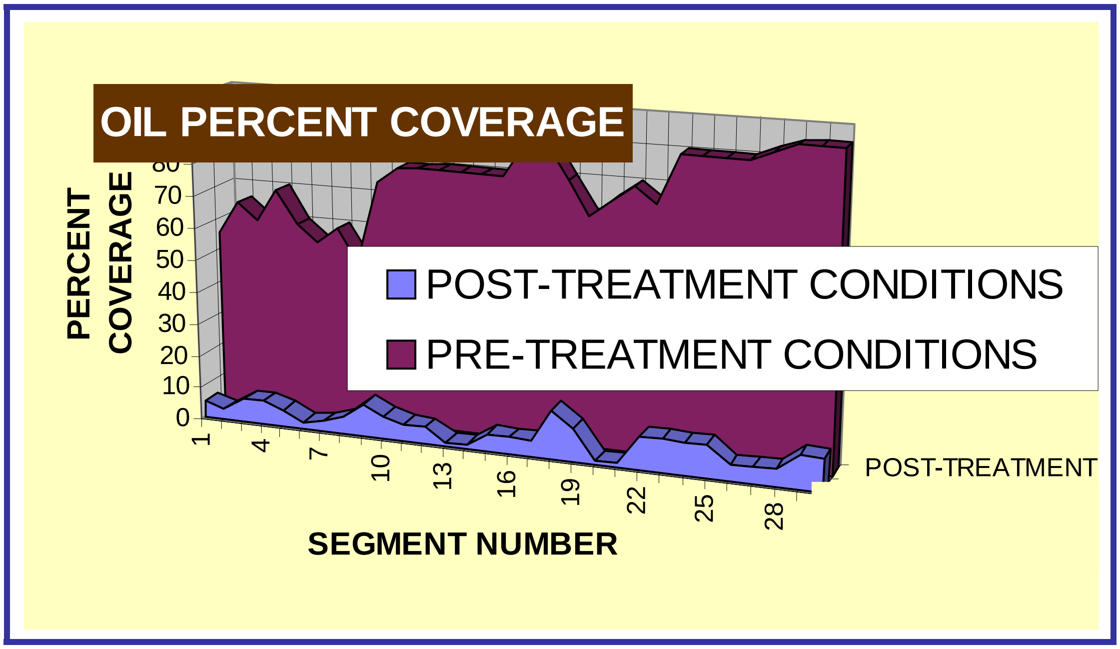
Substrate Type	*Length of shoreline by Oiling Category (m)*					% of Oiled Shore by Substrate Type
	Heavy	*Moderate*	*Light*	*Very Light*	*NOO*	
Bedrock	243	278	1,025	4,802	23,007	4.1
Seawall	60	270	10,220	12,457	49,767	14.7
Sand	290	304	15,965	37,299	30,893	34.5
Sandy Gravel	578	200	1,135	1,291	25,950	2.1
Coarse Gravel	0	0	3,795	3,534	37,790	4.7
Cobble-Pebble	905	1,559	4,289	3,921	18,048	6.8
Boulder	75	946	909	960	14,196	1.8
Rip-Rap	802	5,126	12,373	27,793	98,900	29.5
Mud	0	0	989	250	14,491	0.8
Vegetation	150	345	869	200	140,312	1.0
Debris	0	0	0	22	1,832	0.0
Total	**3,103**	**9,028**	**51,569**	**92,529**	**455,186**	
Total Surveyed					**611,415**	
% total by category	0.5	1.5	8.4	15.1	74.4	
Total Oiled					**156,229**	
% of oiled by category	2.0	5.8	33.0	59.2		

Data – Map Output Examples

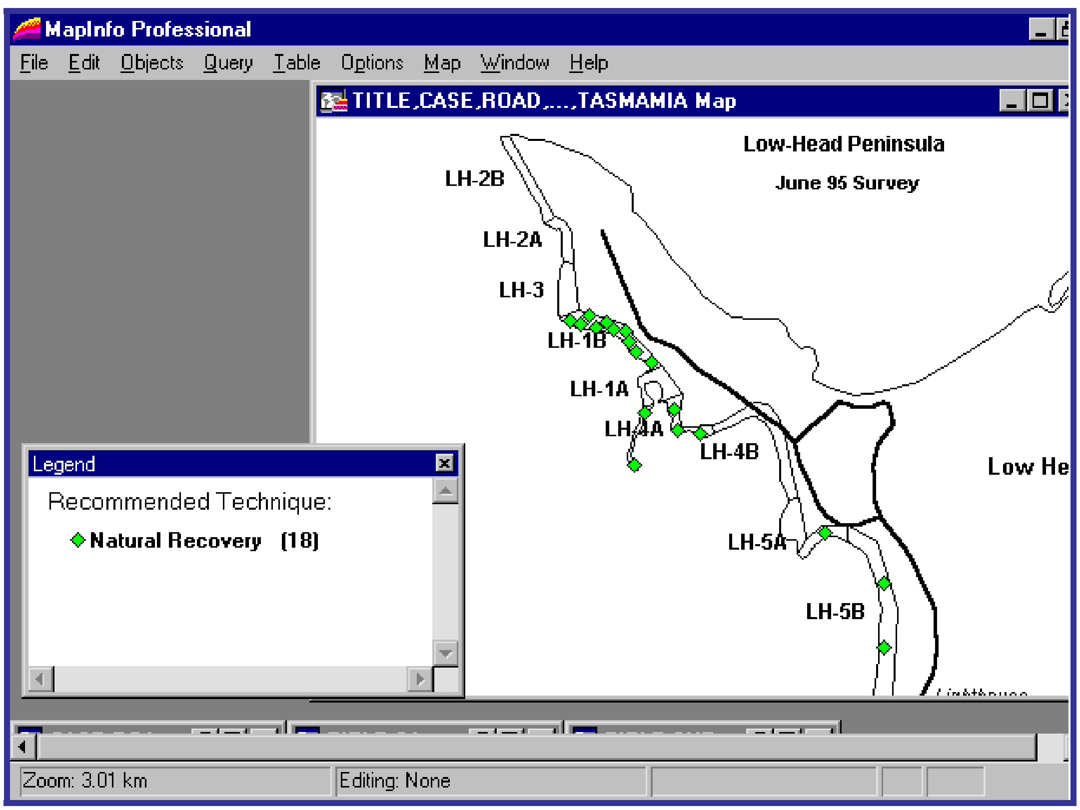
- Oil category/volume by segment
- Shore type/treatment recommendations
- Status of treatment operations
- Segment volume changes through time

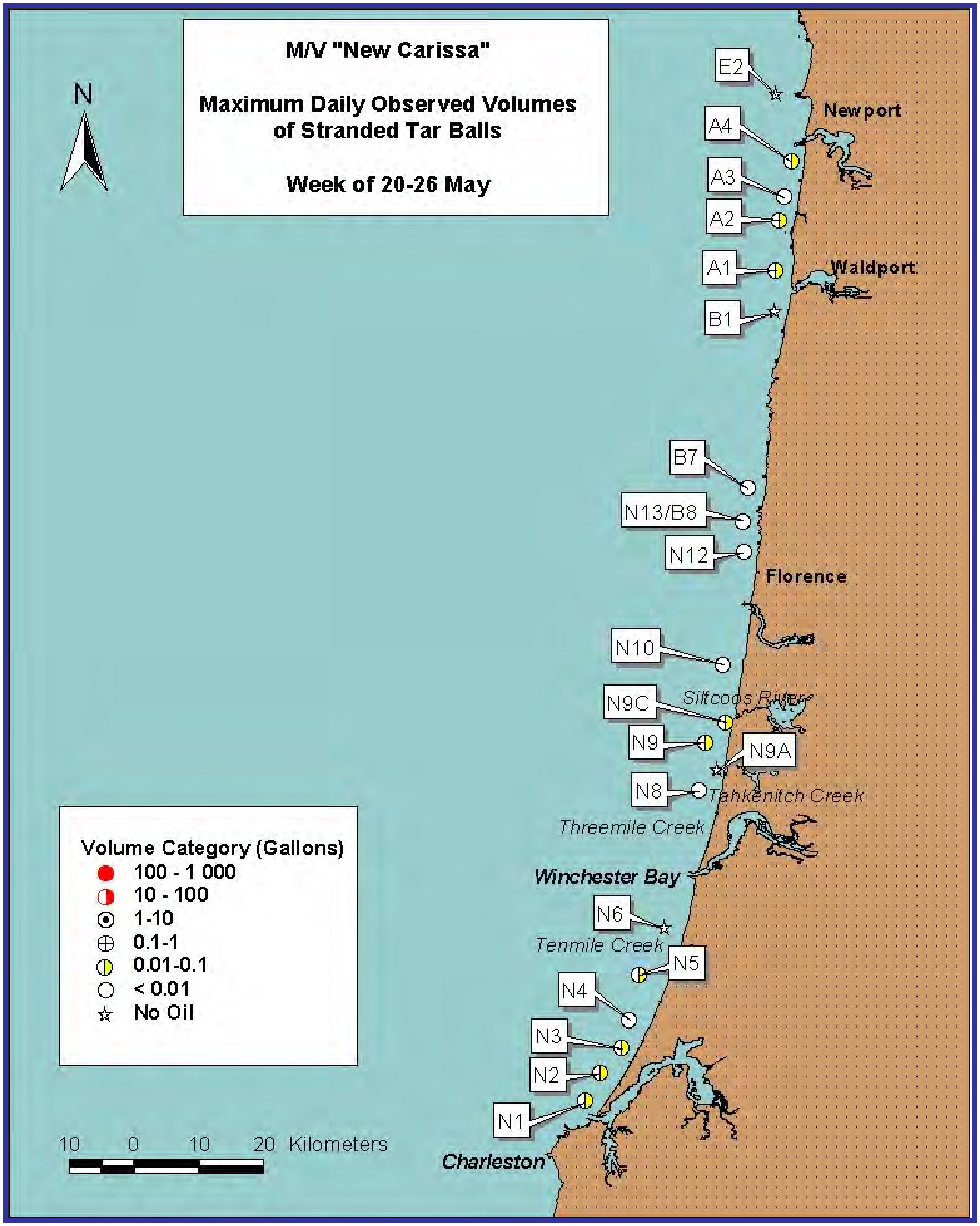

Cosco Busan Incident
Maximum Observed Oiling Category
(from Nov 8, 2007 to April 16, 2008 SCAT surveys)
Oiling Category
Heavy
Moderate
Light
Very Light
No Observed Oil
Produced on Jul 31, 2008.
0 2 4 8 12 16 20
Kilometers

Example Oil Cover Graph



Example Treatment Recommendation Map




M/V "New Carissa"
Maximum Daily Observed Volumes of Stranded Tar Balls
Week of 20-26 May
N
E2
A4
A3
A2
A1
B1
Newport
Waldport
B7
N13/B8
N12
Florence
N10
N9C
Siltcoos River
N9
N9A
N8
Tahkenitch Creek
Threemile Creek
Winchester Bay
N6
Tenmile Creek
N5
N4
N3
N2
N1
Charleston
Volume Category (Gallons)
100 - 1 000
10 - 100
1-10
0.1-1
0.01-0.1
< 0.01
No Oil
10 0 10 20 Kilometers

5.6. SCAT Case Studies

<u>"North Cape" Spill - Rhode Island, 19 January 1996</u>

❖ 828,000 gallons No. 2 fuel oil

❖ Shoreline Assessment Teams

< 23 January survey

< 4 categories:
(1) could smell but could not see oil,
(2) greasy film could be felt but not seen,
(3) sheen visible, and
(4) coat of oil visible.

< Only one section of coast in category 4.

< Cleanup recommended at a few sites, involving oily debris removal and sorbents.

<u>"New Carissa" Spill - Oregon, 2000</u>

❖ after the initial oiling phase, standard SCAT procedures yielded oil volumes that were always too high

(1) the AREA covered by tar balls generally was less than 1% (and thus approximated to 1%), and the thickness category was always a COVER (> 1 mm and < 1 cm)

(2) the WIDTH of the area covered by tar balls often was reported as the width of the beach

As a result of these standardized measurements, the degree of oiling was always reported as VERY LIGHT, and the estimated volumes tended to be uniformly too high.

❖ Solution: Generated a new form (Beach Assessment Report Form) that has been adopted by NOAA and Environment Canada for reporting tar balls.

Additional Case Studies are presented in the Environment Canada SCAT manual (Owens and Sergy, 2000)

INCIDENT	M/V *Selandang Ayu* Unalaska Island, Alaska December 2004 – June 2006	M/V *Cosco Busan* San Francisco Bay, California November 2007 – April 2007
PREPLANNING (local area)	none	no segmentation – Area Contingency Plan divisions
SPILL	480,000 gallons (11,300 bbl)	54,000 gallons (1,275 bbl)
REACTIVE PHASE	aerial reconnaissance and video – remote area – no direct access	ground reconnaissance – easy access
Affected Area	760 km surveyed 50.4 km had observed oil	390 km surveyed 107.5 km had observed oil
Number of SCAT teams	4	4
SCAT Coordinator	Yes - RP	Yes - RP
SCAT Data Manager	Yes	Yes
Treatment End Points	Agreed and approved by UC prior to Phase 2	Agreed and approved by UC prior to Phase 2
Shoreline Treatment Recommendation	Yes – STRT forms	Yes – STRT forms
Treatment and Inspection Phases	1. limited bulk oil removal in winter 2. oil removal to/near endpoint criteria: remote area "*clean as you go and sign off as you go*" strategy 3. Final Sign Off inspection with landowner/manager	Phase 1 - bulk oil removal Phase 2 - oil removal to/near endpoint criteria Phase 3 - maintenance and monitoring Phase 4 - Final Sign Off inspection with landowner/manager
Inspection process	• Transition from Phase 2 to 3 **driven by Operations** (Lowest Practicable Level of Contamination), Safety Constraints, and NEB considerations. • **Pre-inspection survey** (PEST) conducted prior to Final Sign Off inspection • **SIR process** and forms used in Final Sign Off inspections of segments	• Transitions from Phase 1 to Phase 2 and from Phase 2 to Phase 3 **driven by Operations** (Lowest Practicable Level of Contamination), Safety Constraints, and NEB considerations. • **Pre-inspection survey** (POM) conducted prior to Phase 3 inspection • Phase 3 inspection and **SIR process** involved (i) completion of a new SOS form and (ii) common use of the concept that "*NFT is appropriate because natural weathering is considered to be the most appropriate remaining cleanup strategy*".
COMPLETION PHASE	UC Memo 23 June 2006	219 out of 226 segments "signed off" by UC 28 August 2008

5.7. *Pre-Spill SCAT Survey*

The SCAT process is based on the use of a systematic approach and standardized terms and definitions. Pre-spill SCAT activities follow this same process to collect, collate, and organize information using survey forms (an example of a Pre-Spill SCAT Segment Survey Form is shown on pages 5-46 and 5-47).

- Pre-spill SCAT data collection and/or collation is intended to complete as many phases of the SCAT process as can be undertaken prior to a spill. This activity can:
  - *reduce field survey effort* at the time of a spill,
  - identify *operational and logistical constraints or opportunities* (e.g., access, safety hazards, etc.),
  - identify *suitable types and quantities of cleanup equipment*, and
  - provide an opportunity for interested/responsible parties to consider *response priorities and strategies* and reach a *pre-spill consensus*.
- The process may involve:
  - FIELD SURVEYS, and/or
  - COLLATION OF AVAILABLE DATA.

The pre-spill SCAT activities do not replace environmental mapping or other spill-related data collection programs or contingency planning, but rather are designed to build on those activities and to *collect relevant, or organize existing, data in a form that is suitable for use by Planning and Operations* groups.

The pre-spill SCAT work is particularly valuable in high risk or highly sensitive and vulnerable areas *where time would be of the essence* at the time of a spill event to reach agreement and to implement a shoreline protection and/or cleanup strategy.

Pre-Spill SCAT Programs

- Provides segmentation as the framework for a regional data base
- Has been applied to Atlantic Canada, British Columbia, Oahu, Sakhalin Island, Alaskan North Slope, Chukchi Sea, and Prince William Sound Alaska

Pre-Spill SCAT Database

Relevant information that can be included in a SCAT database relates to not only the shore-zone character, but also to operational factors and to appropriate response (i.e., protection and cleanup) strategies. Examples of pre-spill data that can be included are summarized below.

Examples of Data That Can Be Included in a Pre-spill SCAT Database

1) **GENERAL INFORMATION**
   - segment area, location number, date of survey
   - tidal level/weather conditions
   - observer's name, participants in pre-spill assessment
2) **PHYSICAL SHORE-ZONE CHARACTER**
   - segment width, length
   - substrate type
   - nearshore conditions
   - potential oil behavior
3) **RESOURCE ISSUES**
   - primary resources at risk
   - resource (environmental, cultural, economic) constraints on response operations
4) **OPERATIONAL CHARACTERISTICS**
   - backshore human use activities
   - local logistics (e.g., shelter; power sources; toilet facilities; potable water; fire hydrants; etc.)
   - pre-impact debris pickup
   - operational constraints (access, nearshore conditions, ice, etc.)
5) **OPERATIONAL SAFETY CONSIDERATIONS**
   - backshore or on-land hazards
   - hazards at the waters' edge or in the nearshore
6) **RESPONSE GOALS (SEGMENT OBJECTIVES AND STRATEGIES)**
   - segment protection objectives and strategy(ies)
   - cleanup/treatment objectives and strategy(ies)
7) **METHODS**
   - potential protection options
   - potential cleanup/treatment options
8) **OPERATIONAL ISSUES**
   - segment/spill site access
   - equipment use feasibility
   - safety

Pre-Spill SCAT segment survey form (page 1).

PRE-SPILL SCAT SEGMENT SURVEY

1 GENERAL INFORMATION

Area:______________________ Location:______________________ Segment Number:______________________
Survey Date:__________________ Survey Time:__________________ Tide Level: ______________m
Observer Name:______________________ Weather/Wind Conditions:______________________
Participants:______________________
Snow-Ice Conditions:______________________

2 PHYSICAL CHARACTER

Segment Length:__________________m
Width (intertidal):__________________m
Width (backshore):__________________m
Nearshore Reef/Shoal: Yes____ No____
Shoreline Waves (normal/average breaker height):
< 25 cm____; 25-50 cm____; 50 cm-1 m____; > 1 m____

POTENTIAL OIL BEHAVIOUR:

natural alongshore movement barrier: yes / no
man-made alongshore barrier: yes / no
natural bay or embayment: yes / no
tidal inlet or channel: yes / no
tidal lagoon or estuary: yes / no
sand shoreline/potential for burial: yes / no
overwash into lagoon or marsh: yes / no
pebble-cobble shoreline/penetration potential: yes / no
riprap, boulder shoreline/penetration-remobilization potential: yes / no
marsh-wetland/potential for oiling meadow area: yes / no
other:

SUBSTRATE TYPE (from list below)	*LITZ	UITZ	SU
Bedrock			
Man-Made Solid (Impermeable)			
Sand Beach			
Mixed Sediment Beach (Sandy Gravel)			
Pebble-Cobble Beach (Shingle)			
Mixed Sediment Beach (Coarse Gravel)			
Boulder Beach			
Man-Made Permeable (wharf: pilings)			
Mud Tidal Flat			
Sand Tidal Flat			
Mixed and Coarse Sediment Flat			
Salt Marsh			

* LITZ = lower intertidal zone; UITZ = upper intertidal; SU = supratidal zone

COASTAL CHARACTER

____ cliff ____ tidal inlet ____ marsh
____ platform ____ beach ____ overwash
____ man made ____ delta ____ scree/talus
____ estuary ____ dune ____ forest
____ channel ____ flats ____ field

3 RESOURCE ISSUES

	Primary Resource(s) at Risk	*Response Constraints*
Environmental		
Cultural		
Human Use/ Economic		

4 OPERATIONAL CHARACTERISTICS

Surrounding Human-Use Activities (if any): Natural / Agricultural / Commercial / Residential / Recreational
Potential nearby access: fixed-wing__________; helo.pad/landing__________; boat landing__________; ATV__________
Access constraints/limitations:______________________
Describe the amount of pre-impact debris pickup/relocation work? ____(light / moderate / heavy)____ No. of bags? __________
(estimate # of bags)

remote: yes / no
staging areas: yes / no
road access: yes / no / ?
alongshore access: yes / no / ?
winter shore ice: yes / no / ?
exposed coast: yes / no
strong currents: yes / no
nearshore shoals/reefs: yes / no / ?
narrow intertidal zone: yes / no
shore zone suitable for machinery: yes / no / ?
backshore cliff yes / no
high tidal range: yes /no

Comments:

5 OPERATIONAL SAFETY CONSIDERATIONS

Note Safety Constraints Beyond Normal — or N/A:

(form revision: August 2012) Page 1 of 2

Prespill_Segment Form _Temperate August 2012

Pre-Spill SCAT segment survey form (page 2).

PRE-SPILL SCAT SEGMENT SURVEY

GENERAL INFORMATION Survey Date:___
Area:___ Location:___ Segment:___

6 RESPONSE GOALS

SEGMENT PROTECTION OBJECTIVES:
_____ **Prevent contact with shore or resource(s) at risk**
_____ **Minimize contact**
_____Prevent oil movement to adjacent segment(s)
_____Contain stranded oil
_____Prevent oil transport into inlet, estuary, or channel
_____Other:

SEGMENT PROTECTION STRATEGIES:
_____Contain/recover oil on water
_____Alter direction of movement of oil on water
_____Prevent oil movement (landward) on flooding tides
_____Trap/contain and collect oil at the shoreline
_____Prevent remobilization of stranded oil
_____Prevent overwash into the backshore or a lagoon
_____Pre-impact shoreline debris removal
_____Other:

SHORELINE CLEANUP/TREATMENT OBJECTIVES:
_____ **Allow natural recovery**
_____ **Restore shore to pre-oiling condition**
_____ **Accelerate natural recovery**
_____Restore with minimal removal of material
_____Minimize oil remobilization
_____Minimize damage to dune, marsh, or peat bog
_____Other:

SHORELINE CLEANUP/TREATMENT STRATEGIES:
_____Monitor
_____Act quickly to remove stranded oil before burial
_____Remove bulk oil only
_____Minimize waste generation using *in-situ* treatment methods
_____Manual techniques preferred
_____Salt-marsh fringe/meadow treatment strategies
_____Man-made backshore riprap treatment techniques
_____Other:

7 METHODS --------- *(check all that are appropriate and feasible)* -----------
(mark "?" if possibly useful; mark "X" if not recommended or inappropriate)

POTENTIAL PROTECTION OPTIONS:
____1. Nearshore containment/recovery
____2. Nearshore redirection (away)
____3. Nearshore redirection (towards)
____4. Exclusion boom
____5. Shoreline (intertidal) protection boom
____6. Shoreline barrier/berm
____7. Contact barrier
____8. Channel boom/barrier

POTENTIAL CLEANUP/TREATMENT OPTIONS:
____1. Natural recovery
____2. Flooding
____3. Low-pressure, cold wash
____4. Low-pressure, hot/warm wash
____5. High-pressure, cold wash
____6. High-pressure, hot/warm wash
____7. Steam cleaning
____8. Sandblasting
____9. Manual removal
____10. Vacuums
____11. Mechanical removal
____12. Vegetation removal
____13. Passive sorbent
____14. Tilling/Aeration
____15. Surf washing/Sediment reworking
____16. Burning
____17. Dispersants
____18. Shoreline cleaners
____19. Solidifiers
____20. Bioremediation/Nutrient enrichment

8 OPERATIONAL ISSUES

SPILL SITE ACCESS: (Enter "No" or "Yes")

To/From:	Trucks	Heavy Equip.	2X4 P/U	Backhoes	ATVs	> 50 ft. Vessel	< 15 ft. Runabouts
Staging Area/ Backshore							
Intertidal						(shaded)	(shaded)
Subtidal Water	(shaded)	(shaded)	(shaded)	(shaded)	(shaded)		

HEAVY EQUIPMENT USE FEASIBILITY: (Enter "Good", "Fair", "Poor", or "No" based on ability to operate)

	Grader	Bulldozer	Front-end Loader	Backhoe	Bobcat	4x4 P/U	ATVs
Access Alongshore							
Bearing Capacity							
Beach Slope/Width							

Maximum Distance to Temporary Storage from Cleanup Site? ___________ (metres)

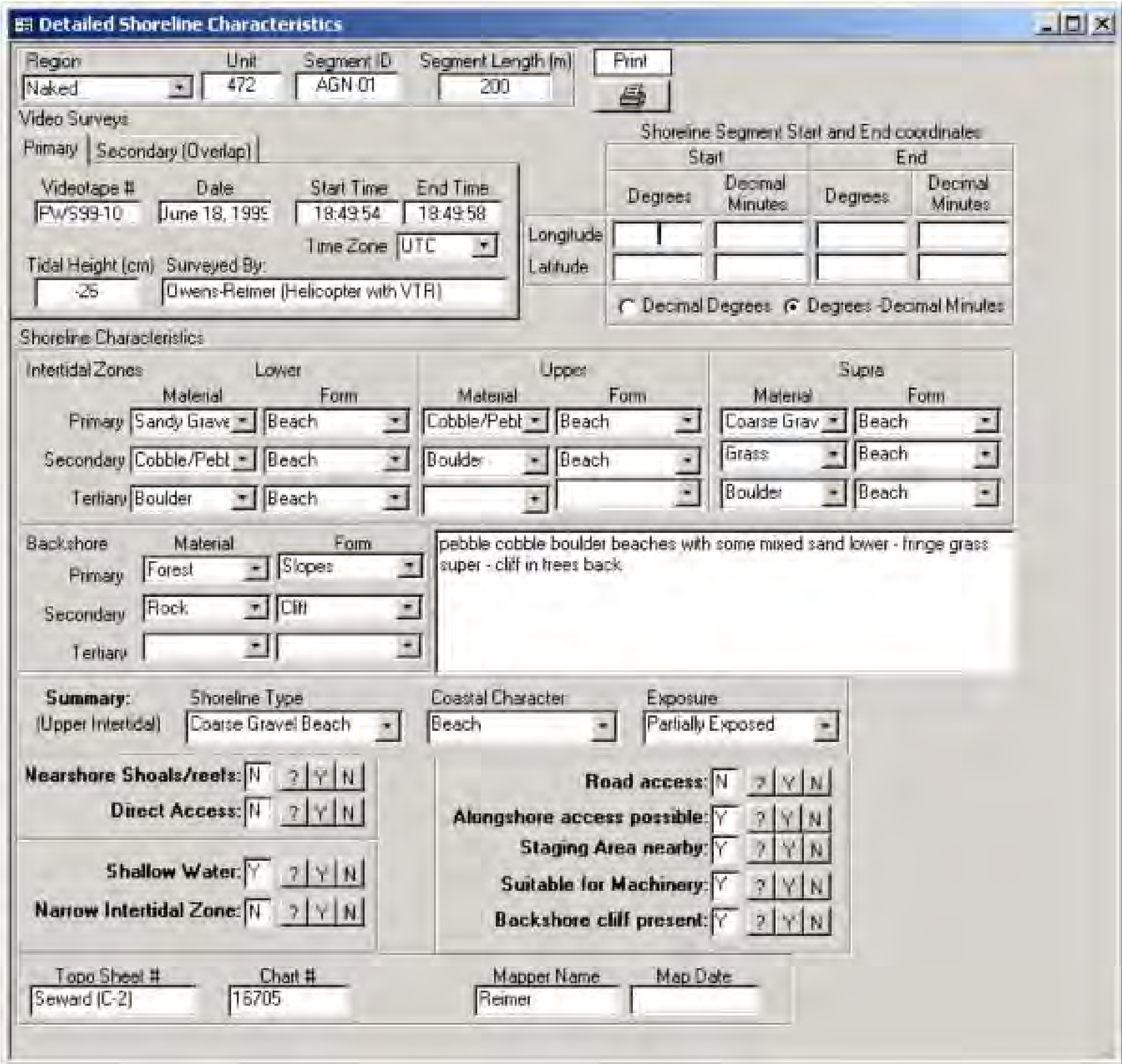
9 COMMENTS

10 VISUALS
SKETCH Attached: yes_____ no_____; PHOTOS Attached: yes_____ no_____
VIDEO: yes_____ no_____; tape #__________;

Page 2 of 2

Prespill_Segment Form _Temperate August 2012

Pre-spill SCAT database entry form.



Detailed Shoreline Characteristics

Region: Naked | Unit: 472 | Segment ID: AGN 01 | Segment Length (m): 200 | Print

Video Surveys — Primary | Secondary (Overlap)

Videotape #: PWS99-10 | Date: June 18, 1999 | Start Time: 18:49:54 | End Time: 18:49:58

Time Zone: UTC

Tidal Height (cm): -25 | Surveyed By: Owens-Reimer (Helicopter with VTR)

Shoreline Segment Start and End coordinates

	Start Degrees	Start Decimal Minutes	End Degrees	End Decimal Minutes
Longitude				
Latitude				

○ Decimal Degrees ◉ Degrees -Decimal Minutes

Shoreline Characteristics

Intertidal Zones	Lower Material	Lower Form	Upper Material	Upper Form	Supra Material	Supra Form
Primary	Sandy Grave	Beach	Cobble/Pebt	Beach	Coarse Grav	Beach
Secondary	Cobble/Pebt	Beach	Boulder	Beach	Grass	Beach
Tertiary	Boulder	Beach			Boulder	Beach

Backshore	Material	Form
Primary	Forest	Slopes
Secondary	Rock	Cliff
Tertiary		

pebble cobble boulder beaches with some mixed sand lower - fringe grass super - cliff in trees back

Summary: (Upper Intertidal) — Shoreline Type: Coarse Gravel Beach | Coastal Character: Beach | Exposure: Partially Exposed

Nearshore Shoals/reefs: N ? Y N
Direct Access: N ? Y N
Shallow Water: Y ? Y N
Narrow Intertidal Zone: N ? Y N

Road access: N ? Y N
Alongshore access possible: Y ? Y N
Staging Area nearby: Y ? Y N
Suitable for Machinery: Y ? Y N
Backshore cliff present: Y ? Y N

Topo Sheet #: Seward (C-2) | Chart #: 16705 | Mapper Name: Reimer | Map Date:

5.8. *Who Uses SCAT Data ?*

❖ **Unified Command** to evaluate the scale of the problem and the scope of the response

❖ **Planning** to:
- < define priorities
- < select cleanup or treatment methods
- < identify the required level of effort
- < apply cleanup or treatment end-point criteria
- < monitor progress

❖ **Logistics** to figure out what is required to complete the job on a site-by-site (segment) basis

❖ **Operations** to find the site and implement the cleanup task

❖ **Waste Team** to determine what type of and how much waste will be generated at each site

❖ **Environmental and NRDA Teams** to (i) assess effects and recovery, and (ii) identify potential liabilities

❖ **Safety Officer(s)** to identify shore-zone hazards and other safety issues at each work site

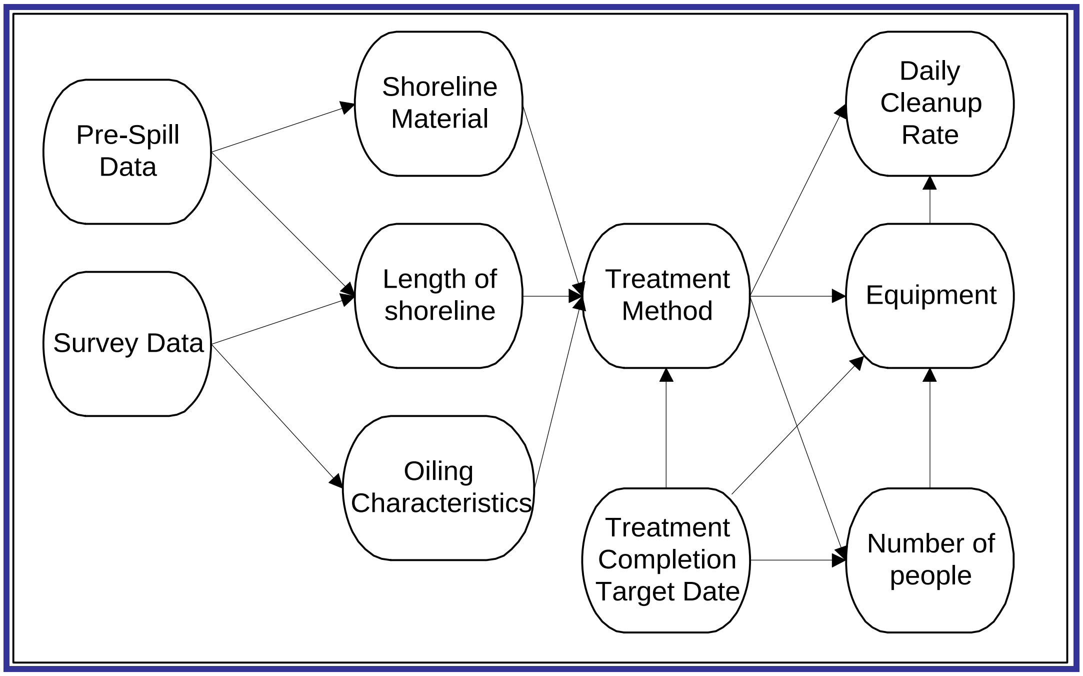
❖ **Public Information Team** to provide accurate data to the media on the scale of the oiling and on the progress of the cleanup

❖ **Agencies and Trustees** to evaluate the proposed activities and to monitor progress (they now expect to see a SCAT team in action very early in a spill response - and to participate)

❖ SCAT is included in the NIIMS ICS as a function of the Environmental Unit

❖ etc., etc., etc. ...

Schematic that shows the application of pre-spill and shoreline oiling data to the decision process for treatment methods and for planning treatment resources and rates.



Final Thoughts……

Problems

- Untrained observers
- Team substitutions
- Segmentation
- Following "protocols" too closely and not adapting to the spill conditions
- Making "form completion" the goal of the survey
- Timely input of information in the Planning process and the development of the IAP

Solutions

- Training and calibration
- SCAT is not technically difficult but does require an understanding of the basic principles and the uses to which the data are applied
- Almost always requires a data manager to provide timely QA/QC and rapid data turn around times

The SCAT Survey has been successful if :

- The right number of people in a cleanup crew...
- show up with the right tools...
- at the right place, and...
- see what they expect to see (i.e., no surprises !!!)

This means that the appropriate information has been generated by the SCAT survey and that the planning process has worked well.

SCAT Information

- Provide accurate information quickly before media can "invent" information
- Counter hype with facts
- SCAT data provides an accurate perspective

"Truth"

The Economist 20 March 1999:

- EXXON VALDEZ… "spread oil a much as 3 feet thick across 1,400 miles of beach"

SCAT Facts:

- Total shoreline with "heavy oil" = 114 miles
- Total length of all oiled shorelines = 1,304 miles

Conclusions

- ❖ In some ways SCAT is taken for granted — often thought to be "an easy job that anyone can do". Actually involves a thorough understanding of coastal landforms and coastal processes, the behavior and weathering of oil, shoreline treatment methods, and data management.
- ❖ Provides management and Operations support from Day 1 through to the completion of the Inspection and Sign-off process.
- ❖ A SCAT program requires good planning and management, just like any other phase of a spill response.

Part 6 Treatment or Cleanup

Table of Contents

Part 6 Treatment or Cleanup

6.1. Treatment Decision Process/Actions

Gather & Assess Information & Data

- Define regional distribution of oiled shorelines (e.g., aerial VTR survey).
- Extract data from sensitivity maps and resource databases.
- Segment shorelines and assess (local) oiling conditions — ground SCAT survey(s).
- Estimate persistence of stranded oil.
- Identify ecological/cultural constraints.

↓

Define Objectives

- Set regional cleanup objectives.
- Define regional treatment priorities.
- Identify acceptable treatment level.
- Establish segment (local) treatment objectives and priorities.

↓

Develop Strategy

- Develop regional treatment strategy to meet the objectives and priorities.
- Establish segment (local) treatment strategy(ies) to meet the segment treatment objectives.

↓

Select Response Options

- Define those acceptable and available procedures and techniques (tactics) that can achieve the treatment objectives and strategies.

↓

Evaluate Operational Feasibility

- Identify environmental (physical), ecological, and logistical constraints that might affect the proposed operations.
- Evaluate the Net Environmental Benefit of the proposed actions.
- Evaluate the practicality and ability of the proposed operations and procedures to achieve the segment (local) treatment objectives/strategies.
- Evaluate the need to redefine an objective or strategy if the original proposed actions cannot be conducted in a safe or effective manner.

↓

Prepare Shoreline Treatment Plan

- Develop a long-range regional shoreline treatment/cleanup plan.
- Prepare individual segment (or group-of-segments) treatment/cleanup plans.

(Owens, 1996)

Objectives

The *OBJECTIVES* of response actions for the treatment of a shoreline can include:

- □ allow the oiled shore zone or riverbank to recover naturally,
- □ restore the oiled shore zone or riverbank to its pre-spill condition,
- □ accelerate the natural recovery of the oiled shoreline or riverbank,
- ? restore with minimal material removal,
- ? minimize remobilization of stranded oil,
- ? minimize operational damage to dune or marsh system.
- T avoid causing more damage in responding to the spill than the oil would cause alone,
- T use available resources in a safe, efficient, and effective manner,
- T minimize the generation and handling of waste materials.

SELECT ONE OF THE FIRST THREE OBJECTIVES (□) to define the level of treatment for the segment. Then identify which of the next three (?) also might apply to the segment.

Λ The last three objectives (T) are generic and apply to all shoreline response operations.

Strategies

The goals can be achieved by the development of a number of specific *OPERATIONAL STRATEGIES* that include:

- ❖ monitor,
- ❖ act quickly to remove oil before it is reworked and/or buried,
- ❖ remove bulk oil — allow residue to degrade
- ❖ minimize waste generation by *in-situ* techniques,
- ❖ manual treatment techniques preferred,
- ❖ marsh treatment strategy,
- ❖ backshore riprap treatment techniques.

Strategies \ Objectives	Allow to recover naturally	Restore to pre-spill condition	Accelerate natural recovery	Restore with minimal material removal	Minimize remobilization of stranded oil	Minimize operational damage
Monitor	✓					
Remove oil before reworked/buried		✓		✓	✓	
Remove bulk oil—allow residue to degrade			✓	✓	✓	✓
Minimize waste by in-situ techniques			✓	✓		✓
Manual treatment techniques preferred			✓	✓		✓
Marsh treatment strategy			✓			✓
Riprap treatment techniques			✓	✓		

(Owens 1996)

Feasibility

The *FEASIBILITY* of a selected shoreline treatment strategy is considered in the context of environmental constraints, both physical and ecological, that may affect the likely success of a proposed activity.

Examples of constraints to be evaluated include:

- is this a remote area,
- is there direct road access to the shore,
- is alongshore access possible within the segment,
- is there a suitable staging area nearby,
- is the shore zone suitable for machinery,
- is a backshore cliff or bluff present,
- would nearshore shoals or reefs affect access by water,
- are ecological resources present that might be adversely affected by response activities,
- are cultural resources present that might be adversely affected by response activities.

6.1.1. Treatment or Cleanup Options

Strategies							
Monitor	Remove oil before burial/reworking	Remove bulk oil—residue degrades	Minimize waste/In-situ techniques	Manual techniques preferred	Salt-marsh or wetland treatment	Riprap treatment techniques	**Method**
✓							1. natural recovery
	✓	✓			✓		2. flooding
	✓	✓			✓	✓	3. low-pressure, cold wash
						✓	4. low-pressure, warm/hot wash
						✓	5. high-pressure, cold wash
						✓	6. high-pressure, warm/hot wash
						✓	7. steam cleaning
						✓	8. sandblasting
	✓		✓	✓			9. manual removal
	✓	✓					10. vacuums
	✓	✓					11. mechanical removal
				✓	✓		12. vegetation cutting
		✓	✓		✓		13. passive sorbents
	✓	✓	✓				14. tilling/aeration
	✓	✓	✓				15. sediment reworking/surf wash
			✓				16. burning
		✓	✓			✓	17. dispersant
		✓				✓	18. shoreline cleaners
		✓		✓			19. solidifiers
		✓	✓				20. bioremediation

(Owens 1996)

- ❖ Shoreline treatment or cleanup usually involves a combination of methods to achieve the defined objective.
- ❖ Differentiate between —
  - – LARGE RIVERS where one bank is cleaned at a time, and
  - – SMALL RIVERS, STREAMS OR CREEKS where both banks are cleaned at the same time. Cleanup Systems

Technique Selection

The response options, in terms of the actual treatment or cleanup techniques, should be selected to be compatible with the *CHARACTER OF THE SHORE ZONE* and with the *OILING CONDITIONS*.

Selection of Cleanup / Treatment Options (1)

! Based primarily on:

— shore-zone character

— oiling conditions

! Specifically, would need to know:

— site conditions
(substrate, type, slope, access, trafficability, etc.)

— oiling character
(type, volume, distribution, thickness, penetration, etc.)

Selection of Cleanup / Treatment Options (2)

! Matrices provide a guide as to what is feasible and efficient

! Site-specific conditions will determine exactly:

(1) what options can be used and

(2) how effective they may be

Selection of Cleanup / Treatment Options (3)

Most important characteristics of oil on the shore:

! "Stickiness"

! Viscosity

! Specific gravity

Treatment Systems

Cleanup operations often involve a number of related components. For example, low-pressure washing can be seen as four activities (washing–recovery–transfer–disposal), each of which involves a number of separate actions. This combination of activities often is called a "**system**".

- Wash
  - pump(s)
  - hose(s)
- Recover
  - booms
    - boats
    - lines
    - anchors
  - skimmer(s)
    - pumps
    - power
    - fuel
  - container(s)
- Transfer
  - tank(s)
  - vehicle(s) / vessel(s)
- Disposal

Treatment Options

"Rules of Thumb"

- ❖ Basic treatment or cleanup options are:
  - < Removal
    - – wash and recover
    - – manual* or mechanical pickup
  - < Treatment in Place
    - – mix or surf wash
    - – chemical dispersant*
    - – bioremediation*

    (* = primarily for polishing or small amounts of oil only)
- ❖ Mechanical cleanup of beaches is quicker and costs less, but generates more waste than manual removal.
- ❖ Rarely will one technique be used alone.
- ❖ May use one or more methods for the gross oil and others for residual oil or "polishing".
- ❖ Minimum effort and waste generation is the goal for remote area operations.
- ❖ Multiple handing increase effort (and costs).

Shoreline Treatment Phases

Phase 1 — Bulk Oil Removal

- Recover oil that can be easily removed
- Remove oil that can be easily remobilized
- 90% of the oil for 10% of the effort

Phase 2 — Polishing

- Where necessary, remove the residual stain or coat after bulk oil removal
- Usually only necessary in recreational areas or where there is a risk to wildlife
- 10% of the oil for 90% of the effort

Phase 3 — Restoration

- Clearing up and fixing things after the operation — especially staging areas
- e.g., replacing sediment, regrading roads, mending fences, removing all waste and rubbish
- Whatcom Creek — recreating stream bank habitats

Bedrock

Typically:

- Difficult access
- Safety issues – slips/trips/falls – tides
- Ecological constraints: sensitive subtidal and intertidal biota plus supratidal lichens

Phase 1

- Vacuum — wash/recover

Phase 2

- Scraping
- Increase water temperature and pressure

Sand Beaches

Typically:

- Alongshore access straightforward
- Suitable for machinery
- Burial potential – only light products penetrate
- Few ecological constraints

Phase 1

- Manual – mechanical removal

Phase 2

- Tilling — surf washing

Coarse Sediment Beaches

Typically:

- Often difficult pedestrian movement and substrate not suitable for machinery
- Penetration and burial potential – all oil types can penetrate if no sand present
- Few ecological constraints – minimize sediment removal

Phase 1

- Washing and removal

Phase 2

- Increase water temperature and pressure
- Surf washing

Marshes — Wetlands

Typically:

- Difficult access — boats, walkways
- Safety issues — tides
- Ecological constraints: sensitive intertidal biota

Phase 1

- Sorbents — wash / recover

Phase 2

- ? ? ?

6.1.2. Treatment or Cleaning Rates

Natural Cleaning Rates

- Spilled oil is subject to degradation and weathering processes:
  - < biodegradation,
  - < dissolution,
  - < emulsification,
  - < evaporation, and
  - < photo-oxidation.
- *PHYSICAL (MECHANICAL) PROCESSES*, such as wave action, are a key factor as these break the oil down into smaller particles so that degradation processes then can act on larger surface areas of the oil.
- Oiled shorelines will clean themselves naturally in most cases (Owens, 1978, 1985). Where oil is stranded *above the limit of all wave action* or becomes *buried* — normal shore-zone mechanical and weathering or degradation processes cease.
- Thin oil residues may clean rapidly if there are fine-grain sediments in the nearshore waters and the oil is not too weathered or too viscous (Bragg and Owens, 1994, 1995; Owens, Bragg, and Humphrey, 1994). (see Section 2.1)

Natural Recovery vs Treatment — "Rules of Thumb"

- First of all, evaluate: the *POTENTIAL PERSISTENCE (RESIDENCE TIME) AND FATE OF THE OIL*; the *EFFECTIVENESS OF CLEANUP OR TREATMENT TO ACCELERATE NATURAL RECOVERY*; then *CONSIDER NATURAL RECOVERY AS THE PRIMARY OPTION IF RESPONSE ACTIONS CANNOT ACCELERATE THIS PROCESS*.
- *WAVE ACTION IS THE MOST EFFECTIVE AND LEAST EXPENSIVE METHOD OF HYDRAULIC WASHING.*
- All treatment and cleanup methods have some environmental effects; some are just more intrusive or more injurious than others (see *NET ENVIRONMENTAL BENEFIT* — Section 3.4).
- Recent studies have shown that *CLEANUP RARELY ACCELERATES NATURAL RECOVERY* for *(1) BEDROCK SHORES*, and *(2) MARSHES*. Despite our best intentions and efforts, usually we end up delaying rather than accelerating recovery in these two habitats; exceptions to this general statement occur for large amounts of viscous oil above the zone of normal wave action.

Treatment or Cleaning Rates

Can only generalize, it is very difficult to predict or estimate except on a case-by-case basis. Cleaning rates are basically affected by the oiling conditions and the site character (see Section 2). The following is a list of key factors that can affect cleanup or treatment rates.

❖ Oiling Conditions:

- < oil type
- < distribution (surface cover)
- < thickness
- < penetration
- < burial

It usually is more efficient and easier to collect large amounts of surface oil. To remove the remaining oil becomes progressively more difficult as cleanup proceeds and the amount of oil decreases.

❖ Site Character:

- < substrate type
- < slopes in the shore-zone
- < access from the backshore or nearshore
- < alongshore access
- < nearby staging areas

❖ Physical Environmental Factors:

- < tidal range
- < breaking wave action
- < weather conditions (particularly temperature and wind)
- < timing of tidal highs and lows
- < sunrise and sunset (length of work day)

❖ Resource Availability:

- < personnel
- < cleanup equipment
- < recovery/transfer/storage/disposal equipment
- < support services (shelter, food, etc.)

Cleaning Rates

"Rules of Thumb"

- ❖ Manual Removal:
  - < On a sand beach,
    - – one person can remove a maximum of 0.5 m^3 to 2 m^3 of oiled sediment in one day (8 hours);
    - – this is equal to between 500 and 2000 linear metres of beach for a 10-person team.
  - < These rates exclude waste transfer.
- ❖ Mechanical Removal:
  - < Rate is controlled by, among other things:
    - – size and physical area to be cleaned,
    - – swath width of blade or bucket,
    - – depth of sediment removal,
    - – operating speed of vehicle, and
    - – distance to temporary storage or disposal.
  - < Graders and elevating scrapers work at about 3 to 3.5 hours/hectare
  - < FEL = 8 to 10 hours/hectare
  - < Bulldozer = 12.5 hours/hectare
  - < Backhoe = 15 to 17 hours /hectare
- ❖ Mixing/Tilling/Surf Washing:
  - < Tilling/surf washing can work at 2 – 3 km/hour, and can cover:
    - – a 3-m swath 2 km long in one hour, or
    - – a 20-m swath 2 km long in about one day.
- ❖ Hydraulic Washing
  - < One low-pressure hose unit can flush bulk oil at a rate of about 50 m2/hour
    - – excluding setup/recovery/demobilization.
  - < A team of 5 washing units can cover between tens of m2/hour to 500 m2/hour
    - – usually, once set up, the teams tend to be relatively static, when in fact the majority of the oil that can be removed is dislodged in the first 5 passes with the hose; so these rates require almost continuous movement of the washing units.

6.2. Treatment or Cleanup Methods

Natural	
	1) Natural Recovery
Physical Cleaning — Washing and Recovery	
	2) Flooding
	3) Low-Pressure Cold Water Wash
	4) Low-Pressure Hot/Warm Water Wash
	5) High-Pressure Cold Water Wash
	6) High-Pressure Warm/Hot Water Wash
	7) Steam Cleaning
	8) Sandblasting
Physical Cleaning — Removal and Disposal	
	9) Manual Removal
	10) Vacuums
	11) Mechanical Removal – Elevating Scraper – Motor Grader & Elevating Scraper – Motor Grader & Front-end Loader – Front-end Loader – Bulldozer & Front-end Loaders – Backhoe – Dragline, Clamshell – Beach Cleaner
	12) Vegetation Removal/Cropping
	13) Passive Sorbent Collection/Removal
Physical Cleaning — *In-Situ* Treatment	
	14) Tilling – Mixing
	15) Surf Washing – Sediment Reworking
	16) Burning
Chemical/Biological Treatment	
	17) Dispersants
	18) Shoreline Cleaners
	19) Solidifiers
	20) Bioremediation/Nutrient Enrichment

Impact of Response Options

- All options except for natural recovery involve some form of intrusion on the ecological character of the shoreline type that is being treated or cleaned.
- The selection of response techniques involves an assessment of the trade-off associated with the effects of the cleanup operations and leaving the oil to be cleaned naturally. In some cases, cleanup that involves intrusion may be preferred to natural recovery.
- The table on the following page lists the response options and summarizes the relative level of impact that each option may have for the shoreline types used in these guidelines, irrespective of the type or volume of oil that may be involved in a spill.

Summary of Relative Potential Impact of Response Techniques in the Absence of Oil

(Modified from API, 2001)

Response Method	Shoreline Intertidal													Ice	
	Exposed Rocky Shores	Exposed Solid Man-Made Structures	Exposed Wave-Cut Platforms	Sand Beaches	Mixed Sand and Gravel Beaches	Gravel Beaches	Riprap	Exposed Tidal Flats	Sheltered Rocky Shores	Sheltered Solid Man-Made	Sheltered Tidal Flats	Marshes	Peat Shores	Accessible Ice	Inaccessible Ice
Natural Recovery	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Flooding	—	—	B	B	B	B	B	B	B	—	B	B	B	—	—
Low-Pressure, Ambient-Water Flushing	B	B	B	B	B	B	B	C	B	B	C	B	B	B	B
Low-Pressure, Hot-Water Flushing	D	D	D	D	D	D	D	—	D	D	—	—	—	B	B
High-Pressure, Ambient-Water Flushing	C	C	C	—	C	C	C	—	C	C	—	—	—	—	—
High-Pressure, Hot-Water Flushing	D	D	D	—	D	D	D	—	D	D	—	—	—	—	—
Steam Cleaning	D	D	D	—	D	D	D	—	D	D	—	—	—	B	B
Sandblasting	D	D	D	—	—	—	D	v	D	D	—	—	—	—	—
Manual Oil Removal/Cleaning	B	B	B	B	B	B	A	C	B	B	D	D	B	B	—
Vacuum	B	—	B	B	B	B	A	B	B	—	B	C	B	B	B
Mechanical Oil Removal	—	—	—	C	C	C	C	D	—	—	-	D	D	B	B
Vegetation Cutting/Removal	—	—	—	C	C	—	—	D	D	—	D	D	C	—	—
Sorbents	B	B	B	B	B	B	A	B	B	A	B	C	B	B	B
Sediment Reworking	—	—	—	C	C	C	—	D	—	—	—	D	B	—	—
Sediment Tilling	—	—	—	C	C	C	—	D	—	—	—	D	B	—	—
***In-Situ* Burning**	—	—	D	C	C	C	D	—	D	—	—	C	—	B	B
Dispersants	—	—	—	—	—	—	—	—	—	—	—	—	—	B	B
Surface Washing Agents	B	B	B	—	C	B	B	—	B	B	—	B	—	—	—
Solidifiers	—	—	B	B	B	B	B	B	B	—	B	C	—	B	B
Nutrient Enrichment	—	—	—	B	B	B	B	I	B	I	I	B	B	I	I

A = may cause the least adverse impact
B = may cause some adverse habitat impact
C = may cause significant adverse habitat impact
D = may cause the most adverse habitat impact
I = incomplete information
— = not applicable to this habitat type

6.2.1. Physical Cleaning — Washing and Recovery

This group of methods involves a variety of washing or flushing techniques to move oil from the shore zone to a location for collection, from where it can be removed and disposed.

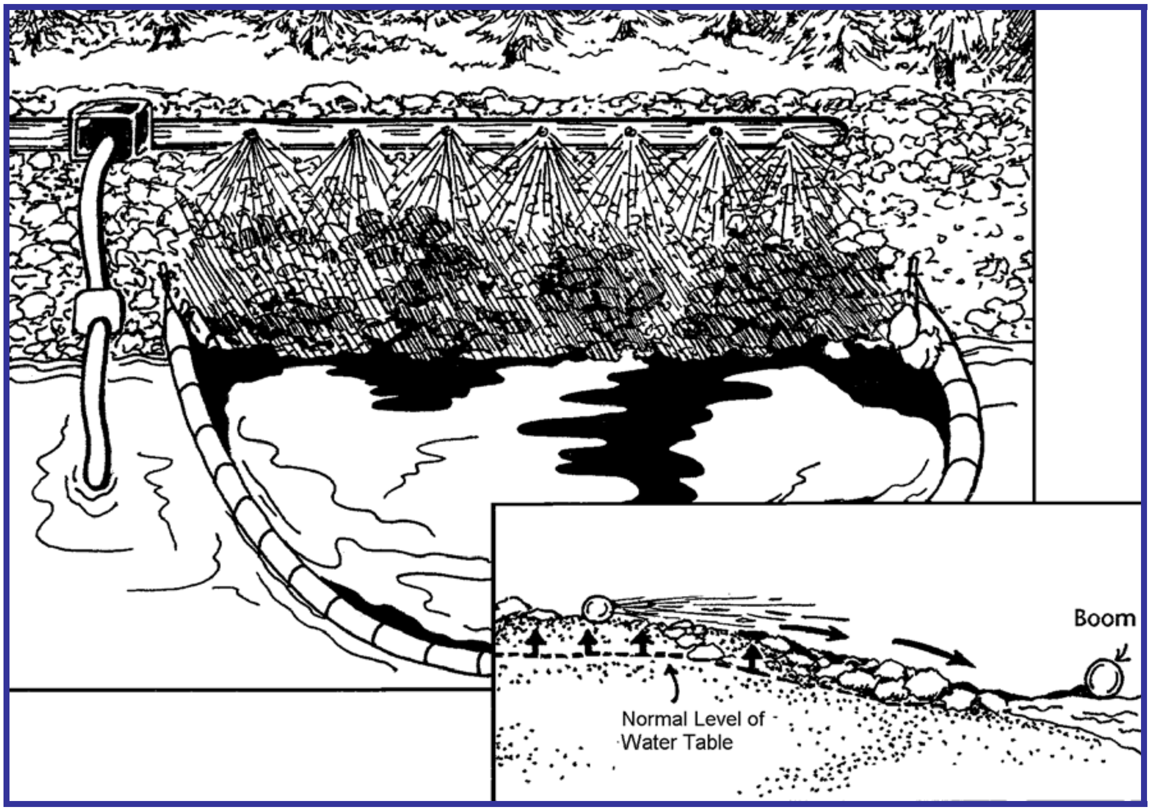
- Often this involves washing the oil —
  - (a) onto the adjacent water where it can be contained by booms and collected by skimmers, or —
  - (b) towards a collection area, such as a lined sump or trench, where it can be removed by a vacuum system.
- The variables that distinguish one particular washing technique from another are *PRESSURE* and *TEMPERATURE* (see table below). All of the equipment used for these techniques would be available commercially.
- The flushing or steam cleaning techniques (3 through 7) are sometimes referred to as *SPOT WASHING* when applied to *small sections* of shoreline.

Summary of Washing or Flushing Technique Ranges

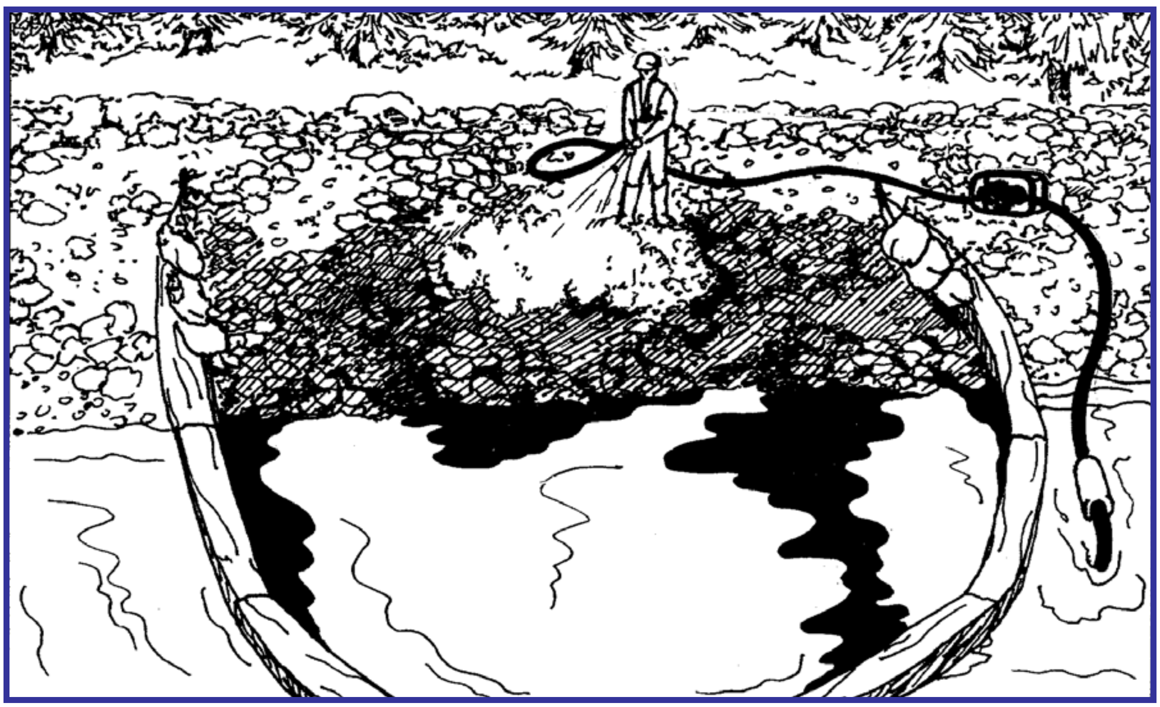
(Owens 1996)

Technique	Pressure Range		Temperature Range (°C)
	bars	[psi]	
2) Flooding ("*deluge*")	< 1.5	[< 20]	ambient sea water
3) Low-pressure, Cold Washing	< 3	[< 50]	ambient sea water
4) Low-pressure, Warm/Hot Washing	< 3	[< 50]	30 – 100
5) High-pressure, Cold Washing	4 – 70	[50–1000]	ambient sea water
5) "*Pressure Washing*"	> 70	[> 1000]	ambient sea water
6) High-pressure, Warm/Hot Washing	4 – 70	[50–1000]	30 – 100
7) Steam Cleaning	4 – 70	[50–1000]	> 100
8) Sandblasting	4	[50]	n/a

Flooding technique. (Owens 1996)



Low-pressure washing technique. (Owens 1996)



6.2.2. Physical Cleaning — Removal and Disposal

This group of physical methods involves *removal of the oil or oiled materials* (sediments, debris, vegetation, etc.) from the shore zone to a location where it can be disposed.

- With the exception of sorbent materials, all of the equipment necessary to implement these techniques is used for non-spill related activities and is available commercially. Most sorbents are manufactured specifically for use on oil spills.
- The mechanical techniques essentially use equipment that has been designed for earth-moving or construction projects, although a few commercial devices have been fabricated with spill cleanup as one specific application.

Summary of Efficiency Factors for Removal Techniques (Owens 1996)

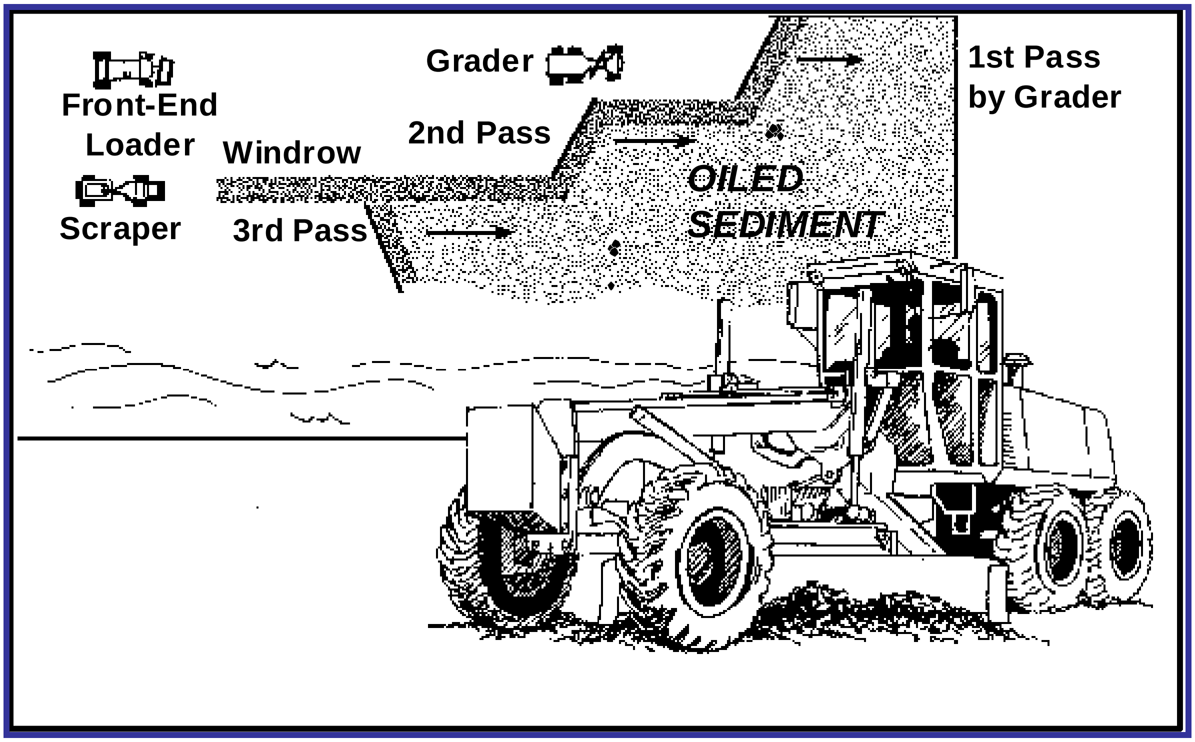
Technique	Resource Requirements	Relative Cleanup Rate	Single or Multiple Step	Waste Generation
(9) Manual Removal	labor intensive	slow	multiple	minimal
(10) Vacuums	labor intensive	slow	multiple	moderate
(11) Grader/Scraper	minimal labor support	very rapid	multiple/single	moderate
Front-end Loader	minimal labor support	rapid	single	high
Bulldozer	minimal labor support	rapid	multiple	very high
Backhoe	minimal labor support	medium	single	high
Dragline/Clamshell	minimal labor support	medium	single	high
Beach Cleaners	minimal labor support	slow	varied	low
(12) Vegetation Cutting	labor intensive	slow	multiple	can be high
(13) Passive Sorbents	labor intensive if used extensively with large amounts of oil	slow	multiple	can be high if frequent change-outs required

Earth-Moving Equipment (in order of preference)

(Owens 1996)

Machine	Technique	Applicability
Elevating scraper	Moves parallel to the water line scraping off a thin layer of surface oiled sediment, which is collected in a hopper; can be used to remove windrows.	Limited to relatively hard and flat sand beaches with surface oiling; reduced tire pressure can extend operations.
Motor grader	Moves parallel to the water line side-casting off a thin layer of surface oiled sediment which forms a linear windrow for pickup; excessive spillage may result if more than 2 passes are made.	Limited to relatively hard sand beaches with surface oiling; can operate on low-angle slopes; reduced tire pressure can extend operations.
Front-end loader (FEL)	Bucket lifts oiled sediments for transfer to truck or temporary storage site; for surface oiling, bucket should lift only a thin cut to avoid removing clean sediments; removes windrows.	Can operate on most sediments to remove surface and subsurface oil; traction reduced as sediment size increases.
Bulldozer	Blade moves oiled sediments for pickup and transfer by other equipment; least preferred earth-moving equipment, has least control of depth of cut and can mix oil into sediments.	Can operate on most sediments to move surface and subsurface oil; traction reduced as sediment size increases.
Backhoe	Bucket lifts oiled sediments for transfer to truck or temporary storage site; for surface oiling, bucket should lift only a thin cut to avoid removing clean sediments; can reach from a platform or clean area.	Can operate on most sediments or on steep slopes to remove surface and subsurface oil; traction reduced as sediment size increases.
Dragline/ Clamshell	Bucket lifts oiled sediments for transfer to truck or temporary storage site; can reach from a platform or clean area; poor control of depth of cut.	Can operate on most sediments or on steep slopes to remove surface and subsurface oil.

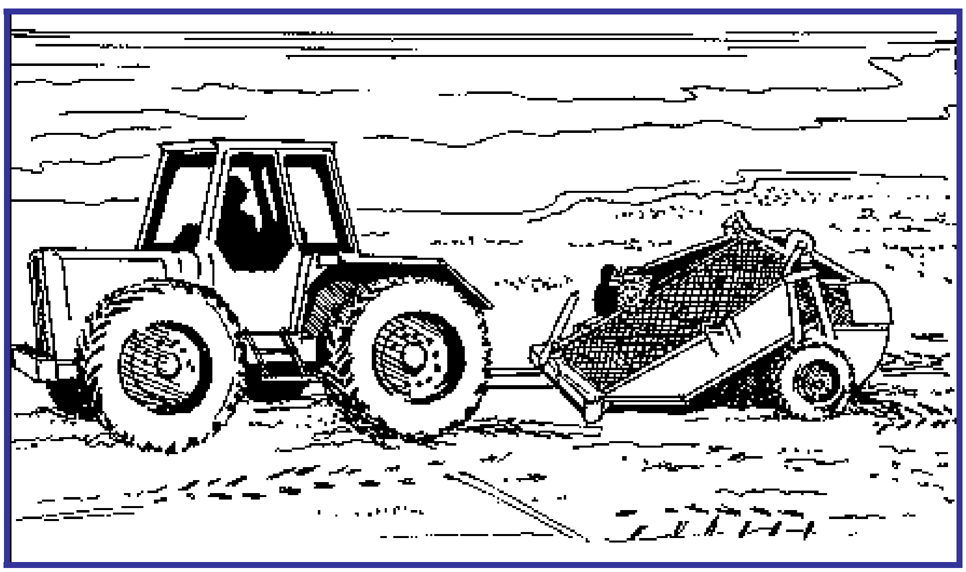
Examples of earth-moving equipment techniques. (Owens 1996)



Beach Cleaning Machines

(see also Taylor and Owens, 1997)

Machine	Technique	Applicability
Mobile Lifters/ Sorters and Rakes	Moving vehicle picks up oil and/or sediment by belts, brushes, rakes, scraper, sieves, tynes or water jets to separate oil from the sediments.	Usually limited to semi-solid, solid, or weathered oils that can be easily separated from clean sediments.
Mobile Vacuums	Vacuum systems that have a fixed slot or similar suction system that is mounted below a mobile platform (usually a tank truck).	Restricted to flat, hard beaches with a thin layer of surface oil.
Mobile Washers	Oiled sediments are picked up, treated, and replaced as the vehicle travels forward.	Can handle thin layers of oiled sands and most oil types; usually slow through-put volumes.
Off-site Sorters	Oiled materials are removed from the beach, sorted, and the clean material is replaced and oily wastes disposed.	Can handle most sizes of sediments but only weathered oil types; usually slow throughput volumes.
Off-site Washers or Treaters	Oiled materials are removed from the beach, treated, and the treated materials are replaced or disposed. Usually involves multiple transfers of sediment.	Can handle most sizes of sediments and oil types; usually slow throughput volumes.



(adapted from ITOPF, 1987)

6.2.3. Physical Cleaning — In-Situ *Treatment*

This group of methods involves physical, on-site, treatment techniques to alter the character of the oil in the shore zone in order to promote weathering and natural degradation.

❖ A key feature of this group of techniques is that essentially *no oiled materials are generated* that require transfer and disposal.

In-Situ Treatment Methods

14) Mechanical Tilling / Mixing

! Involves the mixing of sediments in place or the exposure of subsurface oil: can be carried out by most types of earth-moving equipment or by mechanical rakes/tines.

! "Wet mixing used underwater as a removal technique on beaches during a rising tide or in streams to release/recover oil without sediment removal.

15) Sediment Reworking / Surf Washing

! Either:

(1) oiled material in the zone above the normal limit of wave action is moved downslope to an area where waves can abrade the sediments and remove the oil (sediment reworking; Owens and Teal, 1990); or

(2) stained or oil coated sediments can be mechanically pushed into the surf zone to accelerate wave abrasion or to accelerate fine-particle aggregation (Owens, Bragg, and Humphrey, 1994).

16) Burning

! Oiled debris or logs can be ignited on site or collected and burned in pits or barrels.

! Used in some areas to burn oiled marshes if substrate is wet.

Mechanical Tilling/Mixing

14) Mechanical Tilling/Mixing Techniques
"Dry" Mixing Techniques: • Garden rotary tiller (manual or towed) • Rakes (manual) • Agricultural discs, harrows, or ploughs • Earthmoving ripper (tynes), excavators, or backhoes
"Wet" Mixing Techniques: • Agricultural discs, harrows, or ploughs • Earthmoving ripper (tynes), excavators, or backhoes • High-volume, low-pressure water jets • Low-volume, high-pressure water jets

14) Mechanical Tilling/Mixing	
ACTIVITY — OBJECTIVE	**BENEFITS — APPLICATIONS**
• **Accelerate natural weathering** of penetrated or buried oil without sediment removal or waste generation	• increases natural weathering rate • no sediment removal • no waste generation • useful for small or large amounts of oil in remote areas
• **Break up a surface oil cover** in the upper intertidal or supratidal zones before or after a resistant asphalt pavement forms	• prevents pavement formation • increases natural weathering rate • no sediment removal • no waste generation • useful for small or large amounts of oil in remote areas
• **Mixing** sediments to **expose any subsurface oil** that might have been missed by manual and/or mechanical cleanup	• locates subsurface oil residues • oil removed, little sediment removal • an important secondary step on recreational beaches
• **Release/recover oil** by underwater agitation in a stream or during a rising tide without sediment removal	• oil recovered or volatile oils immediately weathered • no sediment removal

In-Situ Treatment Methods

15) Sediment Reworking/Surf Washing

- ❖ Earthmoving equipment is used to move oil or oiled sediments from surface or subsurface areas where:
  - (a) they are protected from natural physical abrasion and weathering processes, or
  - (b) these processes occur at relatively slower rates.
- ❖ The oiled sediments are moved to a location where these processes are more active.

- ❖ Mechanical Tilling/Mixing (14) and Sediment Reworking/Surf Washing (15) have many similarities.
- ❖ The objective of both techniques is to accelerate evaporation and other natural degradation processes. In tilling this is achieved by turning over the sediments in place, whereas surf washing moves the oil and oiled materials to parts of the beach that have higher levels of physical (wave) energy.
- ❖ Both may involve the use of farm-type equipment such as a disc system, harrow, plough, rakes or tines, or earth-moving equipment such as front-end loaders, graders, or bulldozers.
- ❖ Both may be used in conjunction with *manual removal* (to pick up patches of oil that are exposed) or *bioremediation*.
- ❖ These methods can be used on *coarse-sediment (pebble-cobble)* or *sand beaches*, and is particularly useful in *promoting evaporation and physical abrasion*.
- ❖ Can recover oil in some cases, for example, using booms and sorbents — particularly when using “wet” tilling.

Burning

The objective of this technique is to remove or reduce the amount of oil by burning on site.

- Oil on a beach will not sustain combustion by itself unless it is pooled or has been *concentrated* in sumps, trenches, or other types of containers. This technique is used primarily where *combustible materials*, such as logs or debris, have been oiled and can be collected and burned, or where vegetation, such as a marsh, has been heavily oiled.
- Burning efficiency can be improved by the use of fans to provide wind in burn piles.
- Torches can be used to burn oil from hard substrates but this is a labor-intensive method that uses large amounts of energy to remove small amounts of oil.
- Burning equipment, such as mobile incinerators, may be used if available and if they can be transported to the site.
- Burning is applicable primarily for *OILED PEAT, LOGS, or DEBRIS*, or where oil has been collected and can be ignited with sustained combustion in sumps or drums.
- Burning has been used effectively for *OIL SPILLS ON ICE*.
- Burning of *heavily oiled marsh vegetation* has a major impact on the ecosystem if the marsh soils are dry, as the root systems can be destroyed. Wet soils protect the root systems from heat damage so that recovery from burning is more rapid.
- Burning may require that appropriate permit(s) be obtained.

6.2.4. Chemical/Biological Treatment

Chemical / Biological Methods

(17) Dispersants
(18) Shoreline Cleaners
(19) Solidifiers and Visco-Elastic Agents
(20) Nutrient Enrichment / Bioremediation

This group of methods involves chemical agents or nutrients that alter the character of the stranded oil either to:

< *FACILITATE REMOVAL* of the oil from the shore zone, or

< *ACCELERATE* IN-SITU *WEATHERING*.

❖ Nutrient enrichment and bioremediation can use products that have been developed for other applications.

❖ All of the other techniques involve agents or materials that are *designed specifically for oil spill response* and that are available commercially from manufacturers and/or suppliers.

❖ Only dispersant application (17) and bioremediation (20) are *stand-alone techniques*, the remaining methods require an additional removal component.

Dispersants

! Most effective on very light oils (90%)

! Hibernia – Prudhoe Bay medium crude oils effectiveness 5 – 20%

! Bunker C effectiveness 1 – 2%

! Less effective on weathered oils vs. fresh counterparts

Surface-Washing Agents

! Soak and rinse process

! Low dispersant effectiveness so oil can be recovered

Dispersants	vs.	Surface-Washing Agents
(Dispersancy)		(Detergency)
Oil made into fine droplets		Oil removed from solid surface

! A good dispersant is a poor detergent and vice-versa.

Potential application of treatment agent by oil type

(after Walker *et al*., 1993)

Agent	Oil Type/Degree of Weathering (Light → Medium → Heavy)
(19) Solidifiers	Most Effective → Moderately effective → Ineffective
(19) Visco-Elastic Agents	Most Effective → Moderately effective → Least effective/appropriate → Ineffective
(18) Shoreline Cleaners	Least effective/appropriate → Moderately effective → Most Effective
(18) Shoreline Cleaners as a Pre-soak	Most Effective → Moderately effective → Ineffective

Key:

Most Effective	
Moderately effective	
Least effective/appropriate	
Ineffective	

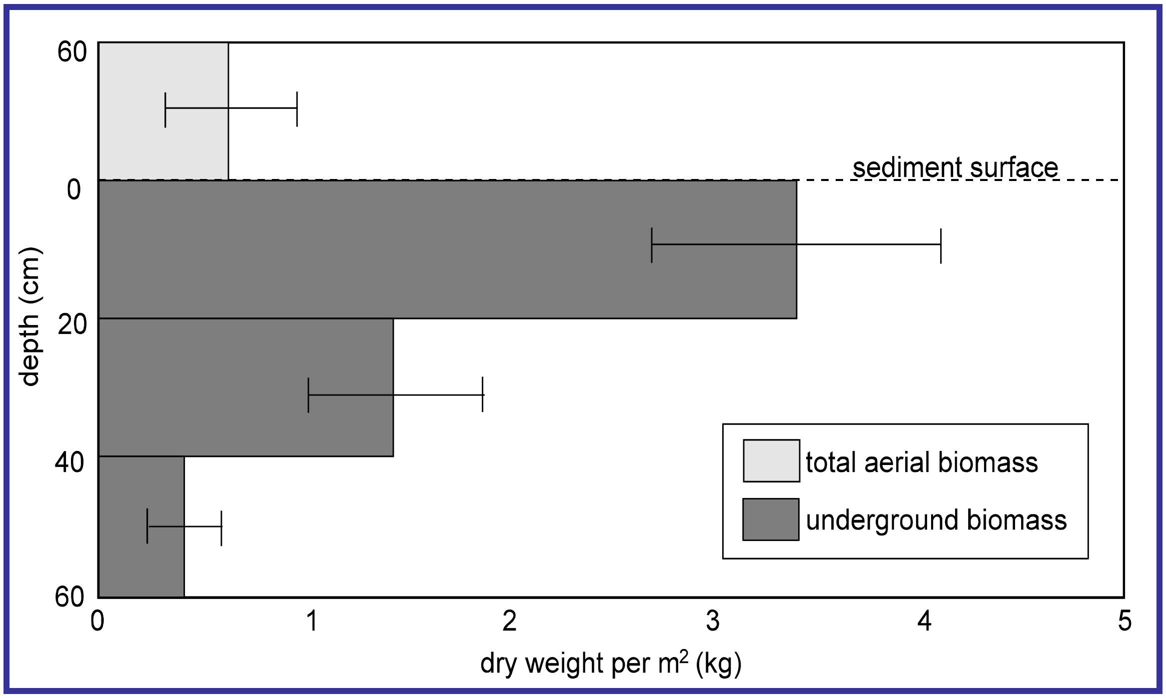
Bioremediation

- ❖ The objective of this technique is to accelerate natural biodegradation processes by the addition of nutrients (fertilizers containing nitrogen and phosphorous).
- ❖ Naturally occurring micro-organisms (bacteria) use oxygen to convert hydrocarbons into water and carbon dioxide. There are few locations where these oil-degrading organisms do not exist, as they are primarily carried to the shoreline in the nearshore waters. This process usually occurs at the water interface and is limited by *oxygen* and *nutrient availability* and by the *exposed surface area* of the oil. If these three factors can be increased, then the rate of biodegradation can be *accelerated*.
- ❖ Fertilizers can be obtained in solid or liquid form. Solid fertilizers, such as pellets, can be *broadcast* using seed spreaders such as are used on lawns or fields. On contact with water, the fertilizer slowly dissolves and releases water-soluble nutrients over time. Liquid fertilizers can be *sprayed* onto a shoreline using a number of commercially available types of equipment, such as paint sprayers or backpacks.
- ❖ This technique is appropriate to accelerate biodegradation on residual oil ("*polishing*") after other techniques have been used to remove mobile or bulk oil from the shoreline.
- ❖ Applications may be repeated periodically (weeks or months as applicable) to continue the supply of nutrients.
- ❖ Fertilizers may be used alone on a shore to degrade residual surface and/or subsurface oil, but the process is *more effective if combined with tilling* or other methods of breaking the oil into smaller particles, thereby significantly increasing the surface area for the micro-organisms to affect.
- ❖ Nutrient enrichment/bioremediation is an effective but relatively slow process compared to other response options. The rate of biodegradation decreases with lower temperatures so that nutrient enrichment is more effective during warmer summer months.

Λ Hoff, 1992, discusses biodegradation vs. bioremediation, and discusses the pros and cons of nutrient addition, microbial addition, and open water bioremediation. Bioremediation is discussed in more detail by Prince, 1993.

6.3. Marshes and Oil

In summer, most biomass is in the top 20 cm of the sediment. Surface oil is less damaging than oil that penetrates the marsh or that is forced into the subsurface (e.g., by trampling or mixing).



Often, cleanup actions can delay, rather than accelerate, natural recovery of oiled marshes.

"AMOCO CADIZ" Oiled Marsh Cleanup — % Change in Area 1971 – 1990

(Baker *et al.*, 1994

Location	% Change	Result
Ile Grande boat harbor	-39%	Cleaned
Ile Grande North marsh	-35%	Cleaned
Ile Grande — Notenno	-26%	Cleaned
Cantel	+21%	Not Cleaned

Freshwater/Brackish Marshes

- ❖ Many species of plants (100s) compared to salt marshes (10s)
  - < therefore, difficult to predict response to oil.
- ❖ Inundation frequency low (<20 days/year)
  - < therefore, edge effects more likely than areal interior oiling.
- ❖ Organic content high (50-80%):
  - < predominantly root systems,
  - < very porous,
  - < poor bearing capacity.

In general:

- ❖ Saline marshes are:
  - < better understood,
  - < less sensitive,
  - < more vulnerable, and
  - < easier to access

  — than freshwater/brackish marshes

Part 7 Waste Management and Operational Considerations

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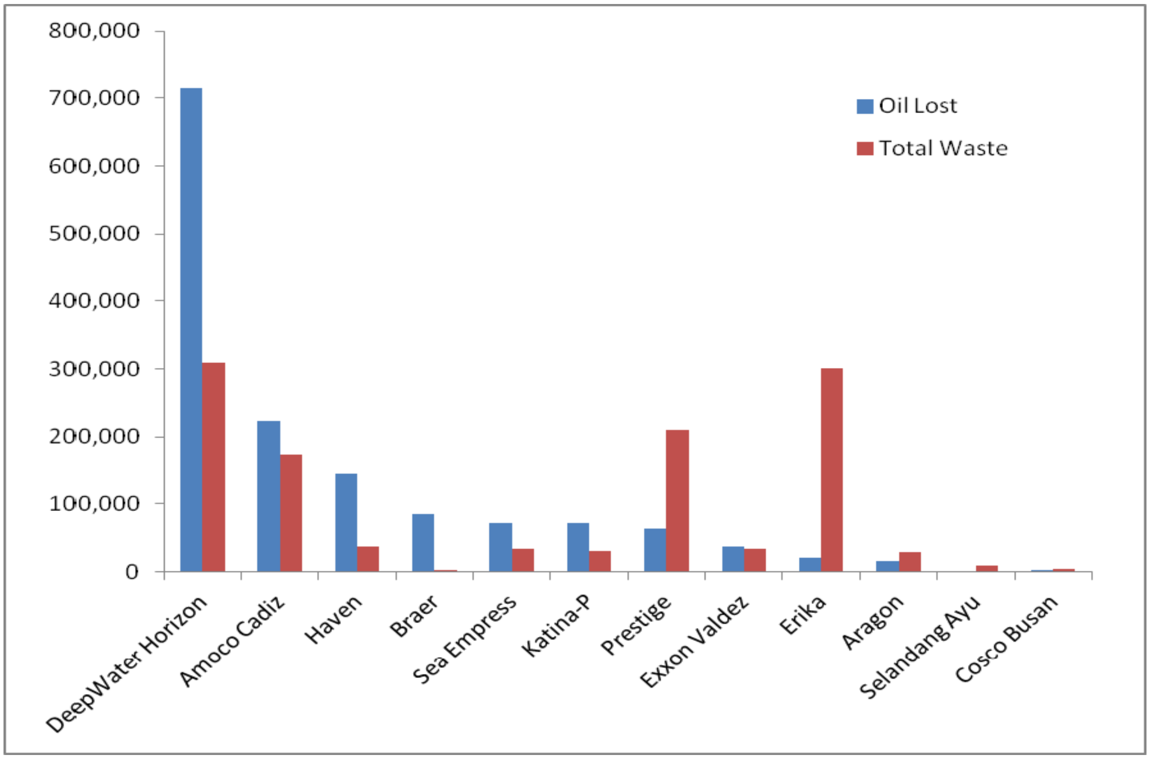
Part 7 Waste Management and Operational Considerations

7.1. *Waste Separation, Transfer, and Disposal*

Different types and amounts of waste will be generated by a response operation depending on the:

- size of the spill,
- shoreline types where the oil becomes stranded,
- the treatment end points selected by the spill management team, and
- the treatment or cleanup method(s) implemented.

There is no direct link between the volumes of waste generated and the original amount of spilled oil. The response to the T/V *Erika* spill generated more waste as compared to that generated following the T/V *Amoco Cadiz*, although the volume spilled was an order of magnitude less.

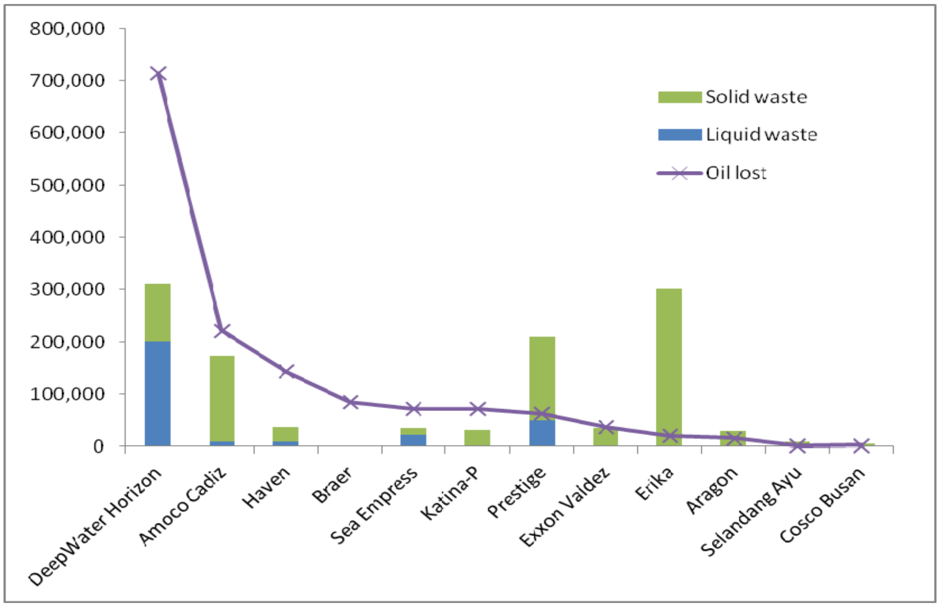


Comparison of spill volumes (tonnes) (adapted and revised from IPIECA 2004)

Examples of liquid and solid wastes generated from marine oil spill response operations (in part from IPIECA 2004 and ITOPF[a])

INCIDENT	OIL LOST (tonnes)	LIQUID WASTES (tonnes)	SOLID WASTE (tonnes)
T/V Amoco Cadiz	223,000	8,500	165,000
T/V Haven	144,000	9,000	28,000
T/V Braer	85,000	0	2,000
T/V Sea Empress	72,000	22,000	12,000
T/V Katina-P	72,000	1,400	30,000
T/V Prestige	63,000	50,000	160,000
T/V Metula	54,000	0	0
T/V Exxon Valdez	37,000	1,300	33,000
T/V Erika	20,000	1,000	300,000
T/V Aragon	15,000	1,200	28,000
M/V Selandang Ayu	1,000	0	8,400

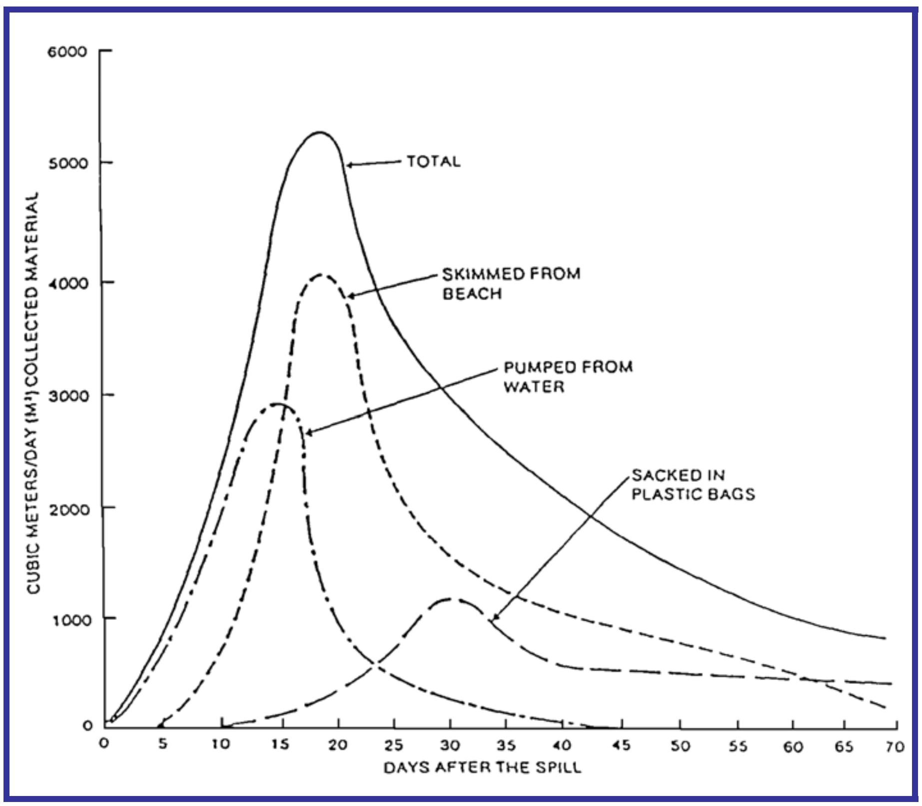
[a] www.itopf.com



Examples of solid versus liquid waste generated (tonnes)

- ❖ Usually, more than one cleanup technique will be implemented so that more than one waste type will be generated at any one cleanup site.

Cubic meters of oil and oil contaminated material pumped, skimmed, and sacked in the Finister region during the *Amoco Cadiz* cleanup.



(from Exxon, 1979)

❖ Oil and oily debris, as well as non-oiled waste from the response operations, may or may not be generated; in some instances, oiled materials may be treated on site or left to natural recovery.

The **objectives of waste management** are to: minimize waste generation, and minimize waste handling and disposal.

Λ The *BEST PRACTICES OF WASTE MANAGEMENT* involve:

< separation of the waste types as they are generated, and

< identifying the ultimate fate of the waste types, so that they can be

< packaged, handled, and stored appropriately

Start at the beginning: **separate** waste types at source Identify ultimate fate of waste types: package / handle / store appropriately

7.1.1. Waste Generation

***In-situ* treatment** is the preferred response option in terms of waste minimization.

❖ All of the *in-situ* treatment techniques (see table below) have significant advantages over wholesale waste removal, especially when treating sediments:

< materials remain in place, decreasing the potential for erosion,

< the techniques are relatively quick and increase cleanup efficiency,

< the techniques employ fewer workers and decrease secondary environmental impacts from cleanup and disposal.

❖ *In-situ* treatment is also the preferred option in terms of cost minimization.

❖

Shoreline Cleanup and Treatment Methods — In Situ vs. Methods Requiring Some Type of Off-Site Disposal

In Situ	**Off-Site Disposal**
Natural Recovery	Flooding
Sediment Tilling	Washing
Surf Washing	Spot Washing
Log/Debris Burning	Steam Cleaning
Dispersants	Sandblasting
Bioremediation	Manual Removal
	Vacuum/Skimming
	Mechanical Removal
	Vegetation Cutting
	Passive Sorbents
	Shoreline Cleaners
	Visco-elastic Agents/Solidifiers

Waste Materials Generated by Shoreline Cleanup Methods

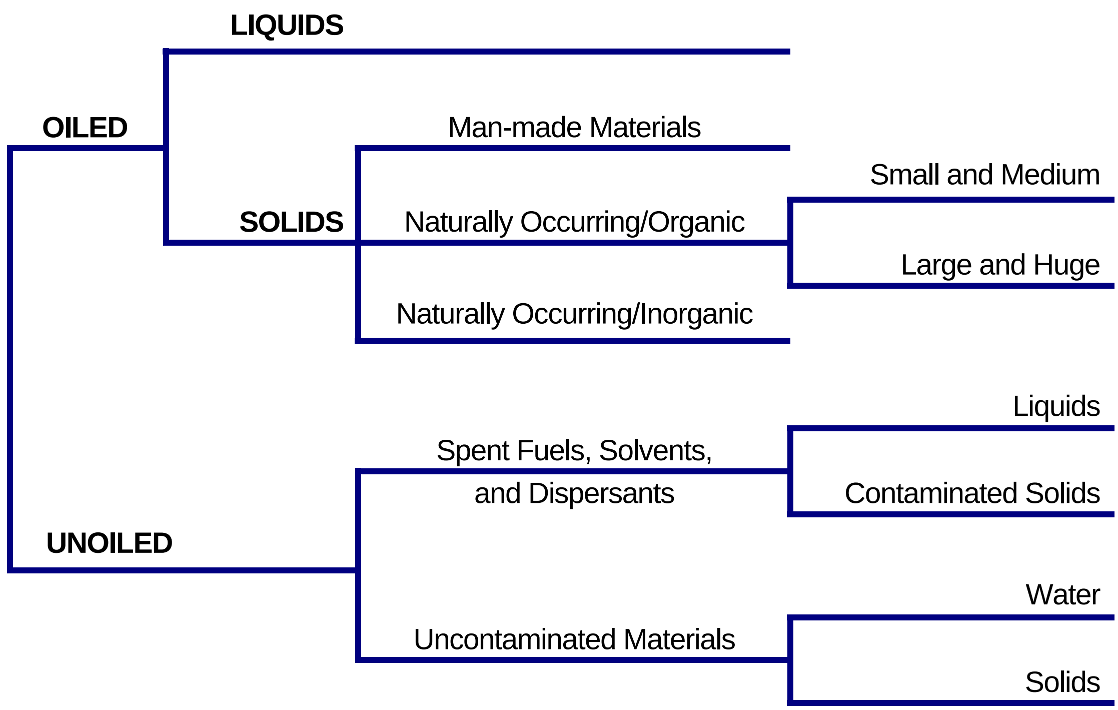
(after Marty, Owens, and Howe, 1993)

CLEANUP METHOD	WASTE GENERATION		
	AMOUNT	TYPE	
Flooding	***High***	Liquids	oil and oily water
Washing	***High***	Liquids	oil and oily water
Spot Washing	Moderate	Liquids	oil and oily water
Steam Cleaning	Moderate	Liquids	oil and oily water
Sandblasting	***High***	Solids	oiled sand
Manual Removal	Moderate	Solids	oiled sediment/debris, etc.
Mechanical Removal	***High***	Solids	oiled sediment/debris, etc.
Vacuum/Skimming	***High***	Liquids	oil and oily water
Off-site Treatment	Low	Liquids	oil and oily water
Vegetation Cutting	Moderate	Solids	oiled organic material
Passive Collection	Moderate/***High***	Solids	oiled sorbents
Log/Debris Burning	Low	Solids	some residue from burning
Dispersants	Low	Solids	unoiled packaging material
Shoreline Cleaners	Moderate	Liquids	remobilized oil, oily water
Visco-elastic Agents/ Solidifiers	Moderate	Solids	oil/agent mixture
Bioremediation	Low	Solids	unoiled packaging material

Note: The terms “High, Moderate, and Low” are intended only as a guide to indicate relative amounts of oil and oiled wastes that can be generated directly by the operations.

7.1.2. Waste Segregation

Often the disposal method is decided after cleanup is completed; the preferred disposal strategy, in most cases, is to *segregate wastes into categories with different properties as soon as they are generated*; materials with the same disposal path can be mixed after the paths are determined.



(after Marty, Owens, and Howe, 1993)

7.1.3. Waste Handling

Each type of material generated has its own handling issues and decision criteria. As an example of the selection process that may be used to develop a waste management plan, the following summarizes appropriate options for handling *oiled sediments*.

Example: Options for *Oiled Sediments* —

Packaging and Temporary On-site Storage (in order – Large to Small Volumes):

Offshore	Onshore
barges	dump trucks
dumpsters	dumpsters
supersacks	lined earthen pits
sealed drums	supersacks
	sealed drums

Transportation (in order – Large to Small Volumes):

Offshore	Onshore
barges	dump truck/rail car
dumpsters	dumpsters
freight boat	light truck

Temporary Off-site Storage (in order – Large to Small Volumes):

supersacks (with plastic underlays and overlays)
dumpsters
lined pits
sealed drums

Disposal and Treatment (in order – Most Preferred to Least Preferred):

On site	Off site
sediment washers	asphalt batch plants
flood/wash	land farming
bioremediation	incineration
natural recovery	landfill
on-site burning	

Temporary Waste Storage Sites

Primary storage:

- small size
- located near the clean-up sites
- short life

Intermediate storage:

- larger size
- longer life

Heavy storage:

- potentially huge site
- life linked to the treatment duration (months - to years)

ERIKA Waste Management

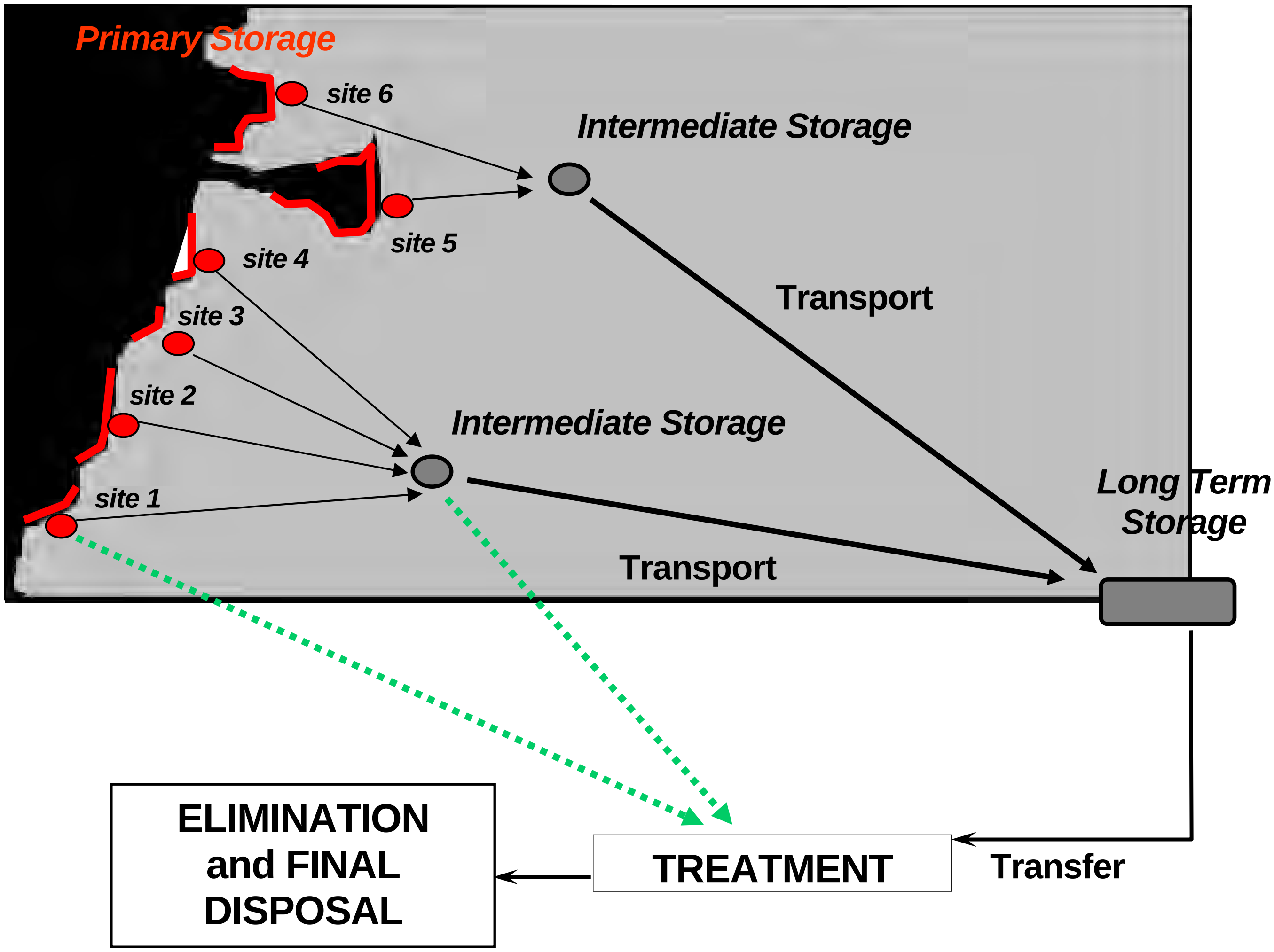
210 000 tonnes of waste collected during clean-up operations

+ 60 000 tonnes of waste storage building materials

270 000 tonnes of waste to treat

33 Intermediate storage sites
4 Heavy storage sites
Waste program began April 2001
Final Treatment completed November 2003

Coastal Recovery and Storage Schemes



7.1.4. Packaging, Storage, Transportation, and Disposal

Packaging and Storage

Techniques available for *packaging and storage* of oil spill waste materials include:

- Tank Vessels
- Barges
- Flexible Towable Tanks/Pillow Tanks
- Lined Earthen Pits
- Lined Earthen Dikes
- Prefabricated Kits
- Sealed-Top Drums
- Livestock Tanks
- "Oilfield" Tanks
- Unused Above-Ground Tanks
- Unused Under-Ground Tanks
- Dumpsters
- "Supersacks"
- Plastic Trash Bags

Transportation

Techniques available for *transporting* oil spill waste material include:

- Freight Boats,
- Tank Trucks or Railroad Cars,
- Freight Trucks or Railroad Cars,
- Light Trucks,
- Helicopters,
- Dump Trucks

Disposal

Hot Mix Asphalt Batch Plants
Cold Mix Asphalt Batch Plants
Reprocessing
Incineration
Open Pit Burning
Land farming/Bioremediation
Stabilization and Landfill
Beach Cleaners and Sediment Washers
In-situ Sediment Washing
Treatment and Discharge
Natural Recovery

- ExxonMobil (2008) and Marty *et al.* (1993) provide more detailed information on waste management procedures.

7.1.5. Waste Management “Rules of Thumb”

- Waste generation begins when the first person shows up on site; the *WASTE STREAM SHOULD* be organized before giving the go-ahead to start an activity.
- Work with Planning and Operations to try to develop accurate estimates of waste generation from the different operational activities.
- The waste stream is the most likely bottleneck for operations — *IT MAY BE NECESSARY TO STOP MECHANICAL RECOVERY, USING SKIMMERS OR FRONT-END LOADERS FOR EXAMPLE, IF THERE IS INSUFFICIENT* transfer and storage capacity.
- Segregate wastes at source and label immediately.
- In particular, separate wastes that:

  (1) are oiled versus non-oiled;

  (2) are liquid versus solid;

  (3) can be incinerated;

  (4) are biodegradable; or

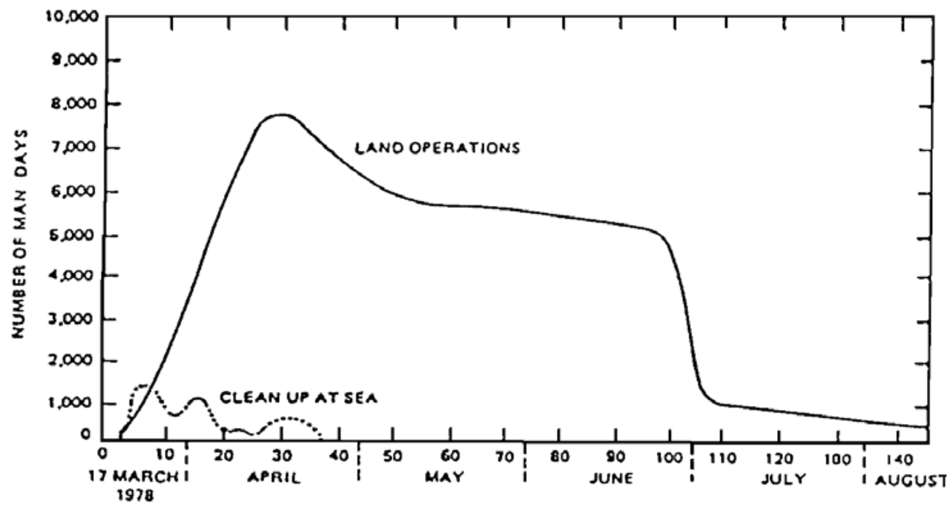
  (5) may be considered hazardous.
- Waste volumes and types will change during the life of a response

7.2. Operational Considerations

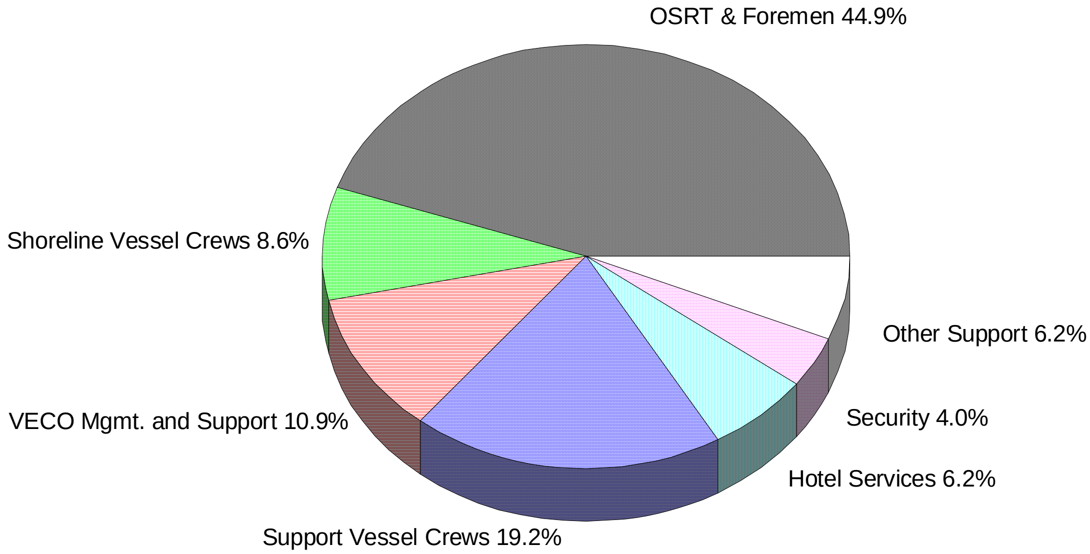
Personnel Requirements

These graphs depict operational data from a large land-based cleanup of a spill *(Amoco Cadiz)*.

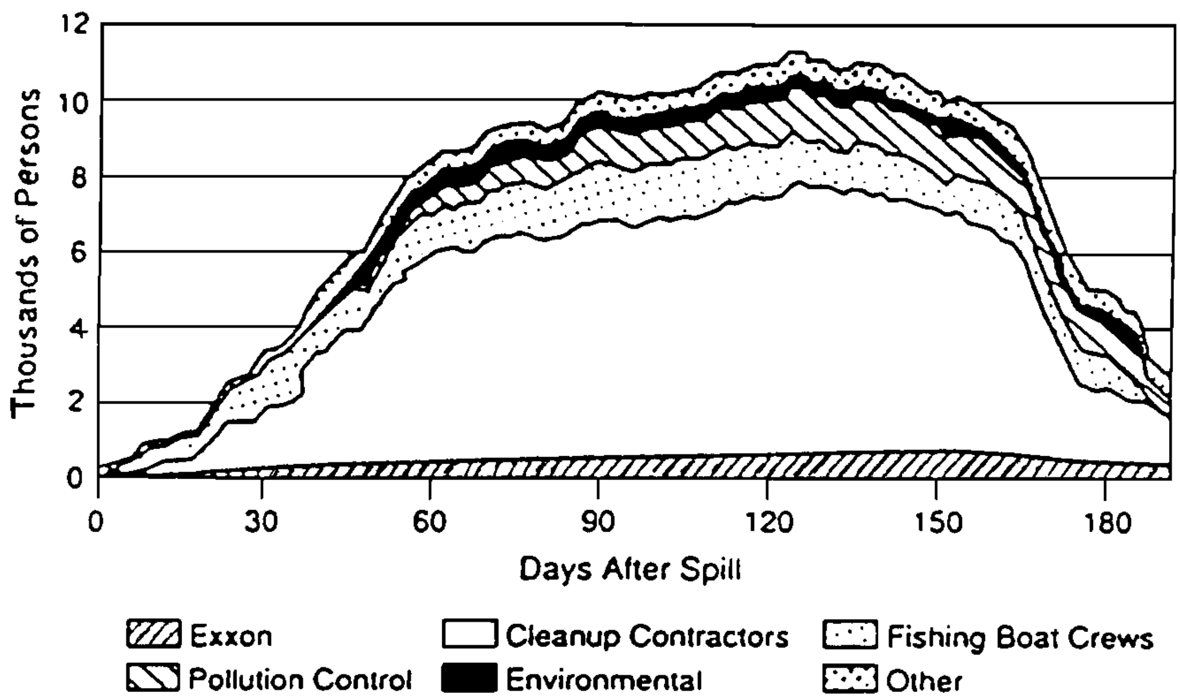
Approximate manpower involved.



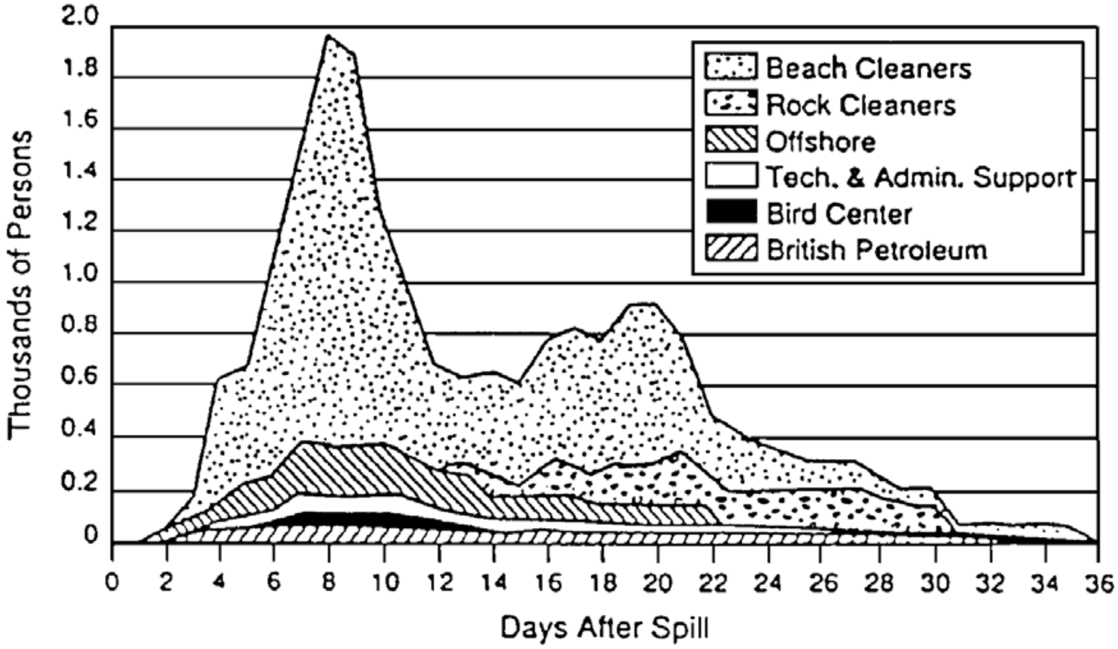
The *Exxon Valdez* response was in a remote area and the field task forces involved essentially one support person for each responder (Carpenter et al. 1991).



Personnel involved in the* Exxon Valdez *spill.



Personnel involved in the* American Trader *spill.



Operational/Logistics Factors

Distance from Regional Staging Area

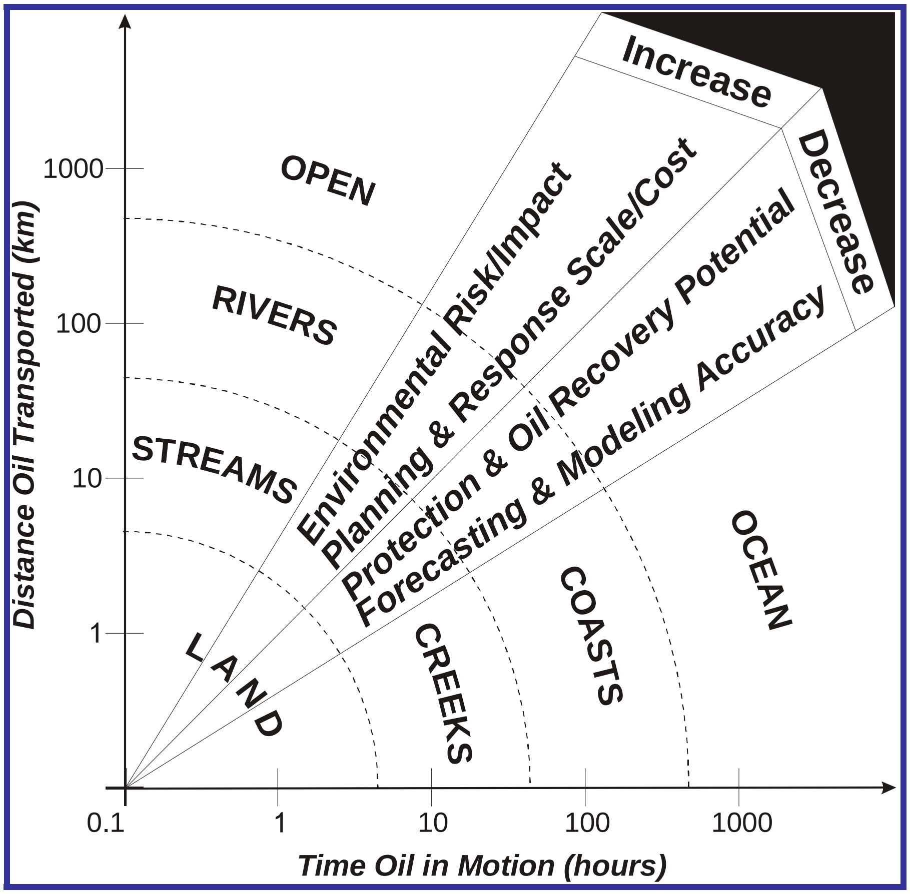
Access

- Land
  - Vehicle
  - Pedestrian
- Water
  - Large craft
  - Shallow draft only

On - Site Operational Area

- Limited room to maneuver
- Suitable for onshore operations
- Suitable for local staging area

Volume / Type of materials for disposal



Increase
Decrease
OPEN
RIVERS
STREAMS
LAND
CREEKS
COASTS
OCEAN
Environmental Risk/Impact
Planning & Response Scale/Cost
Protection & Oil Recovery Potential
Forecasting & Modeling Accuracy
Distance Oil Transported (km)
1000
100
10
1
0.1
1
10
100
1000
Time Oil in Motion (hours)

Oil Spill Response Operations Zones

(after ASTM Standard F 1644-95)

COLD ZONE — Support Area

uncontaminated area

equipment storage and supply functions

food services

offices

WARM ZONE — Contamination Reduction Area

weathered oil

shoreline cleanup

waste management

decontamination

HOT ZONE — Early Response

fresh oil

containment and recovery

Oil Spill Worker Response

(after ASTM Standard F 1644-95)

COLD ZONE — Support Area

Type C workers

Uncontaminated area

No PPE

WARM ZONE — Contamination Reduction Area

Type A and B workers

Weathered oil

PPE required ("buddy system" required in USA)

Respiratory protection *NOT REQUIRED*

HOT ZONE — Early Response

Type A workers only

Fresh oil — potential exposure hazards

PPE required ("buddy system" required in USA)

Respiratory protection *POSSIBLY REQUIRED*

Oil Spill Response Worker Categories

(after ASTM Standard F1644-95)

TYPE A — HOT ZONE Personnel

Response Managers
Supervisors
Equipment Operators

- boat operators
- boom deployers
- skimmer crews
- dispersant handlers
- barge personnel
- tank truck operators
- loader/bulldozer operators
- other initial response personnel

Security personnel
Shoreline Assessment Team
Site safety and health supervisor
Field medical personnel
Vapor monitoring personnel
etc...

TYPE B — WARM ZONE Personnel

Shoreline clean-up personnel
Decontamination personnel
Wildlife coordinators
Animal handlers
Waste management/handling personnel
etc...

TYPE C — COLD ZONE Personnel

General land-based support personnel
Historians
Legal advisors
Food services personnel
Financial services personnel
Supply personnel
etc...

Recommended Health and Safety Training Matrix for Oil Spill Workers

(after ASTM Standard F 1644-95)

Training Subjects	Worker Types		
	Type A	**Type B**	**Type C**
General Awareness (regulations, response command/management structure, project and local issues, drug/alcohol policy, local hazards (e.g., earthquakes, hurricanes), etc.)	✓	✓	✓
Exposures and Chemical Hazards			
< mechanical hazards	✓	✓	
< slips, trips, and falls	✓	✓	
< explosion and fire	✓	✓	
< biological hazards	✓	✓	
< physical hazards (noise, hypothermia, heat stress, UV hazards, etc.)	✓	✓	
< water hazards	✓	✓	
< exposure routes (air, skin, ingestion)	✓		
< confined space entry	✓	✓	✓
< first aid	✓		
Safety and Health Requirements			
< industrial hygiene monitoring	✓		
< respiratory protection	✓		
< eye and ear protection	✓	✓	
< flotation devices	✓	✓	
< footwear	✓	✓	
< skin protection (gloves and PPE)	✓	✓	
< hard hats	✓	✓	
< personnel hygiene	✓	✓	
< decontamination procedures	✓	✓	

Safety

Safe =

Zero hours — Lost Time Accidents

Zero — OSHA Recordable Incidents

Economic Considerations

- Efficiency decreases and costs increase with time, particularly once the "easy to recover oil" has been removed.
- The most expensive aspects of a spill are (a) shoreline cleanup and (b) coastal zone damages; so burn, disperse, or recover at sea whenever possible.
- If oil reaches the nearshore and coastal zones: ecological damages likely will increase, NRDA damages will increase, and cleanup costs will increase.
- There is every ecological and economic incentive to keep oil out of the nearshore and coastal zones.

Operational Costs

On Water — *smaller spills (<2000 bbl)*
cost approximately 2 to 3 times more than larger spills.

Burn costs on water are estimated to be $500/bbl.

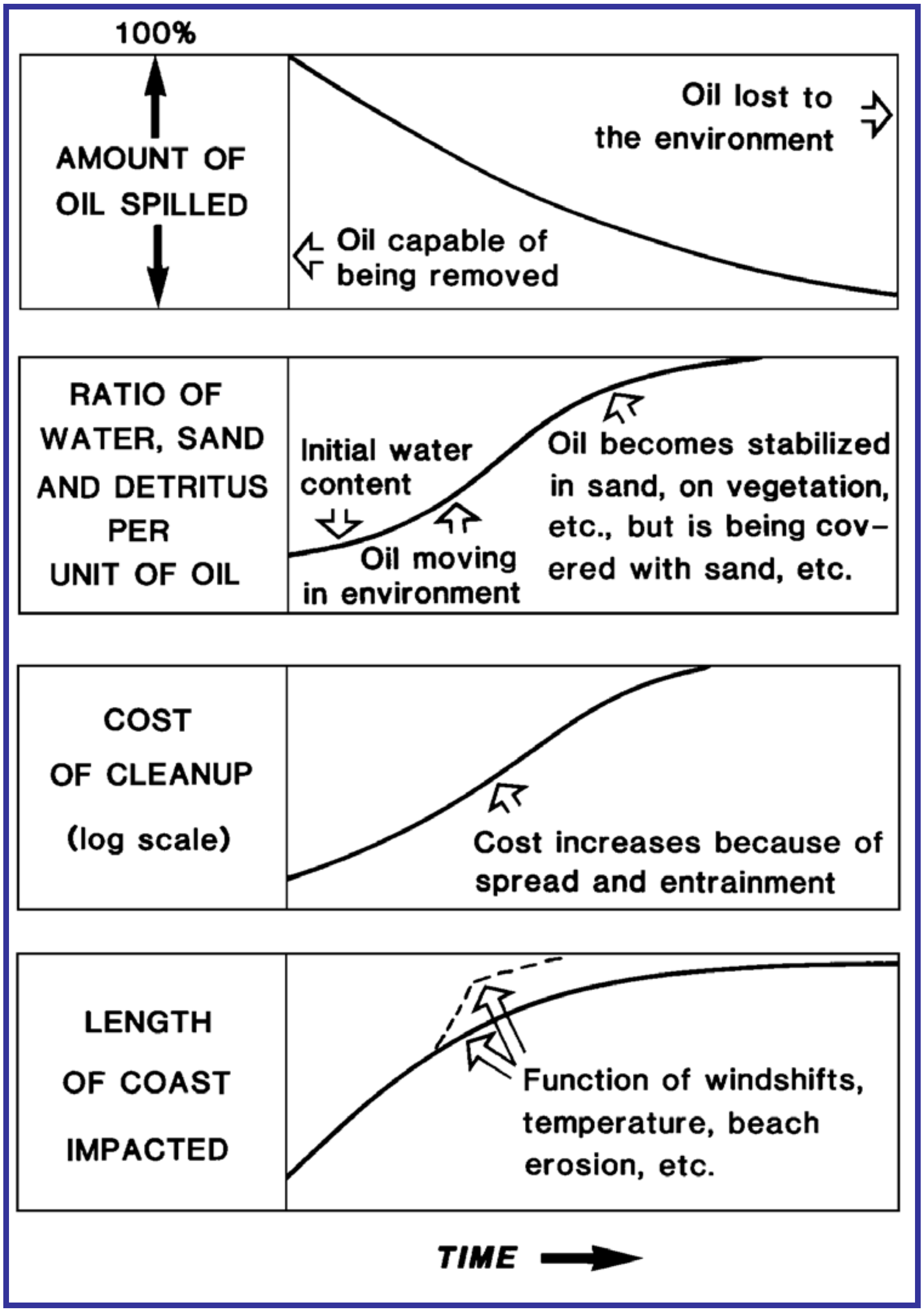
	$ / bbl		
	Average	**General Range**	**Extreme Range**
On Water Mechanical	2,500	2,000 – 6,000	10 – 10,000
Shoreline Cleanup	8,000	5,000 – 20,000	200 – 80,000

after Harper and Allen, 1995

- NRDA costs >> cleanup costs.

Operational Changes Through Time

This set of diagrams shows how different aspects of a spill response operation change through time. This emphasizes the need to be flexible in planning and to adapt to changing requirements (Wheeler, 1978).



7.2.1. Response in Remote Areas

Remote areas are defined as locations where there exist little or no local infrastructure to support spill response operations; these areas require logistic support to stage a shoreline treatment program.

❖ Shoreline cleanup would have to be conducted from temporary onshore or floating offshore/nearshore staging areas that could accommodate personnel and equipment overnight.

The need for logistic support in a remote area places focus on activities that:

∈ limit the need for extensive equipment and personnel resources, and

∉ minimize waste generation.

Λ ❖ With these two constraints in mind, the preferred response is —

< PREVENT THE OIL FROM REACHING THE SHORELINE if and when possible.

❖ If this is not feasible or practical, the preferred onshore option is —

< *TREAT THE OIL* IN SITU so that environmental recovery is accelerated without the requirements for a labor-intensive effort or waste management/ disposal.

Remote Operational Requirements

Operations in remote locations involve considerable logistic support for protection, cleanup, and disposal.

Example: These data are for **one day** for one of the Prince William Sound Task Forces from the 1989 *Exxon Valdez* cleanup.

- Each Task Force:

< Fuel	17,000 gallons/day
< Food	5 tons/day
< Water	11,000 gallons/day
< Materials	3 tons/day

There were seven such Task Forces, and the approximate total figures for the 1989 operations were:

- 10,000 people,
- 1,000 boats, and
- 100 aircraft.

See diagram on page 7-17.

Part 8 References

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NOTE:

Updated through 2009.

More recent publications, including some on DWH, and pdf files of key SCAT papers and materials can be found at:

http://www.shorelinescat.com/

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8.6. Additional Resources

SCAT — Copies of the NOAA Shoreline Assessment Manual, NOAA SCAT forms and other Job Aids can be downloaded from:

http://response.restoration.noaa.gov/shor_aid/shor_aid.html

SCAT Forms — the most up-to-date versions of the SCAT SOS forms (2013) can be downloaded from:

http://www.shorelinescat.com/

NOAA spill tools web site:

http://response.restoration.noaa.gov/

Other sources of information on SCAT surveys include:

CEDRE
http://www.cedre.fr/en/publication/operational-guide/surveying/surveying.php

REMPEC

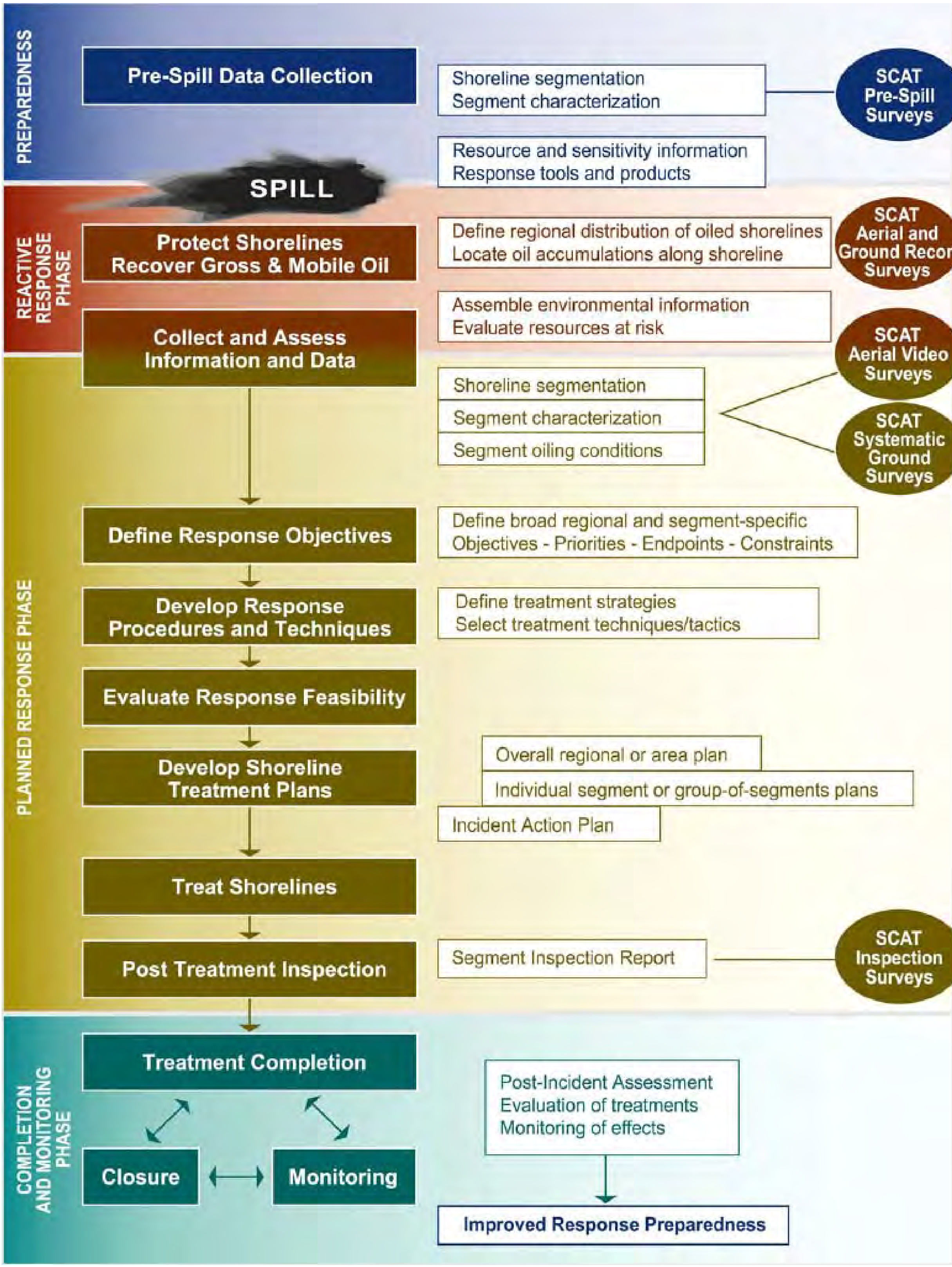
http://www.posow.org/documentation/ manual/shorelineassessmentwebversion.pdf

UK MCA

http://www.dft.gov.uk/mca/corp119ext.pdf

ATTACHMENT A

SCAT ACTIVITY FLOW DIAGRAM

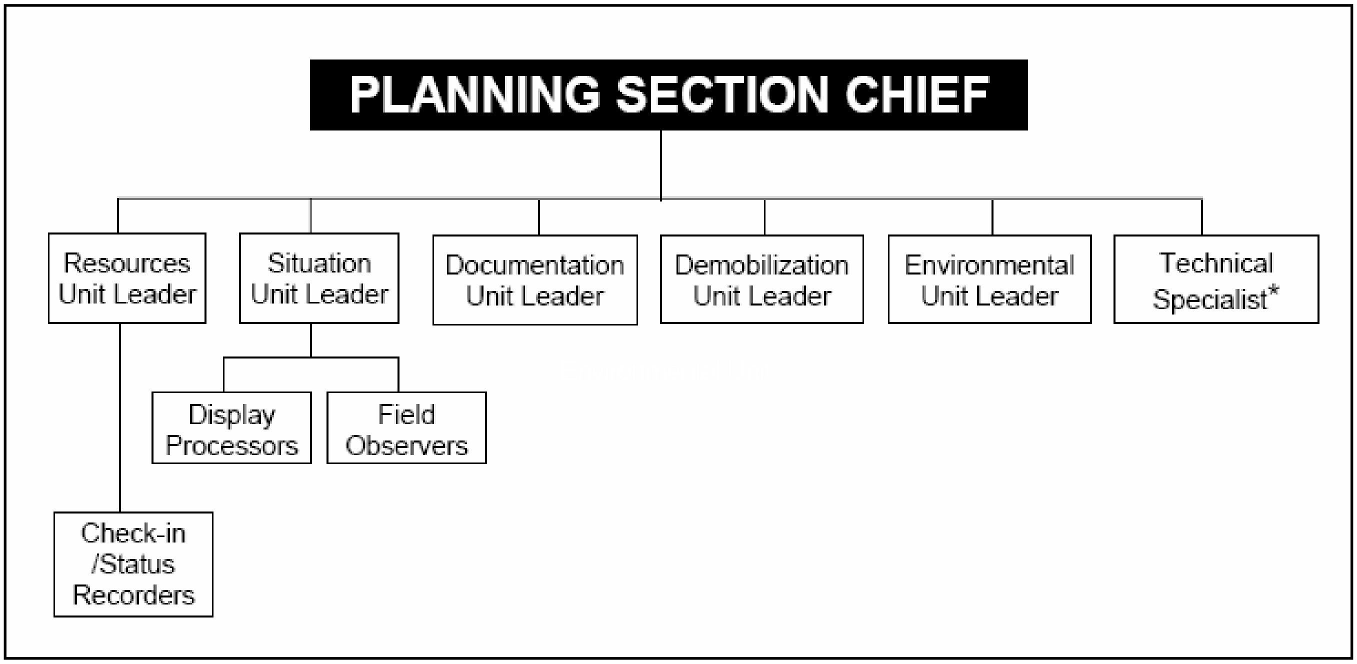

PREPAREDNESS
Pre-Spill Data Collection
Shoreline segmentation
Segment characterization
SCAT Pre-Spill Surveys
Resource and sensitivity information
Response tools and products
SPILL
REACTIVE RESPONSE PHASE
Protect Shorelines
Recover Gross & Mobile Oil
Define regional distribution of oiled shorelines
Locate oil accumulations along shoreline
SCAT Aerial and Ground Recon Surveys
Collect and Assess Information and Data
Assemble environmental information
Evaluate resources at risk
SCAT Aerial Video Surveys
Shoreline segmentation
Segment characterization
Segment oiling conditions
SCAT Systematic Ground Surveys
PLANNED RESPONSE PHASE
Define Response Objectives
Define broad regional and segment-specific
Objectives - Priorities - Endpoints - Constraints
Develop Response Procedures and Techniques
Define treatment strategies
Select treatment techniques/tactics
Evaluate Response Feasibility
Develop Shoreline Treatment Plans
Overall regional or area plan
Individual segment or group-of-segments plans
Incident Action Plan
Treat Shorelines
Post Treatment Inspection
Segment Inspection Report
SCAT Inspection Surveys
COMPLETION AND MONITORING PHASE
Treatment Completion
Closure
Monitoring
Post-Incident Assessment
Evaluation of treatments
Monitoring of effects
Improved Response Preparedness

Attachment B

ICS and the Environmental Unit

B.1 Environmental Unit Organization

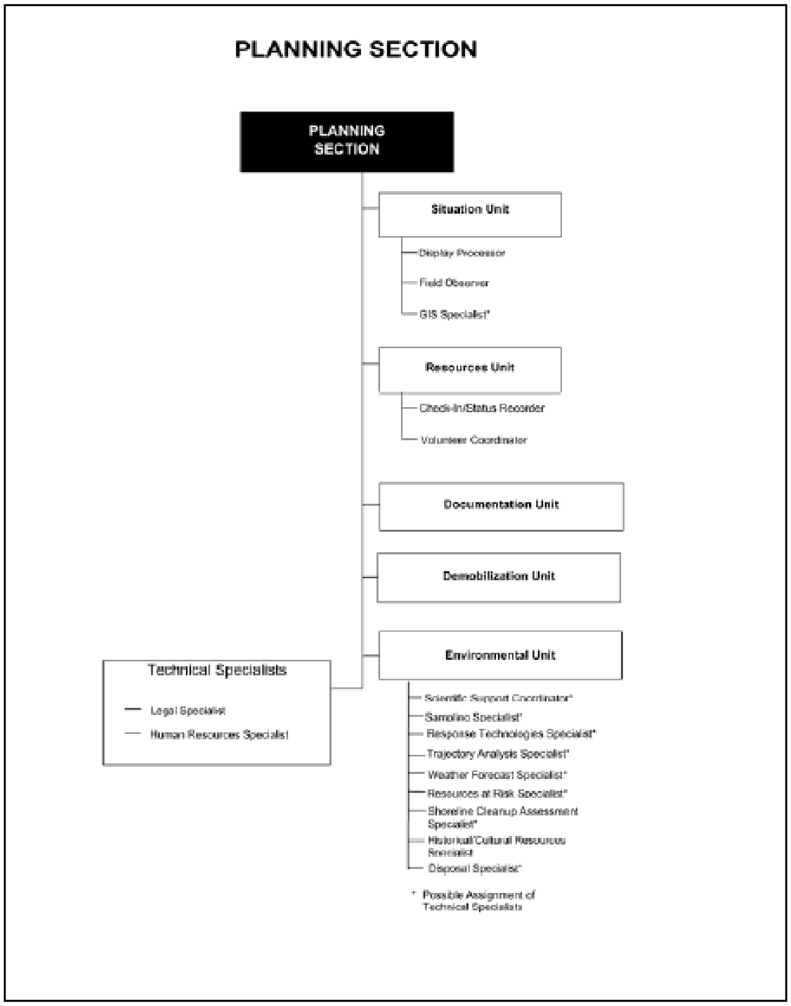
The Environmental Unit is within the Planning Section:



(after USCG IMH, 2006)

Environmental Unit:

- A key function of the Planning Section
- Goal is to support OPS
    1. Characterize and predict environmental conditions and oil movement/behavior
    2. Priorities for protection and cleanup; Endpoints.
    3. Coordinate environmental stakeholder issues.
- After Safety and Health of the public and spill responders, environmental protection and mitigation is the highest priority of response (usually before socio-economic concerns).



(after USCG IMH, 2006)

B.2 Environmental Unit Responsibilities

Environmental matters of the response:

- Strategic Assessment – Operations Support
- Surveillance of Oil Movement and Environmental Conditions
- Predictions (modeling) of oil transport and behavior, and Environmental Conditions
- Monitoring environmental effects:

Permitting: Cleanup, disposal/waste management, protection and treatment techniques, access, decanting, etc.

ENVIRONMENTAL UNIT RESPONSIBILITIES

Prepare Environmental Data for Situation Unit, Unified Command, Operations Section, Planning Section Chief, Joint Information Center, Regional Response Team, Trustee Agencies, Tribes and other Stakeholders:

- Current and Predicted Conditions
- Weather, Tides, Oil Movement and Fate

ENVIRONMENTAL UNIT PRIORITIES

- Identify sensitive areas and recommend response priorities.
- Consult Natural Resource Trustees and provide input on wildlife protection strategies.
- Determine extent, fate, effects of oiling.
- Weather forecasts (tides, sunset)
- Monitor environmental consequences of response actions
- Develop shoreline cleanup and assessment plans.
- ID and initiate permitting/consultation requirements (ESA, MMPA, decanting,…)
- FOSC's Historical/Cultural Resources Technical Specialist
- Develop plan to protect affected resources, including OPS CONSTRAINTS
- Evaluate Alternative Response Tech.
- Develop Waste Management, Disposal Plans – WA DOE credit
- Develop Sampling plan – where, how many, why, who, chain of custody.
- Maintain Unit Log (214).

B.3 Technical Specialists

The Environmental Unit Leader is responsible for managing the unit and its resources, which include a Deputy Environmental Unit Leader and a number of Technical Specialists. A response may include any number of the Technical Specialists and these roles may be filled by a group or one individual may fill more than one Technical Specialist role.

- Scientific Support Coordinator (NOAA SSC)
- Resources at Risk Specialist
- Response Technologies Specialist
- Trajectory Analysis Specialist
- Weather Specialist
- Shoreline Cleanup Assessment Specialist
- Historical/Cultural Resources Specialist
- Disposal/Waste Management Specialist
- Sampling Specialist

SCIENTIFIC SUPPORT COORDINATOR

The Scientific Support Coordinator (SSC) is a technical specialist and is defined in the NCP as the principal advisor to the FOSC for scientific issues.

The SSC is responsible for providing expertise on chemical hazards, field observations, trajectory analysis, resources at risk, environmental tradeoffs of countermeasures and cleanup methods, and information management.

The SSC is also charged with gaining consensus on scientific issues affecting the response, but also ensuring that differing opinions within the scientific community are communicated to the incident command.

Additionally, the SSC is responsible for providing data on weather, tides, currents, and other applicable environmental conditions. The SSC can serve as the Environmental Unit Leader.

a. Review Common Responsibilities in Chapter 2.
b. Review Technical Specialist Job Aid.
c. Attend planning meetings.
d. Determine resource needs.
e. Provide overflight maps and trajectory analysis, including the actual location of oil, to the Situation Unit.
f. Provide weather, tidal and current information.
g. Obtain consensus on scientific issues affecting the response.
h. In conjunction with Natural Resource Trustee Representatives and the FOSC's Historical/Cultural Resources Specialist, develop a prioritized list of resources at risk, including threatened and endangered species.
i. Provide information on chemical hazards.
j. Evaluate environmental tradeoffs of countermeasures and cleanup methods, and response endpoints.
k. Maintain Unit Log (ICS 214-CG)

TRAJECTORY ANALYSIS TECHNICAL SPECIALIST

The Trajectory Analysis Technical Specialist is responsible for providing to the UC, projections and estimates of the movement and behavior of the spill.

The specialist will combine visual observations, remote sensing information, and computer modeling, as well as observed and predicted tidal, current, and weather data to form these analyses.

Additionally, the specialist is responsible for interfacing with local experts (weather service, academia, researchers, etc.) in formulating these analyses. Trajectory maps, over-flight maps, tides and current data, and weather forecasts will be supplied by the specialist to the Situation Unit for dissemination throughout the ICP.

a. Review Common Responsibilities in Chapter 2.
b. Review Technical Specialist Job Aid.
c. Schedule and conduct spill observations/overflights, as needed.
d. Gather pertinent information on tides, currents and weather from all available sources.
e. Provide a trajectory and over-flight maps, weather forecasts, and tidal and current information.
f. Provide briefing on observations and analyses to the proper personnel.
g. Demobilize in accordance with the Incident Demobilization Plan.
h. Maintain Unit Log (ICS 214-CG).

RESPONSE TECHNOLOGIES SPECIALIST

The Response Technologies Specialist is responsible for evaluating the opportunities to use various response technologies, including mechanical containment and recovery, dispersant or other chemical countermeasures, in-situ burning, and bioremediation.

The specialist will conduct the consultation and planning required by deploying a specific response technology, and by articulating the environmental tradeoffs of using or not using a specific response technique.

a. Review Common Responsibilities in Chapter 2.
b. Review Technical Specialist Job Aid.
c. Participate in planning meetings, as required.

SAMPLING TECHNICIAL SPECIALIST

The Sampling Technical Specialist is responsible for providing a sampling plan for the coordinated collection, documentation, storage, transportation, and submittal to appropriate laboratories for analysis or storage.

a. Review Common Responsibilities.
b. Review Technical Specialist Job Aid.
c. Determine resource needs.
d. Participate in planning meetings as required.
e. Identify and alert appropriate laboratories.
f. Meet with team to develop an initial sampling plan and strategy, and review sampling and labeling procedures.

d. Determine resource needs. e. Gather data pertaining to the spill, including spill location, type and amount of petroleum spilled, physical and chemical properties, weather and sea conditions, and resources at risk. f. Identify the available response technologies (RT) that may be effective on the specific spilled petroleum. g. Make initial notification to all agencies that have authority over the use of RT. h. Keep the PSC advised of RT issues. i. Provide status reports to appropriate requesters. j. Establish communications with the RRT to coordinate RT activities. k. Maintain Unit Log (ICS 214-CG).	g. Set up site map to monitor the location of samples collected and coordinate with GIS staff. Coordinate sampling activities with the NRDAR Representative, Investigation Team, and legal advisors. h. Provide status reports to appropriate requesters. i. Maintain Unit Log (ICS 214-CG).
WEATHER FORECAST TECHNICAL SPECIALIST The Weather Forecast Technical Specialist is responsible for acquiring and reporting incident-specific weather forecasts. The specialist will interpret and analyze data from NOAA's National Weather Service and other sources. This person will be available to answer specific weather related response questions and coordinate with the Scientific Support Coordinator and Trajectory Analysis Specialist as needed. The specialist will provide weather forecasts to the Situation Unit for dissemination throughout the ICP. a. Review Common Responsibilities in Chapter 2. b. Gather pertinent weather information from all appropriate sources. c. Provide incident-specific weather forecasts on an assigned schedule. d. Provide briefings on weather observations and forecasts to the proper personnel. e. Maintain Unit Log (ICS 214-CG).	**RESOURCES AT RISK (RAR) TECHNICAL SPECIALIST** The Resources at Risk (RAR) Technical Specialist is responsible for the identification of resources thought to be at risk from exposure to the spilled oil through the analysis of known and anticipated oil movement, and the location of natural, economic resources, and historic properties. The RAR Technical Specialist considers the relative importance of the resources and the relative risk to develop a priority list for protection. a. Review Common Responsibilities in Chapter 2. b. Review Technical Specialist Job Aid. c. Participate in planning meetings as required. d. Determine resource needs. e. Obtain current and forecasted status information from the Situation Unit. f. Following consultation with Natural Resource Trustee Representatives, identify natural RAR, including threatened and endangered species, and their critical habitat. g. Following consultation with the FOSC's Historical/Cultural Resources Specialist, identify historic properties at risk. h. Identify socio-economic resources at risk. i. In consultation with Natural Resource Trustee Representatives, Land Management Agency Representatives, and the FOSC's Historical/Cultural Resources Specialist, develop a prioritized list of the resources at risk for use by the Planning Section. j. Provide status reports to appropriate requesters. k. Maintain Unit Log (ICS 214-CG).
SHORELINE CLEANUP ASSESSMENT TECHNICAL SPECIALIST The Shoreline Cleanup Assessment Technical Specialist is responsible for providing appropriate cleanup recommendations as to the types of the various shorelines and the degree to which they	**HISTORICAL/CULTURAL RESOURCES TECHNICAL SPECIALIST** The Historical/Cultural Resources Technical Specialist is responsible for identifying and resolving issues related to any historical or cultural sites that are threatened or impacted

have been impacted. This technical specialist will recommend the need for, and the numbers of, Shoreline Cleanup Assessment Teams (SCATs) and will be responsible for making cleanup recommendations to the Environmental Unit Leader. Additionally, this specialist will recommend cleanup endpoints that address the question of "**How clean is clean?"** a. Review Common Responsibilities in Chapter 2. b. Review Technical Specialist Job Aid. c. Obtain a briefing and special instructions from the Environmental Unit Leader. d. Participate in Planning Section meetings. e. Recommend the need for and number of SCATs. f. Describe shoreline types and oiling conditions. g. Identify sensitive resources (ecological, recreational, historical properties, economic). h. Recommend the need for cleanup. In consultation with Natural Resource Trustee Representatives, Land Management Agency Representatives, and the FOSC's Historical/Cultural Resources Specialist. i. Recommend cleanup priorities. In consultation with Natural Resource Trustee Representatives, Land Management Agency Representatives, and the FOSC's Historical/Cultural Resources Specialist. j. Monitor cleanup effectiveness. k. Recommend shoreline cleanup methods and endpoints l. Maintain Unit Log (ICS 214-CG).	during an incident. The Specialist must understand and be able to implement a "Programmatic Agreement on Protection of Historic Properties" (Consult NRT's document "Programmatic Agreement on the Protection of Historic Properties During Emergency Response under the NCP" for guidance) as well as consulting with State Historic Preservation Officers (SHPO), land management agencies, appropriate native tribes and organizations, and other concerned parties. The technical specialist must identify historical/cultural sites and develop strategies for protection and cleanup of those sites in order to minimize damage. a. Review Common Responsibilities in Chapter 2. b. Review Agency Representative Responsibilities in Chapter 6. c. Review Technical Specialist Job Aid. d. Implement the Programmatic Agreement (PA) for the FOSC. e. If a PA is not used, coordinate Section 106 consultations with the SHPO. f. Consult and reach consensus with the concerned parties on affected historical/cultural sites. g. Identify and prioritize threatened or impacted historical/cultural sites. h. Develop response strategies to protect historical/cultural sites. i. Participate in the testing and evaluation of cleanup techniques used on historical/cultural sites. j. Ensure compliance with applicable Federal/State regulations. k. Maintain Unit Log (ICS 214-CG).
DISPOSAL (WASTE MANAGEMENT) TECHNICAL SPECIALIST **T**he Disposal (Waste Management) Technical Specialist is responsible for providing the OSC with a Disposal Plan that details the collection, sampling, monitoring, temporary storage, transportation, recycling, and disposal of all anticipated response wastes. a. Review Common Responsibilities in Chapter 2. b. Review Technical Specialist Job Aid. c. Determine resource needs. d. Participate in planning meetings as required. e. Develop a Pre-Cleanup Plan and monitor recleanup operations, if appropriate. f. Develop a detailed Waste Management Plan. g. Calculate and verify the volume of petroleum recovered, including petroleum collected with sediment/sand, etc. h. Provide status reports to appropriate requesters. i. Maintain Unit Log (ICS 214-CG).	

(from USCG IMH, 2006)

Attachment C

SCAT Management, Planning and Tracking Forms

SHORELINE OILING ASSESSMENT SURVEY (SCAT) PROGRAM MANAGEMENT, PLANNING AND TRACKING FORMS

SUMMARY

SCAT management forms generally fall into three categories based on their functionality and purpose:

1. Long-range strategy and survey planning table,
2. Short-term rolling mission planner, and
3. Daily field team tasking and logistics plan.

A. MANAGEMENT, PLANNING AND TRACKING FORMS

No "official" ICS forms exist for the management of a Shoreline Oiling Assessment Survey, or SCAT, program as part of an overall response within ICS, but a number of forms have evolved and become standard practice over many spill response operations, and are available from various agencies in the U.S., Canada, Great Britain and from other nations and organizations. These "standard practice" forms provide managers and coordinators with a process to develop and track long-range (weeks to months), short-term (days to weeks), and daily strategies and tactics.

At a minimum, three types of forms should be distributed widely each day (or as often as produced) to key members of the Incident Management Team (IMT), that is, within the Incident Command Post (ICP). Those on the distribution list include: participating agencies, other Environmental Unit (EU) teams, Planning, Operations, Logistics, and Safety, as well as the Situation Unit, Air Operations, Documentation and other IMT members as appropriate.

1. LONG-RANGE SURVEY STRATEGY

A "**SCAT Strategy and Tracking Table**" provides a long-range survey strategy plan for a period of a month or longer (Figure 1).

- The survey strategy is developed by the SCAT Coordinator in consultation with the Environmental Unit Leader (EUL).
- The table is created by the SCAT Logistics Coordinator and enables planning for long-term staffing and logistics support, taking into account factors such as survey priorities, low-tide windows, environmental constraints (e.g. bird or turtle nesting site timing), etc.
- This same table tracks each mission and activity that has been completed and provides a program history.

2. SHORT-TERM ROLLING MISSION PLAN

Planning field activities for the several days to ensure appropriate data, logistics and safety support, requires a continuous updating process that is based on survey priorities and on work that has been completed.

- This process is accomplished with a "**SCAT Mission Planner**" that is generated by the SCAT Logistics Coordinator in consultation with the SCAT Coordinator and the EUL.
- This Mission Planner is updated and reissued daily by the SCAT Logistics Coordinator based on the completion of scheduled prior missions and provides a rolling 7-day (or 10- or 14-day) plan to accomplish the priorities set by the EUL (Figure 2).
- Input to the Mission Planner also is provided by Operations (or SCAT Ops Liaison) who indicate when treatment in a segment or zone is nearing target end points, or has been completed, so that appropriate surveys (Post-Treatment Assessment – PTA) or inspections (Shoreline Inspection Report - SIR) can be scheduled.
- This rolling plan is based on the long-range survey strategy as developed in the "SCAT Strategy and Tracking Table**"**

3. DAILY TEAM TASKING

A key form which links the management of the SCAT program to the ICS process and the planning cycle is the "**SCAT Team Daily Tasking and Logistics Plan**" which describes the planned activities for the following day, i.e. Next Operational Period (Figure 3).

- The "SCAT Team Daily Tasking and Logistics Plan" is prepared by the SCAT Logistics Coordinator and provided to the SCAT Coordinator, who passes this on to the EUL to be discussed during preparation for the Tactics Work Period and Tactics Meeting during each Planning Cycle.
- The field activities outlined in this daily tasking plan are part of the package of EU field assignments and activities reviewed in the Tactics Meeting to ultimately aid the development of the Work Assignments that are captured on the ICS 204 forms (*Assignment List)* for the Next Operating Period. These field assignments are then included in the Incident Action Plan (IAP).
- An example of an ICS 204 form can be found at:
  https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=80572

Templates for each of these three forms are provided on the following pages. The "SCAT Strategy and Tracking Table" (Figure 1) is populated with fictitious information: with the yellow rows tracking completed missions and activities and the white rows indicating the planned strategy and missions. Typically this table or a similar planning table would be used by the SCAT Coordinator to plan forward up to 30 days or even longer.

B. FIELD AND PROCESS FORMS

In addition to these management and planning forms, the other, more commonly known set of field forms that are part of a Shoreline Oiling Assessment, or SCAT, survey program are those used during a response both in the field to document shoreline oiling and as part of the process to manage the information and recommendations coming from the field. These SCAT process forms have evolved over many years of responses in different countries and are available from a range of response agencies in countries and organizations around the world.

This suite of field and process forms includes:

- **Shoreline Oiling Survey** (SOS) forms to capture the field teams' observations; these SOS forms include variations for marine and lake shores, river and stream banks, and for temperate and winter/arctic environments.
- **Shoreline Treatment Recommendation** (STR) forms that provide recommendations for each oiled segment and provide an opportunity for review and input on each set of treatment recommendations by each key member of the IMT (e.g. EUL, Planning Section Chief, Operations Section Chief, State Historical Preservation Officer, and any other consultation reviews as required); once approved, the STR effectively is a Work Permit for Operations.
- **Post-Treatment Assessment** (PTA) survey forms that document the status of a segment that is ready for, or close to, a sign off inspection; and
- **Shoreline/Segment Inspection Report** (SIR) forms that document that end point criteria have been met for a segment and that agreement has been reached that No Further Treatment (NFT) is required. SIRs may be required for different stages of a multi-phase response.

Copies of the SOS forms for coasts, lakes, rivers, and streams and templates for the STR and SIR forms are available under "Forms" at http://shorelineSCAT.com.

Additional tables and spreadsheets for program management can be created to track specific activities, such as the status and progress of STRs and of the inspection (PTA) and sign-off (SIR) surveys. One example of a summary table that records completed Daily Field Activities is provided in Figure 4. This "SCAT Daily Field Activities" table simply records how many teams were deployed each day and the category of missions that were completed or attempted.

Figure 1 SCAT Program Strategy and Tracking Table

	SCAT TEAM # 1	SCAT TEAM # 2	SCAT TEAM # 3
Sunday, January 02, 2000	Travel Day TL = Team Lead	Travel Day TL	Travel Day TL
Monday, January 03, 2000	N Duck Bay MON PL01-029 & PL01-036-10 - both passed TL	Cancelled due to access issues / Wind West Nags Head SIR TB04-004-10 TL	Klawah BP TL
Tuesday, January 04, 2000	Canceled Due to Small Craft Advisory Night Before Pencil Isle SIR SB05-017-10 TL	Canceled Due to Small Craft Advisory Night Before Callope Island MON LF01-044-30 TL	Klawah BP TL
Wednesday, January 05, 2000	N Duck SIR PL01-036-10 - passed TL	N Duck Bay PTA PL01-034-30 - failed MON PL01-053-30 - passed MON PL01-053-70 - did not get to TL	Office - profile data reduction TL
Thursday, January 06, 2000	Canceled Due to Access Issues West Klawah PTA LF01-036-20 TL	Canceled Due to Fog Duck Bay - partial MON SB06-002-10 Crab Isle SIR SB05-017-10 TL	Rodondo Beach SIR PL01-008-10 - passed TL
Friday, January 07, 2000	Klawah Beach PTA LF02-007-10 - passed TL	N Drum PTA PL01-053-20 - passed TL	Callope Island MON LF01-044-30 - failed TL
Saturday, January 08, 2000	N Duck Bay SIR PL01-029-10 - failed TL	Riverboat Pass SIR SB05-014-20 - passed due to ALARP TL	N Duck Bay MON PL01-053-70 - passed due to NEE TL
Sunday, January 09, 2000	N Drum Bay SIR PL01-027-10 w/OPS TL	Canon Beach Augering TL	Canon Beach Augering TL
Monday, January 10, 2000	N Duck PTA PL01-034-10 TL	N Duck Bay SIR PL01-053-20 - if has passed PTA TL	Rodondo Beach Beach Profiles 1-5 for March and PM site #25 TL
Tuesday, January 11, 2000	Pit Survey check-up at all areas TL	Cannon Beach Augering TL	Rodondo Beach Augering TL
Wednesday, January 12, 2000	Riverboat Pass SIR SB05-015-10 w/ OPS - will need 3 crewboats TL	Canon Beach Pit Survey TL	Rodondo Beach Pit Survey TL
Thursday, January 13, 2000	Klawah BP TL	Little Klawah BP TL	N Duck Bay SIR PL01-053-70 - if has passed PTA TL

Figure 2 SCAT Mission Planner

DATE	SCAT TEAM # 1	SCAT TEAM # 2	SCAT TEAM # 3	SCAT TEAM # 4
DD Month YYYY	Location Mission(s) Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead
DD Month YYYY	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead
DD Month YYYY	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead
DD Month YYYY	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead
DD Month YYYY	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead
DD Month YYYY	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead
DD Month YYYY	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead	Location Mission Team Lead

This template is a rolling planning table that is updated DAILY
Provides a 7-day plan for upcoming missions

MISSION

SOS	Shoreline Oiling Assessment Survey
PTA	Post-Treament Assessment Survey
SIR	Shoreline Inspection Report Survey
OLS	Operations Liaison Suport
BP	Beach Profiling
MON	Monitoring
PM	Photo Monitoring

Figure 3 SCAT Team Daily Tasking and Logistics Plan

SCAT TEAM LOGISTICS for DD Month YYYY					Issued : Date Time	
Team	Staff		Survey Area	Mission	Logistical Arrangements	Time
SCAT #1	Team Lead	Name Cell Phone	*County/Parish* *Place Name* Segment Number(s)			
	FED					
	STATE					
	Safety					
SCAT #2	Team Lead	Name Cell Phone	*County/Parish* *Place Name* Segment Number(s)			
	FED					
	STATE					
	Safety					
SCAT #3	Team Lead	Name Cell Phone	*County/Parish* *Place Name* Segment Number(s)			
	FED					
	STATE					
	Safety					
SCAT #4	Team Lead	Name Cell Phone	*County/Parish* *Place Name* Segment Number(s)			
	FED					
	STATE					
	Safety					

Mission Codes

SOS = Shoreline Oiling Assessment Survey PTA = Post-Treatment Assessment Survey SIR = Segment Inspection Report Survey

OLS = OPS Liaison Support BP = Beach Profiling Survey MON = Monitoring PM = Photo-Monitoring

Time

Enter scheduled time for each logistics action

OCC *30 March 2013* 1

Figure 4 SCAT Daily Field Activities

updated through 31 Jan 2000

DATE	# of teams planned	WX or Safety	Logistics (Boat/UTV)	Other (see notes at right)	SOS	PTA	SIR	BP	PM	OPERATIONS SUPPORT (OLS)	MON	
01/01/00	0											**New Year's Day - Holiday**
01/02/00	0											**Travel Day**
01/03/00	3	3										*safety- safety stand-down ICP
01/04/00	6			2						4		*other- office / *ICP- auguring meeting
01/05/00	6	1								4	1	
01/06/00	6	2								4		
01/07/00	6	2								4		
01/08/00	6			1	1	1		1		2		*other- office due to small craft advisory
01/09/00	6	2						1		3		
01/10/00	6	2						1		3		
01/11/00	5					1			1	3		
01/12/00	6					1	1		1	3		
01/13/00	6			6								*other- augering meeting ICF
01/14/00	6	1			1					4		
01/15/00	9	2			1	1	1			6		
01/16/00	9	3								6		
01/17/00	9				2	1				6		
01/18/00	9			1	1		1			6	0.5	*office -profile data
01/19/00	9	2			1	1				6		
01/20/00	6		1		1.5	1.5	1.5				2	
01/21/00	10				3					6	1	
01/22/00	9					2	2			6	1	
01/23/00	9				1	1	1		2	4		
01/24/00	9		1		2				2	4		
01/25/00	5				2	1		2				
01/26/00	5				1	1	1	1		2		*OLS - Waikiki for final data collection
01/27/00	4			3		1						*other- safety training at ICF
01/28/00	11	11										all teams canceled due to Wx
01/29/00	10	10										all teams canceled due to Wx
01/30/00	10	10										all teams canceled due to Wx
01/31/00	10				2	2	2			5		
JANUARY	***211***	***51***	***2***	***13***	***19.5***	***15.5***	***10.5***	***6***	***6***	***91***	***5.5***	

Page 1

Attachment D

Establishing a Shoreline Assessment (SCAT) Program

Checklists from the NW Area Contingency Plan- DRAFT (March 2013) available at:

http://private.rrt10nwac.com/Files/WorkGroup/130315055901.pdf

ESTABLISHING A SHORELINE ASSESSMENT PROGRAM

Our shorelines are the source of environmental, cultural, and economic vitality. Physically removing oil from the shoreline must be done with great care, using trained workers, to avoid additional harm to environmental or cultural resources, or injuries to workers. Strategies for removing oil from impacted shorelines should strike a balance between environmental impact and benefit. Decisions on how - or even if - to remove oil from shorelines are made using information that is gathered through a systematic and scientific process. This process is called Shoreline Cleanup Assessment Technique (SCAT).

The purpose of a SCAT Program is to:

- Systematically survey and document the area affected by oil to provide rapid and accurate geographic descriptions of the shoreline oiling conditions and real-time issues or clean up constraints;
- Recommend treatment or cleanup of oiled shorelines to OPS and UC;
- Recommend shoreline cleanup endpoint standards to OPS and UC;
- Monitor and evaluate shoreline treatment;
- Provide inspection teams for segment sign off; and,
- Manage data collected from shoreline surveys.

This “Establishing a Shoreline Assessment Program” document was prepared by the Northwest Area Committee (NWAC) to provide guidelines for setting up a Shoreline Assessment (i.e. SCAT) Program during an oil spill incident and is designed to assist spill response managers establish a SCAT program, from “pre-SCAT” activities through the treatment endpoints and sign off process.

The information provided within this document is NOT intended to be prescriptive and may be modified as appropriate with subsequent updates to the Northwest Area Contingency Plan. The document is designed to be generic and generalized, and it is expected that spill response managers will modify as appropriate to the conditions of each incident.

This document includes:

- An organizational chart with color-coded descriptions of the roles and responsibilities of positions working in support of a SCAT function.

- A work flow/timing diagram highlighting the major milestones in a SCAT program (which also serves as a short-form SCAT Coordinator checklist) and a depiction of key SCAT tasks as they relate to the ICS planning “P.”

- A data flow diagram depicting information flow from the field to decision makers thorough each SCAT step.

- A long-form SCAT Coordinator Checklist that is designed to aid users in establishing a SCAT program at an oil spill that has or will likely impact shorelines. The checklist is divided into three sections (Pre-SCAT, Active SCAT, and Sign-Off) to reflect the major phases in the SCAT process. The checklist is further organized by position-specific responsibilities and includes Best Practices where applicable.

- A list of select SCAT resources available for download that can provide further information for responders.

TABLE OF CONTENTS

SECTION **PAGE**

Abbreviation	Definition
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EU	Environmental Unit
EUL	Environmental Unit Leader
FOSC	Federal On-Scene Coordinator
FTP	file transfer protocol
HAZWOPER	hazardous waste operations and emergency response
GIS	geographic information system
GPS	global positioning system
IAP	incident action plan
ICS	Incident Command System
IMT	Incident Management Team
NEB	net environmental benefit
NFT	no further treatment
NOAA	National Oceanic and Atmospheric Administration
NOO	no oil observed
NRDA	Natural Resource Damage Assessment
NWAC	Northwest Area Committee
OP	operational period
OPS	Operation Section
PDA	personal digital assistant
PPE	personal protective equipment
PSC	Planning Section Chief
QA/QC	quality assurance/quality control
RP	responsible party
RPIC	Responsible Party Incident Commander
RRT	Regional Response Team
SCAT	shoreline cleanup assessment technique
SIR	shoreline inspection report
SOSC	State On-Scene Coordinator
STAG	Shoreline Treatment Advisory Group
STR	shoreline treatment recommendation
SU	Situation Unit
UC	Unified Command
USCG	United States Coast Guard
USGS	United States Geological Survey

ORGANIZATIONAL CHART

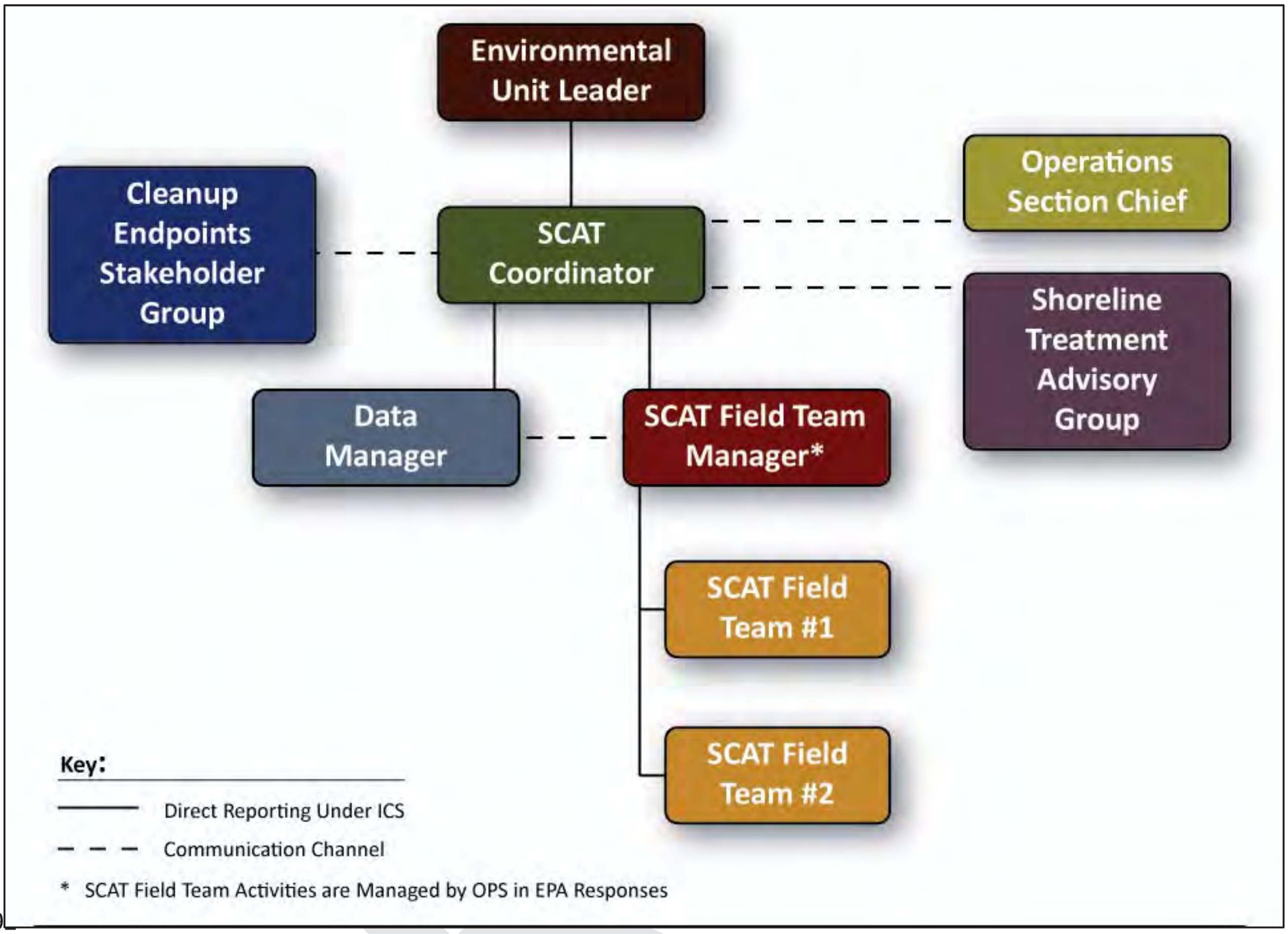


Figure 1: Organizational Chart. Please refer to pages 7 and 8 of this document for a description of the responsibilities associated with each position.

ORGANIZATIONAL CHART

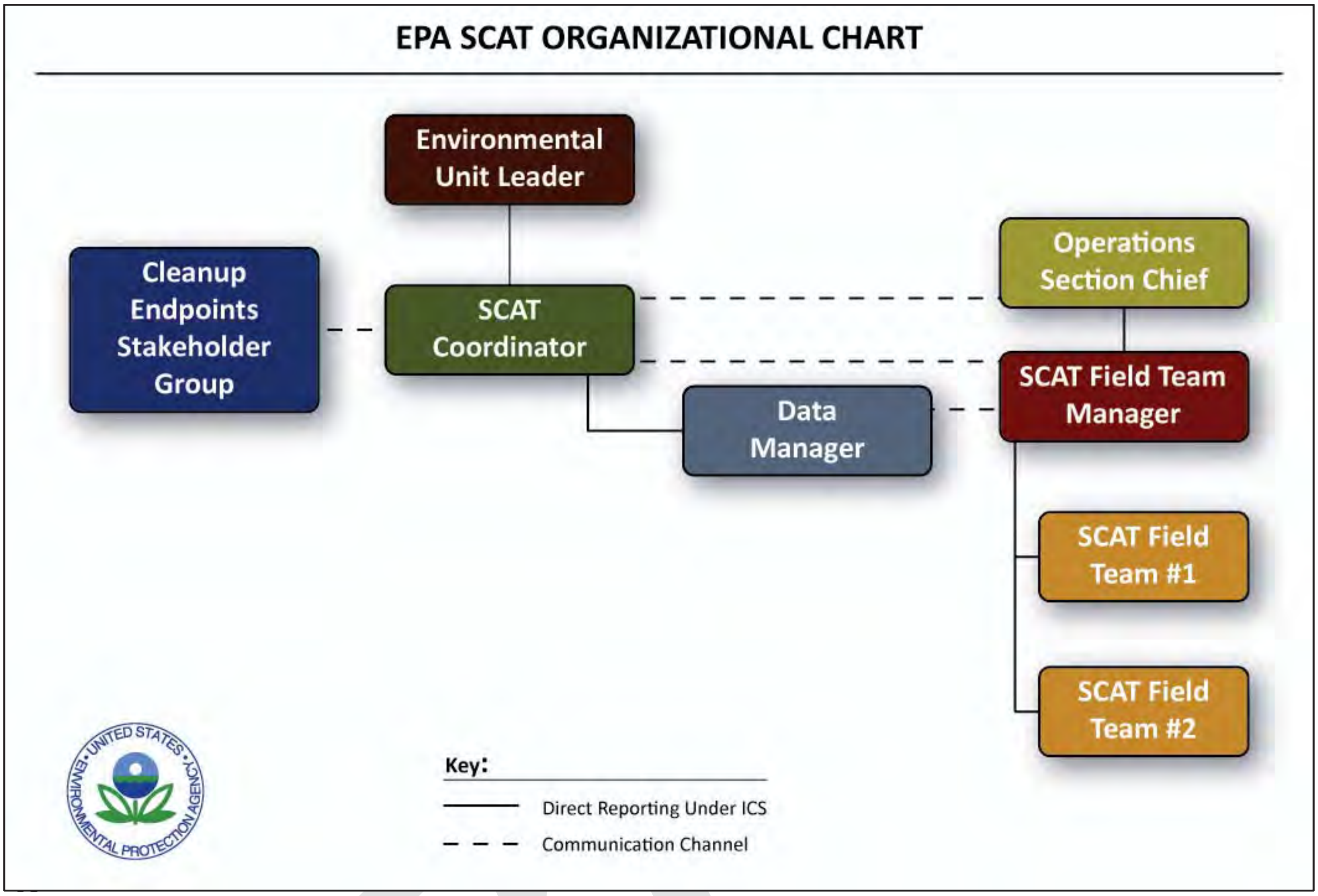


Figure 2: EPA SCAT Organizational Chart. Under EPA-led responses, SCAT teams will report directly to the Operations Section. Please refer to pages 7 and 8 of this document for a description of the responsibilities associated with each position.

ROLES & RESPONSIBILITIES

Environmental Unit Leader

- Communicates Command objectives to SCAT Coordinator
- Communicates SCAT progress and challenges to PSC
- May provide SCAT recommendations into IAP process

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SCAT Coordinator

- Conducts reconnaissance to determine scope of shoreline oiling issues
- Develops a survey and reporting schedule to produce survey results in time for incorporation into the Incident Action Plans
- Sets SCAT field objectives
- Serves as the primary point of contact for all SCAT activities
- Coordinates development of treatment recommendations and cleanup endpoints for Command approval, possibly with the assistance of a Shoreline Treatment Advisory Group (see below) Leads the evaluation of treatment methods and cleanup endpoints and modifies them as necessary
- Works with Operations Section on implementation of cleanup method recommendations
- Attends tactics meetings as appropriate to help provide SCAT input into IAP development
- Briefs the response management team on issues raised by the SCAT, particularly where cleanup methods must be modified to increase effectiveness or decrease impacts
- Coordinates with other members of the response effort with concerns on shoreline assessment to optimize data sharing, including NRDA team
- Integrates cleanup concerns of the various resource agencies and managers into the decision-making process, possibly through a Cleanup Endpoint Stakeholder Group.

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Deputy SCAT Coordinator (optional position or may be fulfilled by the SCAT Coordinator)

- An optional, early phase position primarily responsible for establishing and maintaining communication for mutual understanding and cooperation between SCAT program and Division leaders in OPS
- May conduct work in the command post and/or out in the field facilitating the implementation of early cleanup recommendations
- This position may function as a SCAT/Ops Liaison

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SCAT Field Team Manager (May be combined with SCAT Coordinator)

- Serves as the primary point of contact for all SCAT field-based activities
- Develops daily assignments for each team
- Assigns SCAT teams to meet SCAT field objectives
- Ensures that teams use proper terminology and apply guidelines uniformly
- Ensures that all teams have the necessary representation and all members have the necessary training, equipment and transportation.
- Helps the team reach consensus and reports dissenting opinions when consensus is not reached to SCAT Coordinator
- Conducts briefings with SCAT team members as needed
- Ensures adequate data is collected and communicated
- Communicates physical location of SCAT teams to OPS, SO & others
- Verify that all SCAT field teams return at the end of the day
- Receives reports from field teams and synthesizes them into a daily summary for SCAT Coordinator.

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Data Manager

- Ensures dataflow meets OPS and Planning needs
- Provides SCAT data entry forms and field manuals to field teams
- Reviews daily SCAT forms for completeness and consistency
- Enters or supervises the entry of daily SCAT data
- Conducts data QA/QC; identify common data problems and train SCAT members how to prevent future problems
- Generates daily summary reports, maps, and data summaries
- Maintains an archive of all SCAT data, forms, photographs, GPS data, etc.

SCAT Field Team

- Surveys shorelines as assigned by the SCAT Field Manager to evaluate oiling conditions, identify sensitive resources, determine cleanup needs, and recommend oil treatment/cleanup methods.
- Attends SCAT briefings as required

Operations Section Chief (or Designee)

- Coordinates on the development of treatment recommendations (may be done via STAG participation)
- Directs and oversees shoreline cleanup activities
- Coordinates specific information needs with SCAT Coordinator
- Requests SCAT cleanup verification once shoreline has been cleaned to designated endpoint

Shoreline Treatment Advisory Group (STAG)

- Workgroup typically comprised of staff from OPS and Planning Sections.
- Develops treatment recommendations and cleanup endpoints for Command approval
- Facilitated by SCAT Coordinator

Cleanup Endpoints Stakeholder Group

- A stakeholder group external to the ICS whose input and comments are sought by the SCAT Coordinator regarding the general treatment recommendations and cleanup endpoints for Command approval
- Coordinated by Liaison with assistance from the SCAT Coordinator.
- The group may be comprised of Federal, Tribal, State, Local, non-governmental organizations (such as an environmental advocacy group), or other interested parties

WORKFLOW & MILESTONES

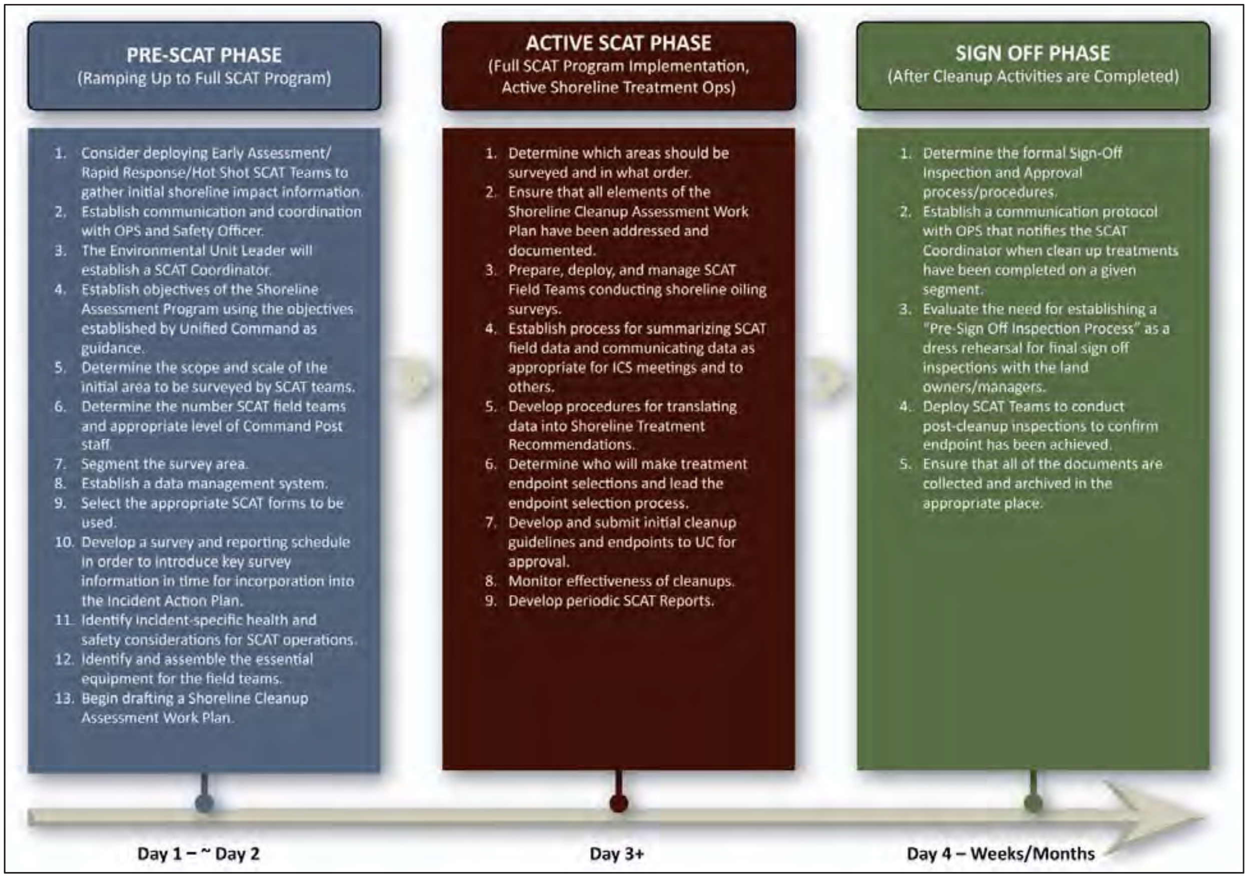

Figure 2: SCAT Workflow and Milestones (Short SCAT Coordinator Checklist). For more detailed information please see SCAT Program Implementation Checklist.

SCAT IN THE PLANNING "P"

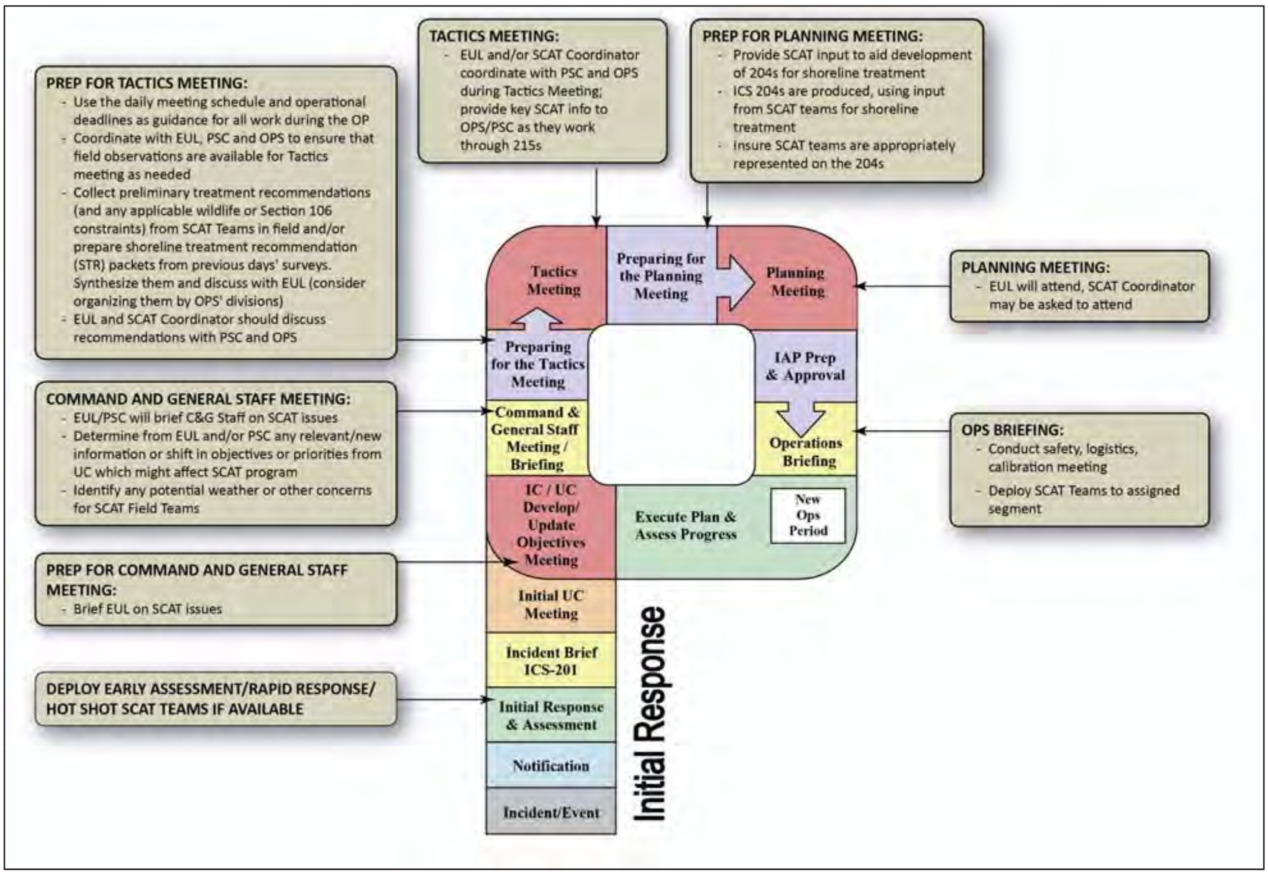

Figure 3. SCAT in the Planning "P."

DATA FLOW

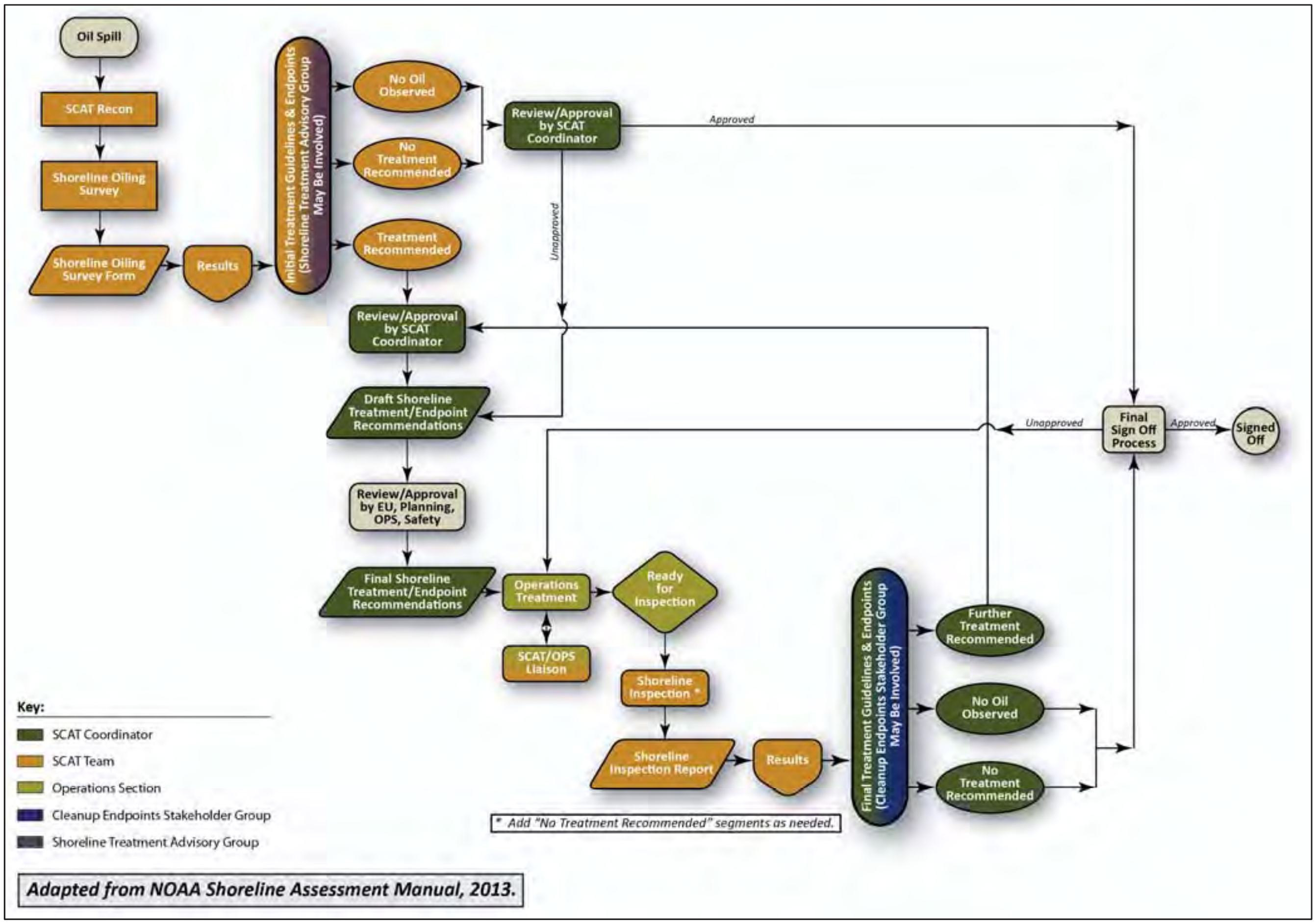

Figure 4. SCAT Data Flow.

SCAT PROGRAM IMPLEMENTATIONCHECKLIST

The following program implementation checklist is designed to aid users in establishing a SCAT program at an oil spill that has or will likely impact shorelines. The checklist is divided into three sections (Pre-SCAT, Active SCAT, and Sign-Off) to reflect the major phases in the SCAT process. The checklist is furthered organized by position-specific responsibilities and includes Best Practices where applicable.

PRE-SCAT PHASE CHECKLIST

The Pre-SCAT phase begins when initial responders first receive notification that a spill has occurred. This phase typically lasts no more than a few days after the incident is reported and is comprised of planning and preparation for the Active SCAT Phase.

ENVIRONMENTAL UNIT LEADER

- ❑ **Consider deploying early assessment/rapid response/"hot shot" SCAT teams to gather initial shoreline impact information, if available.**

    - The goal is to obtain a general snapshot of the impacted areas or areas that may be impacted. These teams can provide valuable information that will support planning activities for the formal SCAT process as well as near-real time information to OPS. Any assessment conducted by these teams should be broad in scope and scale.

> **BEST PRACTICE:** Start aerial reconnaissance started as early as possible in the response.

> **BEST PRACTICE:** Consider the use of "hot shot" cleanup crews as well, particularly those that are able to implement passive and other low-impact methods to prevent re-oiling.

- ❑ **Establish communication and coordination with OPS and Safety Officer.**

    - Determine the most appropriate point of contact in OPS. This may be the OPS Section Chief or the Shoreline Cleanup Supervisor.

- ❑ **The Environmental Unit Leader will establish a SCAT Coordinator.**

    - This position may be filled by a government, agency, trustee agency, RP representative, or other representative.
        - Considerations for SCAT Coordinator Selection:
            - Level of training and experience with SCAT implementation and/or coordination.
            - Ability to maintain consistent participation throughout duration of response.
            - Ability to coordinate effectively and appropriately with NRDA.
            - Perception of government oversight and leadership.

    - If warranted by SCAT coordination workload, consider employing Deputy or Co-Coordinators to assist with various SCAT coordination functions. The decision to add a deputy or co-coordinator may be based on incident specific circumstances such as the scale of the incident or the anticipated workload.

- o The SCAT Coordinator will establish and maintain the SCAT Program for a response. The SCAT Coordinator must be trained in SCAT and must have experience in implementing SCAT methodologies during a spill. The SCAT Coordinator also needs to be familiar with the ICS process and structure. This person needs to understand the role that SCAT recommendations from the field play in the planning cycle and the need for coordinating this information with the timing of the development of the IAP and the 204s for shoreline treatment.

BEST PRACTICE: When selecting SCAT Coordinators (or other SCAT positions), consider the need to swap individuals on a 2-3 week rotational calendar. Maintaining continuity of personnel is an important goal as SCAT is typically one of the longest lasting activities in a response.

SCAT COORDINATOR (or DEPUTY) /FIELD TEAM MANAGER

- ❑ **Establish objectives of the Shoreline Assessment Program using the objectives established by Unified Command as guidance.**

  - o Sample SCAT Program Objectives (see the shoreline cleanup assessment work plan for more info):
    - Collect comprehensive information on shoreline oiling conditions using standard protocols and mechanisms;
    - Utilize shoreline oiling data to enhance and expedite shoreline treatment planning, decision-making, and response activities; and
    - Assure that a "net environmental benefit" (NEB) for an oiled shoreline can be achieved by shoreline treatment.

  - o Ensure cultural and tribal resources are adequately addressed in your objectives

BEST PRACTICE: Be clear about the objectives of the SCAT program to avoid mission creep – avoid assigning SCAT extra duties beyond the established objectives (e.g. sampling, NRDA).

- ❑ **Determine the scope and scale of the initial area to be surveyed by SCAT teams.**

  - o Conduct reconnaissance and use trajectory models, tides, winds, river flow, and other relevant environmental conditions to establish the boundaries of the initial survey area.

BEST PRACTICE: The total survey area should extend somewhat beyond the extent of the oiled areas.

BEST PRACTICE: Conducting reconnaissance via aircraft will greatly aid in the initial SCAT planning. Try to reserve a spot on an aircraft as soon as possible.

  - o Select the appropriate initial survey method(s). Surveys may be conducted by different methods and at different scales depending upon the size of the affected area, character of the shoreline type, and level of detail that is required. Select a survey method which meets incident objectives and is achievable with the resources available.

- ❑ **Determine the initial number SCAT field teams and appropriate level of Command Post staff.**

  - o Determine the initial positions that need to be filled (SCAT Field Manager, Data Manager, SCAT Teams, other SCAT Support staff, etc.) and by whom.

The exact number of roles and individuals to fill those roles can vary widely from spill to spill and during a spill as conditions change.

BEST PRACTICE: Conduct early outreach to organizations that may be asked to provide SCAT personnel.

BEST PRACTICE: Consider engaging an oil geomorphologist to assist in the Command Post as well as in the field.

- SCAT personnel should have, at minimum:
  - Received 40 hour HAZWOPER training (field staff)
  - Familiarity/experience with oil spill response
  - Basic ICS training
  - Basic SCAT training

- At minimum, the field SCAT teams should consist of an:
  - RP Representative
  - State government representative
  - Federal On Scene Coordinator representative or designee

- Other field SCAT team members may include:
  - Tribal government representative
  - Landowner or manager
  - Local government
  - Technical specialists

- A variety of technical specialist can support SCAT operations. Depending on the circumstance of the spill, individuals with the following skills should be considered:
  - Oil Geomorphologist: A specialist experienced in identifying the physical processes affecting oil on a shoreline.
  - Ecologist/Biologist: A specialist capable of identifying biological concerns/constraints and providing input on treatment options and endpoints.
  - Archeologist or Cultural Resource Specialist: An individual who can advise on precautions and constraints to protect cultural resources, if needed.
  - Oil Spill Response Cleanup Expert: An individual well-versed in oil removal and remediation techniques. May be an Operations Section representative.

BEST PRACTICE: Keep SCAT teams as small as practicable (e.g. 3-5) for safety and logistical reasons. Where possible, try to use individuals who can fill multiple specialty roles.

> **BEST PRACTICE:** The SCAT Team Leader generally should be the person on the team with the most SCAT field experience, independent of their team specialty.

- Be sure to consider biological and/or cultural/historical constraints. Review the ICS 232 form(s). Determine the need to have a wildlife biologist and/or a cultural resources specialist join the SCAT Field Teams during surveys on shoreline segments that have been identified as having potential ESA or Cultural concerns.

- Consider including tribal representative(s) on SCAT teams as appropriate (must meet same health & safety training requirements as other team members).

- Maintain continuity of staff to the extent possible, throughout the duration of the SCAT program. Develop a staffing calendar with 2-3 week rotations for team.

> **BEST PRACTICE:** Consider the long-term staffing needs for SCAT early. Continuity in assigning teams is a good practice. Avoid calibration drift (staff assigned months into the incident can have a different perspective). Consider developing training/guidance document for staff rotation during long-term responses. Training could include visits to oiled shorelines or photo history of a segment.

❑ **Segment the survey area.**

- An essential first step of a SCAT survey is to divide the coastline into working units called segments, within which the shoreline character is relatively homogeneous in terms of physical features and sediment type.

- Each segment is assigned a unique location identifier. Segment boundaries are established on the basis of prominent geological features (such as a headland), changes in shoreline or substrate type, a change in oiling conditions, or establishment of the boundary of an operations area.

- In general, most segments in oiled areas would be in the range of 0.2 – 2.0 km in length but this will be determined largely by the nature of a given shoreline. Segment lengths should be small enough to obtain adequate resolution and detail on the distribution of oil, but not so small that too much data is replicated (i.e. if multiple adjacent segments are of the same shoreline type, then it would be useful to create larger segments to facilitate quickly assessing them).

- If applicable to the response, identify shoreline access points, restricted areas, and hazards that affect SCAT activities and ensure this information is communicated to SCAT Field Team Manager or SCAT Coordinator.

> **BEST PRACTICE:** Check to see if the survey area has been pre-segmented (e.g. in an Area Plan or by local industry).

> **BEST PRACTICE:** When determining segment boundaries, coordinate with OPS on their shoreline Division Boundaries. To minimize confusion during planning, avoid creating segments that span multiple divisions whenever possible. If an area has been pre-segmented recommend that OPS select division boundaries that coincide with segment endpoints.

Reference: The following documents contain additional guidance on developing segment boundaries that may be useful:

- o Shoreline Assessment Manual – 3rd Addition. NOAA August 2000 http://response.restoration.noaa.gov/sites/default/files/manual_shore_assess_aug2000.pdf

- o The UK SCAT Manual: A field guide to the documentation of oiled shorelines in the UK. John Moore, April 2007. Sec. 1.3.1 www.dft.gov.uk/mca/corp119ext.pdf

❑ **Establish a data management system.**

- o Consider appointing a SCAT Data Manager or refer to the Pre-SCAT Phase Data Management checklist for steps to accomplish this task.

- o Considerations for determining best data management organization:
  - Which system best meets the response needs and/or scale?
  - Electronic vs. paper-based?
  - Is it readily available?
  - Existing policies?

❑ **Select the appropriate SCAT forms to be used.**

- o Use forms appropriate for the conditions of the spill (marine, river, winter, tarball, etc.).
- o Links to commonly used SCAT Forms are available below:
  - NOAA: http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/shoreline-cleanup-and-assessment-technique-scat.html
  - Environment Canada: http://www.etccte.ec.gc.ca/estd_west/estdwest_scat_e.html#04
  - Polaris Applied Sciences. Inc. (includes links to more rarely used forms): http://www.polarisappliedsciences.com/welcome.html

> **BEST PRACTICE**: Ensure SCAT forms and associated data collection documents/tools are available and appropriate.

- ❑ **Develop a survey and reporting schedule as appropriate to provide key survey information as needed for incorporation into the Incident Action Plan.**

    - o Consider the established meeting schedule and the data needs for ICS meetings.

> **BEST PRACTICE:** Work with EUL to coordinate with IAP development and relay time-critical information as appropriate within the Command Post.

- ❑ **Identify incident specific health and safety considerations for SCAT operations.**

- ❑ **Identify and assemble the essential equipment for the Field Teams.**

> **BEST PRACTICE:** *Try to ensure to that the same make/model of equipment (Cameras, GPS, Phones, etc.) is used across the field teams to ensure for data / logistical consistency.*

- ❑ **Begin drafting a shoreline cleanup assessment work plan. When complete, the work plan should describe, at minimum:**

    - o The purpose of the SCAT program including objectives and guiding principles
    - o Health, safety, and environmental considerations specific to the SCAT operations
    - o Organization, staffing, and schedules
    - o Survey methods to be employed
    - o Field documentation and data management processes, and
    - o Cleanup endpoint standards (these will be preliminary).

> **BEST PRACTICE:** A variety of permits (e.g. for shoreline access) may be required during the survey process. Coordinate with the EU to identify applicable permits and constraints and include them in the work plan as appropriate.

DATA MANAGEMENT

- ❑ **Establish general expectations, procedures, and accountability for SCAT data management tasks. Depending on the scale of the response, these responsibilities may be handled by SCAT Coordinator or a delegated Data Manager.**
  - Address data sharing protocols and data access issues between stakeholders (i.e. Fed/State/RP) when making these determinations.
  - Each agency/organization representative working on SCAT data should be familiar with their own organization's data policy and be able to discuss any critical issues including public disclosure requirements.

> **BEST PRACTICE:** Be sure to discuss the following: frequency of data archiving, who can access the data and how, will copies be permitted, etc. If needed, consult NOAA for other data management considerations.

- ❑ **Ensure that the appropriate SCAT forms and associated data collection documents/tools are available, based on the stated needs and objectives of the SCAT program.**
  - Define the specific types of data SCAT teams will and will not collect (e.g. Photos, Pits/Trenches, Samples, Oiled wildlife observations, etc.).
  - Modify the forms to meet incident specific needs as appropriate.
  - Ensure SCAT teams/forms are using standardized location naming conventions (e.g. shoreline segment identification numbers) that can be integrated into geodatabases/GIS systems being developed.

- ❑ **Evaluate equipment requirements/standards for data collection and management**
  - Coordinate this review with the SCAT Program Field Team Manager or Coordinator as appropriate.
  - Common data collection equipment may include: Digital cameras, hand-held GPS units, Forms, PDAs, Tablet Computers, etc.

> **BEST PRACTICE:** Ensure that any equipment being used meets or exceeds accepted data quality standards.

> **BEST PRACTICE:** Ensure that any devices deployed accurately reflect the local time. If possible, cameras should have the date and time set to match that of the associated team's issued GPS. It is a good practice to take a picture of the

team GPS time screen with the digital camera prior to (and after) each deployment. This can then be used to post-process pictures if necessary.

- ❑ **Develop an electronic document management system/database.**

    - Establish file directory structure and file naming conventions for managing documents, data, and photos.
    - Establish both on-site backup and an off-site, secure repository for all data and documentation.
    - Determine/establish appropriate permissions for database access and editing.

- ❑ **As appropriate, identify predetermined standards for data verification, analysis, and reporting.**

    - Identify and put in place verification SOPs & checklists such as standard query language verification queries (auditing of data) and reporting SOPs & procedures and requirements.

- ❑ **Obtain and manage geospatial information.**

    - Coordinate data and map transfers with the SU and EU (e.g., base maps, overflight maps, etc.) as appropriate.

Acquire the spatial data and maps necessary to meet the data needs of the SCAT Program and (in particular) the field teams.

- Create base maps for field planning and use, including laminated or other weather-resistant versions.

BEST PRACTICE: Consider the need to have a dedicated SCAT mapping capability (separate from the SU) as part of SCAT data management.

- ❑ **Develop and maintain contact list for SCAT Team members.**

ACTIVE SCAT PHASE CHECKLIST

The Active SCAT Phase may begin between one and several days into the response, depending on spill-specific conditions. This phase involves field surveys, data collection/analysis, treatment/cleanup endpoint recommendations, as well as shoreline treatment monitoring.

SCAT COORDINATOR (or DEPUTY)/FIELD TEAM MANAGER

- ❑ **Determine which areas should be surveyed and in what order.**
  - o Coordinate with the Operations Section.

BEST PRACTICE: Stay at least a day ahead of cleanup crews if possible.

  - o Continue to re-assess the scope and scale of the survey areas and adjust as needed.

BEST PRACTICE: Daily surveys should be prioritized based on shoreline oiling conditions noted during aerial reconnaissance flights. Segments where heavy oiling has been observed or which are of specific ecological importance should be prioritized for surveys first.

BEST PRACTICE: Ideally, surveys should be conducted during daylight hours and at low tide (if applicable).

- ❑ **Ensure that all elements of the shoreline cleanup assessment work plan have been completed.**

- ❑ **Prepare, deploy, and manage SCAT Field Teams conducting shoreline oiling surveys. (may be managed by SCAT Field Team Manager)**
  - o Assemble SCAT teams to meet SCAT field objectives and ensure that all teams have the necessary representation, training and equipment.
  - o Ensure that team assignments are made daily or as appropriate. Be sure the assignments are reflected in the 204s and passed on to the teams.
  - o Identify and ensure field team safety and logistical needs (transportation via helicopter or boat? PPE issues? Communication via radios, mobile or satellite phones? Lunch? Etc.) are met daily.

- Obtain weather, tidal charts and/or river flow data from credible sources such as NOAA (weather and/or tides) or USGS (river flow data) and distribute to team leaders.

- Conduct SCAT Meetings at the beginning of shifts (as appropriate):
  - This meeting should include those staff in the EU who are involved in the SCAT program or who might have some associated interest (OPS, Wildlife Liaison, etc.). Topics may include: daily assignments, logistics, alterations to the work plan, safety updates, general updates, etc.
  - Review any special considerations that may exist for each team such as: site access, (e.g. need for vehicle, boat, or aircraft), problematic terrain (streams, cliffs), special safety considerations, communications, limitations, etc.

> **BEST PRACTICE:** Conduct safety briefings and calibration training with SCAT field team members on a daily basis, or as appropriate, before sending teams in to the field. Ensure that teams use proper terminology and apply guidelines uniformly.

- Conduct debriefings with SCAT team members at the end of shifts. Debriefings may include the following topics:
  - The need for consensus among team members. If consensus is not reached in the field, make sure that conflicting opinions are documented.
  - Ensure that documentation and equipment for SCAT teams (maps, photography equipment, gear, communications, etc.) are adequate prior to next deployment.
  - Solicit observations from the field team regarding cleanup processes, successes, failures, etc.

- Ensure that data is being collected and recorded appropriately.

❑ **Establish process for summarizing SCAT field data and communicating data as appropriate for ICS meetings, others.**

- Command And General Staff Meeting:
  - Determine from EUL and/or PSC any relevant/new information or shift in objectives or priorities from UC which might affect SCAT program.
  - Identify any potential weather or other concerns for SCAT Field Teams.

- Pre-Tactics and Tactics Meeting
  - Coordinate with EUL, PSC and OPS to ensure that field observations are available for Tactics meeting as needed.
  - Collect preliminary treatment recommendations (and any applicable wildlife or Section 106 constraints) from SCAT Teams in field and/or

prepare shoreline treatment recommendation (STR) packets from the previous days' surveys.

- Synthesize them and discuss with EUL (consider organizing them by OPS' divisions).
- EUL and/or SCAT Coordinator coordinate with PSC and OPS during Tactics Meeting; provide key SCAT info to OPS/PSC to help develop 204s (treatment recommendations, safety constraints, etc.).

- Planning Meeting
  - 204s for shoreline treatment are produced, using input from SCAT teams.
  - 204s for continued SCAT team deployments are produced.
  - EUL typically attends, SCAT Coordinator may be asked to attend.

BEST PRACTICE: Coordinate with the EUL to ensure that there is a process for SCAT data to get to OPS for consideration in the IAP process.

- OPS Briefing
  - Conduct safety, logistics, calibration meeting
  - Deploy the SCAT Teams to assigned segments

BEST PRACTICE: Assist EUL in developing data sharing opportunities with NRDA and others.

❑ **Develop procedures for translating data into shoreline treatment recommendations (STRs).**

- Confirm (or establish if necessary) the incident-specific process for developing STRs.

BEST PRACTICE: Typically the process would be for the SCAT Coordinator to develop STRs for each segment, organized them by Division, and route them through the appropriate parts of the ICS for signatures (Safety Officer, PSC, OPS, Sect 7, Sect 106, UC, etc.). The STRs would then be presented during the Prep for Tactics Work Period and at the Tactics Meetings.

- Ensure that above process is synchronized with IAP development.

BEST PRACTICE: Use shoreline treatment recommendation forms. Once approved they will also serve as work orders or permits to implement the cleanup recommendations.

❑ **Establish the "Shoreline Treatment Advisory Group" (STAG) and lead the effort to develop initial shoreline treatment guidelines for UC review. Later in the cleanup process, the STAG will also contribute to the development of cleanup endpoints.**

BEST PRACTICE: Assemble a STAG comprised of staff from OPS and Planning to develop treatment recommendations and cleanup endpoints for Command approval.

BEST PRACTICE: If any chemical countermeasures or in-situ burn are being considered by a SCAT Team, work with EUL and PSC to seek RRT approval.

- ❑ **Coordinate with Liaison to establish the "Cleanup Endpoint Stakeholder Group" and lead the effort to review shoreline treatment and cleanup endpoint recommendations prior to UC review.**

  - Determine which agencies/organizations must be involved in treatment and endpoint selection process.

  - Integrate cleanup concerns of the various resource agencies and managers into the process of developing treatment and endpoint recommendations.

BEST PRACTICE: Endpoints are typically selected by shoreline type but some segments may have specific sensitivities which require segment-specific endpoints.

References:

- Guidelines for Selecting Shoreline Treatment Endpoints for Oil Spill Response. Environment Canada, 2007. http://publications.gc.ca/collections/collection_2011/ec/En4-84-2008-eng.pdf

- Shoreline Assessment Manual – 3rd Addition. NOAA. 2000. http://response.restoration.noaa.gov/sites/default/files/manual_shore_assess_aug2000.pdf

- Shoreline Assessment Job Aid, NOAA. 2007. http://response.restoration.noaa.gov/sites/default/files/jobaid_shore_assess_aug2007.pdf

- ❑ **Monitor effectiveness of cleanups.**

  - Coordinate with the EUL and OPS liaison on any issues raised by SCAT team observations, particularly where cleanup methods must be modified to increase effectiveness or decrease impacts.

  - Develop a process to ensure that the treatment recommendations on the 204s for shoreline treatment crews are being properly implemented and are effective. This may be achieved by using SCAT Team members, SCAT-OPS liaisons, or other trained oversight personnel.

- These personnel are field-based and will work alongside Shoreline Operations/Cleanup to ensure SCAT instructions are understood, applied properly, and are effective. They are the eyes/ears in the field supporting the SCAT Coordinator.

BEST PRACTICE: Establish a feedback loop during the day to report when field monitors observe ineffective cleanup or when an adverse impact is resulting from an agreed upon treatment technique.

❑ **Develop periodic SCAT Reports. The frequency will be determined by the EUL.**

BEST PRACTICE: Document the highlights of each day for historical and training purposes.

DATA MANAGEMENT

❑ **Implement protocols for the data handling, processing, quality assurance/quality control (QA/QC), outputs, and archiving of the shoreline oiling data collected during the incident.**

❑ **Closely coordinate with OPS/PSC to provide SCAT information to the IAP process.**

- o Data collected in the field should be transmitted to OPS for inclusion in 204s
- o Identify the Pre-tactics needs and develop a process for meeting those needs.

❑ **Closely coordinate with SU to ensure that maps and other outputs are up to date and accurate.**

❑ **As needed, meet with SCAT Teams prior to field mobilizations to instruct/review field documentation protocols and data forms.**

❑ **Ensure that approved SCAT data are made available for internal use by response agencies and to support public affairs products and events.**

❑ **Retrieve data (in all formats) from the Field Teams or Field Team Manager as soon as possible after collection.**

- o Log incoming SCAT field forms, sketches, and other information (films, videotapes, etc.) and review the field information. The review should involve checking to ensure that all sections of the forms have been completed and that the information appears reasonable and consistent.

BEST PRACTICE: GPS units and digital cameras should be surrendered to the Data Manager immediately upon return to the Command Post. GPS track lines and photos should be deleted from the units once they have been saved in a secure repository. Photos should be labeled as soon as possible.

- ❑ **Provide quality control/quality assurance of field-collected data for use in the Incident Command Post.**
  - Manage and QA/QC SCAT Team GPS data capture and waypoints. Ensure GPS tracklogs, data capture, waypoints and digital photos/videos are accounted for, complete, and stored appropriately.
  - Manage and upload digital photos for spatial display as needed by the IMT.
- ❑ **Collect supplemental observations from other sources.**
  - Other sources such as field observers, OPS, the public, and others may provide useful information on shoreline oiling for consideration and dissemination. This might require a separate system for data storage than that used by SCAT. Consider using a GIS Specialist in the Situation Unit to collect non-SCAT observations. Liaison will also be a resource for collecting supplemental information.
- ❑ **Produce SCAT outputs that may include:**
  - Maps of shoreline types
  - Segment oiling conditions
  - Surface oil volumes on the shoreline, changes in volume through time
  - SCAT field survey status
  - Treatment recommendations
  - Cleanup treatment status
  - Lengths of oiled shoreline (by oil rating and/or shoreline type)
  - Lengths treated (by oil rating and/or treatment method)

BEST PRACTICE: Coordinate data needs with the EUL to ensure that there is sufficient time for data input and processing prior to the Tactics Meetings and Pre-Tactics Work Period.

- Produce daily status reports and maps showing current SCAT deployments and assessment activities.
  - Archive copies for distribution and reference; produce other reports as needed.
  - Confirm with SCAT Coordinator on future field map development needs or SCAT survey targets.

- Ensure production of SCAT maps and make them available in all appropriate formats, including hard copies, PDFs, Google Earth kml/kmz files, and web mapping services.

BEST PRACTICE: Develop and use map templates to standardize the layout elements, file path, reference of site location, map layers and naming conventions for mapping products.

❑ **With SCAT Coordinator, review data management performance after first SCAT field activities and modify forms and protocols as necessary. Continue coordinating with SCAT Coordinator and SCAT Teams; provide and receive feedback on data management performance at SCAT and Unified Command briefings.**

❑ **Maintain and ensure the data integrity/availability of the SCAT databases system and it's standardization with other spatial and reporting databases as appropriate.**

❑ **Implement data archival strategy (e.g. offsite external drives/FTP/server, used for ongoing reference and long-term documentation). Ensure that a documented process exists for maintaining data consistency across the various repositories.**

❑ **Periodically review data requirements with the SCAT Coordinator.**

SIGN-OFF PHASE CHECKLIST

The Sign-Off Phase begins when OPS has completed cleanup of affected shoreline segments and requests confirmation inspections by SCAT Teams and land owner/managers.

SCAT COORDINATOR (or DEPUTY)/FIELD TEAM MANAGER

- ❑ **Establish a communication protocol with OPS that notifies the (EUL and/or SCAT Coordinator) when clean up treatments have been completed on a given segment.**

- ❑ **Evaluate the need for establishing a "pre-sign off inspection process" (i.e. "PEST" surveys) as a dress rehearsal for final sign off inspections with the land owners/managers and develop as necessary. A pre-sign off inspection is a particularly valuable practice during larger spills.**

- ❑ **Determine the formal sign-off inspection and approval process/procedures.**

  - Determine which team members have signatory authority and which can only provide comments. One FOSC representative, one SOSC representative, and one RP representative typically sign shoreline inspection report to indicate no further treatment (NFT) or no oil observed (NOO) for a segment. Landowners can comment but will not necessarily be signatories on the shoreline inspection report.

  - Depending on the conditions of the spill, the signatory authority of the team could be limited to simply making the "official" recommendations to UC for their signature or, if appropriate, the team could have the authority to represent the UC and serve as the "final" sign-off authority for a segment.

  - Identify or develop an appropriate sign-off report (SIR) Form to use with input from EUL/PSC/UC.

  - Determine composition of the sign-off team(s). If possible use the original SCAT team plus any additional representatives (e.g. land owner/manager)

  - After the Operations Division Supervisor or Shoreline Supervisor considers that cleanup in a segment has been completed, the segment is inspected by a SCAT team.

BEST PRACTICE: The SCAT Team that conducted the original survey is a good group to conduct the survey as they will have perspective on the original oiling conditions for a given segment.

SIGN-OFF PHASE CHECKLIST

- ❑ **Deploy Sign-Off Teams to conduct post-cleanup inspections to confirm endpoint has been achieved.**

  - o If segment meets endpoints cleanup criteria, then recommend for sign-off/approval by indicating:
    - No oil observed (NOO)
    - No further treatment is recommended (NFT)

  - o If segment does not meet endpoint cleanup criteria, then recommend
    - "Maintenance and monitoring"
    - Continuation of the original cleanup treatment recommendation
    - Continuation of a modified shoreline treatment.

  - o Document the results of the inspection.

BEST PRACTICE: Use a Segment Inspection form. Link this form to the original shoreline oiling summary. The Data Manager should be consulted to help determine form type and content.

- ❑ **Ensure that all of the completed inspection/recommendation documents are collected and archived appropriately.**

DATA MANAGEMENT

- ❑ **Continue collecting segment-specific forms and other documentation recording when/if cleanup standards have been achieved.**
- ❑ **Determine the need for additional deliverables of SCAT data that may be needed for "maintenance and monitoring" efforts.**
- ❑ **Ensure that ongoing monitoring efforts adhere to data standards.**
- ❑ **Confirm final archival storage for all SCAT data from field teams, deliverables of maps, photos, GPS data and GIS outputs. Coordinate with all on data distribution list for final delivery of data and analysis.**
- ❑ **Close out all data and GIS deliverables for SCAT mapping and analysis.**
- ❑ **Identify, evaluate, and report all known gaps, delays, or interruptions of all data deliverables to strengthen future performances in the management and implementation of SCAT data.**

Some useful documents for marine & freshwater spills and where to find them are provided below. Please review the documents prior to using them to ensure that they are consistent with current policy.

Characteristic Coastal Habitats: Choosing Spill Response Alternatives. (NOAA, 2010)
http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id(entry_subtopic_topic)=349&subtopic_id(entry_subtopic_topic)=8&topic_id(entry_subtopic_topic)=1

Fate and Environmental Effects of Oil Spills in Freshwater Environments. (API publication No. 4675, 1999)
http://www.api.org/Publications/

An FOSC's Guide to NOAA Scientific Support. (NOAA, 2010)
http://response.restoration.noaa.gov/foscguide

Physical Processes Affecting the Movement and Spreading of Oils in Inland Waters. (NOAA, 1995)
http://response.restoration.noaa.gov/book_shelf/960_inland.pdf

Shoreline Assessment Job Aid. (NOAA, 2007)
http://archive.orr.noaa.gov/book_shelf/71_jobaid_shore_assess.pdf

Shoreline Assessment Manual. (NOAA, 2000)
http://archive.orr.noaa.gov/book_shelf/72_manual_shore_assess.pdf

The SCAT Manual – A Field Guide to the Documentation and Description of Oiled Shorelines. (Environment Canada, 2007)
http://publications.gc.ca/collections/collection_2011/ec/En4-84-2008-eng.pdf?

The UK SCAT Manual: A field guide to the documentation of oiled shorelines in the UK. (Environment Canada, 2007)
www.dft.gov.uk/mca/corp119ext.pdf

Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments (NOAA, 2010)
http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/characteristics-response-strategies.html

Introduction to Coastal Habitats and Biological Resources for Spill Response
http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/coastal-habitats-biological-resources-job-aid.html

Shoreline Countermeasures Manuals (NOAA)

Alaska:
http://response.restoration.noaa.gov/sites/default/files/shoreline_countermeasures_alaska.pdf

Freshwater:
http://response.restoration.noaa.gov/sites/default/files/shoreline_countermeasures_freshwater.pdf

Temperate:
http://response.restoration.noaa.gov/sites/default/files/shoreline_countermeasures_temperate.pdf

Shoreline Assessment Forms (NOAA)
http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id%28entry_subtopic_topic%29=277&subtopic_id%28entry_subtopic_topic%29=8&topic_id%28entry_subtopic_topic%29=1

WORK PLAN TEMPLATE

The following Shoreline Cleanup Assessment Work Plan template is one of many examples of such plans. The template is not intended to be prescriptive, but to highlight the key components of a SCAT work plan. Responders should modify the plan to best fit the needs of the incident to which they are responding.

NOTE TO REVIEWER: The work plan template and appendices, once finalized, will become a standalone document to supplement the "Establishing a SCAT Program" document. The two documents are presented in a single document format to facilitate the review process.

SHORELINE CLEANUP ASSESSMENT TEAM
WORK PLAN

(Insert Incident Name)

This incident-specific SCAT plan is approved:

______________________________	______________
FOSC	Date
______________________________	______________
SOSC	Date
______________________________	______________
RPIC	Date

cc: Operations Section, Shoreline Cleanup Supervisor
Operations Section Chief
National Oceanographic and Atmospheric Administration, SSC
U.S. Environmental Protection Agency
U.S. Department of Interior, U.S. Fish and Wildlife Service
State Historic Preservation Officer
State Agencies

1. SCAT PLAN PURPOSE AND OBJECTIVES

a. Purpose

This work plan has been developed to describe the process for initiating and implementing Shoreline Cleanup Assessment Technique ("SCAT") actions for shorelines impacted by the XXX ***Spill/Drill***.

The SCAT process for this incident is intended to:

1. Systematically survey and document the area affected by oil to provide rapid and accurate geographic description of the shoreline oiling conditions and real-time issues or constraints;
2. Recommend treatment or cleanup of oiled shorelines to OPS and UC;
3. Recommend shoreline cleanup endpoint standards to OPS and UC;
4. Monitor and evaluate shoreline treatment;
5. Provide inspection teams for segment sign off, and
6. Manage data collected from shoreline surveys.

b. Objectives

The objectives of the SCAT process for this incident are to:

1. Quickly collect data on shoreline oiling conditions using standard protocols and mechanisms;
2. Utilize shoreline oiling data to enhance and expedite shoreline treatment planning, decision-making, and response activities; and
3. Assure that a "net environmental benefit" (NEB) for an oiled shoreline is achieved by shoreline cleanup.

c. Fundamental Principles:

The fundamental principles of the shoreline assessment surveys include:

1. A systematic assessment of all (oiled and non-oiled) shorelines in the affected area;
2. A division of shorelines into homogeneous geographic units or "segments";
3. The use of a standard set of terms and definitions for documentation;
4. A survey team that is objective and trained; and
5. The timely provision of data and information for decision making and planning.

2. Health and Safety

The Site Safety Officer prepares a Site Safety Plan addressing safety issues related to the incident. The Site Safety Plan addresses the principal safety and health hazards from boat and water operations and shoreline assessment and cleanup operations. The site safety plan covers training; equipment safety; protective clothing and equipment;

decontamination; and first aid and medical evacuation procedures to be used during the response.

Specific safety considerations for SCAT operations include the following:

- Follow the Site Safety Plan.
- Attend daily safety meetings regarding SCAT work.
- Wear personal protective equipment.
- Use personal flotation devices when transiting across water.
- Observe careful personal hygiene during the workday.
- Watch for slips, trips, and falls.
- Wearing hearing protection when designated.
- Watch for heat and cold stress.
- Avoid interaction with wildlife.
- Protect hands.
- Operate equipment according to instructions.
- Practice good housekeeping in work areas.

3. Organization, Staffing, and Schedule

Organization

The SCAT Coordinator is in charge of the Shoreline Cleanup Assessment Technique operations. The SCAT Coordinator reports directly to the Environment Unit Leader, but must maintain a close working relationship with the Operations Section, resource agencies, and other affected parties. In the field, SCAT teams will receive priorities and technical directions from the SCAT Coordinator via the SCAT Field Team Manager.

Staffing

The field SCAT teams will consist of up to 6 members (plus vessel/aircraft operators as needed); ideally with the following representation (one or more roles may be combined):

- Geomorphologist or individuals with oil spill experience and SCAT training who can identify and document oil on the shore
- Ecologist/Biologist who can document the impacts of oil and recommend priorities, cleanup endpoints, and ecological constraints
- Archeologist or cultural resource specialist who can advise on precautions and constraints to protect cultural resources, if needed
- State government representative
- Federal government representative
- Tribal government representative
- Land owner/manager
- Local government and/or oversight organization

A total of X SCAT teams have been assembled and deployed for the initial stages of this incident, including X aerial survey teams and X teams for ground surveys.

Field SCAT Team participants will be selected from representatives for industry; tribal state and federal agencies; and/or landowners to provide the primary expertise described above. SCAT Field Team Leaders will be assigned for each team. A listing of the current organization (command & field) is outlined below.

The SCAT Data Manager is responsible for the maintenance of the SCAT data base and for the production of maps and tables as needed. The SCAT Data Manager may request the assignment of a SCAT Documentation specialist if the workload demands it.

<u>Command Post</u>

- **SCAT Coordinator (and Deputy or Co-Coordinator, if needed)**
- **SCAT Field Team Manager**
- **SCAT Data Manager**
    - **SCAT Documentation**
- **Shoreline Treatment Advisory Group**

<u>Aerial Reconnaissance Team</u>

- **Team Lead**
- **State**
- **Federal**

<u>Aerial Video Team</u>

- **Team Lead**

<u>Ground Team 1 – SCAT ST1</u>

- **Federal**
- **State**
- **RP**
- **Landowner/manager**
- **Archeologist/Cultural Specialist (If needed)**
- **Wildlife Biologist/Ecologist (if needed)**
- **Tribal/Local Gov't reps (if needed)**

<u>Ground Team 2 – SCAT ST2 Team Lead:</u>

<u>Ground Team 3 – SCAT ST3 Team Lead:</u>

<u>Ground Team 4 – SCAT ST4 Team Lead:</u>

Efforts will be made to minimize personnel substitutions and select team members who can stay with the SCAT operations, or to have a systematic schedule of alternates: people who see conditions change through time have a better frame of reference for assessing the success of cleanup operations..

Team Priority – Areas where heavy oiling has been noted or which are of specific ecological importance will be prioritized to maximize recovery opportunities and to reduce overall impacts.

Schedule

Initial and subsequently new field team members will be "calibrated" by having them visit shorelines of differing morphology to review the agreed-upon shoreline descriptors and to confirm how oil impacts will be described throughout the response process. Currently deployed SCATs have been calibrated.

(General description of next OP activity) *(NOTE: all following example text in this section should be deleted after inserting actual incident-specific information)*

Example: *SCATs teams were redirected, following the XXX X/XX/XX aerial over flight, at approximately 0630 hrs in Operational Period X. Some surveys, in the locations outlined in the Operational Period X SCAT Plan, may have been completed prior to transfers, and this will be confirmed and data captured by beginning of Operational Period X.*

Operational Period X survey locations are outlined in the table below. Surveys will be completed exclusively at low tide and during daylight hours.

Operational Period X - SCAT Survey Schedule					
SCAT Team	**No. Staff**	**Survey Type**	**Location/Shoreline Segment**	**Start Day & Time**	**Status**
0	3	Aerial Recon	*Ediz Hook to Cp. Flattery*	*xx/xx/xxxx 0700*	
1	4	Ground Survey – Systematic	*Port Angeles Harbor 14301, 14302, 14303*	*xx/xx/xxxx 0700*	
2	4	Ground Survey - Systematic			
3	4	Ground Survey - Systematic			
4	4	Ground Survey – Systematic			
Total Staff	19				

Beginning with Operational Period X, teams will be assigned specific geographical areas outlined in the table below. Specific survey locations will be outlined on a daily basis in applicable 204s. Daily surveys will be prioritized based on shoreline oiling conditions noted during aerial reconnaissance flights. Areas where heavy oiling has been noted will be prioritized to maximize recovery opportunities as will sensitive areas identified on the ICS-232.

Surveys will be completed exclusively at low tide and during daylight hours. Personnel may be relocated to address the additional oil volume released during Operational Period X.

Beginning Period x - SCAT Geographical Locations			
SCAT Team	**No. Staff**	**Survey Type**	**Geographical Areas**
0	3	Aerial Recon	
0	2[1]	Aerial Video	
1	4	Ground Survey – Systematic	
2	4	Ground Survey - Systematic	
3	4	Ground Survey - Systematic	
4	4	Ground Survey – Systematic	
Total	20		

Staff			

4. SCAT Survey Methods

Shoreline surveys will be conducted for this incident by different methods and at different scales depending upon the size of the affected area, character of the shoreline type, and level of detail that is required. The following table presents a summary of the survey methods that will be used for this incident, key objectives of the survey methods, and the purpose of each survey method.

Table 2
Summary of SCAT Survey Methods

Survey Method	Key Objectives	Purpose
Aerial Reconnaissance	Define the overall incident scale to develop regional objectives. Mapping or documentation not required.	Make specific observations, but not to map or document the oiling conditions, so that relatively large areas can be covered in a relatively short time period.
Aerial Survey	Systematically document or map to (i) create segments, (ii) develop regional strategies and plans, and (iii) define lengths of oiled shorelines.	Prepare a map or maps that show the locations of stranded oil and the distribution and character of that oil by flying low altitude (<100 feet) in a helicopter using a videotape camera linked to (1) an audio system for a detailed commentary, (2) a real time, moving map display, and (3) a Geographical Positioning System (GPS).
Systematic Ground Survey	Systematically document shoreline oiling conditions in all segments within the affected area.	Systematically document shoreline oiling conditions in all segments within the affected area and to complete shoreline oiling summary ("SOS") forms, generate sketch maps for each oiled segment and complete Shoreline Treatment Recommendations. ("STRs").
Spot Ground Survey	Systematically document shoreline oiling conditions for selected segments within the affected area.	Systematically document oiling conditions for selected segments within the affected area and to complete SOS forms, generate sketch maps for each oiled segment and complete Shoreline Treatment Recommendations ("STRT").

Inspection Survey	Evaluate effectiveness of treatment methods employed by Operations in meeting shoreline treatment standards.	Systematically document shoreline conditions after treatment and cleanup of segments within the affected area against the applicable treatment standards and complete shoreline oiling summary forms and generate sketch maps for those segments. Make recommendations for closure or further cleanup actions and complete Shoreline Inspection Reports ("SIRs") for each segment for which "No Future Treatment" is being recommended.

Reference pre-segmentation scheme being used if being used or how segmentation will be determined by reference.

Example: *No pre-designated segments exist within the impacted areas associated with this incident. Shoreline segments will be established using methods outlined in The UK SCAT manual: Shoreline Cleanup Assessment Technique - a Field Guide to the Documentation of Oiled Shorelines in the UK. The SCAT Coordinator will work with various members of the IMT to identify and characterize shoreline segments*.

5. Field Documentation

Field documentation will consist, where possible, exclusively of standardized forms. Examples include the SOS and STRT forms found in Appendices A and B, respectively.

Aerial Surveys

Completed field documents (notes, sketches, videos and photos) from aerial reconnaissance teams are to be provided by the team leader and inspected at the Command Post for QA/QC the same day to ensure that any necessary revisions are made prior to the surveys of the next day.

Ground Surveys

The SCAT Field Team Manager and each Field Team Leader is responsible for ensuring that the following tasks and field documentation is completed.

- Complete SOS Form
- Complete STR Form
- Sketch(es) of the segment if oil is observed
- GPS coordinates of segment endpoints and specific features
- Digital photographs and log date/time/location if oil is observed
- Dig pits/trenches if subsurface oil is suspected

SCAT forms appropriate to the spill conditions (inland, tarball, winter, etc) will be selected.

The completed field documentation (SOSs, STRs, sketches and photos) from the ground survey teams are to be provided to the Field Team Manager (or Data Manger) by the Team Leader. This documentation shall be inspected at the command post for QA/QC on the same day as the survey to ensure that any necessary revisions are made prior to the surveys of the next day.

All GPS units and digital cameras will be surrendered to SCAT Data Manger immediately upon return to the Command Post for downloading. The Data Manager will ensure that device times are synchronized and that all waypoints, tracklogs, and digital pictures are erased from each device prior to being redeployed with Field Teams.

In order to facilitate planning, the Team Leader will notify the SCAT Field Team Manager on a daily basis if any segments are identified that will require Operations mobilization.

6. Command Post Data Management and Results

Data QA/QC

Data from SCAT field surveys is used to plan cleanup activities for the subsequent shoreline cleanup operations.

The SCAT Data Manager receives and logs incoming SCAT field forms, sketches, and other information (films, videotapes, etc.) and reviews the field information. The review involves a quick check to make sure that all sections of the forms have been completed and that the information appears reasonable and consistent. Any questions regarding missing information or apparent inconsistencies are discussed with the field team leaders before the next field assignment. After the quality control is complete, forms are copied and distributed as needed and key information is transferred to tables or computer data files.

Data Outputs

In general, the types of data, graphics, and tables that will be generated from the SCAT database may include:

- Maps of shoreline segments and soil/sediment types
- Oiling conditions
- Surface oil volumes, changes in volume through time
- SCAT field survey status
- Treatment recommendations
- Cleanup treatment status
- Lengths of oiled shoreline (by oil rating and/or shoreline type)
- Lengths treated (by oil rating and/or treatment method)

Record Keeping

Original SCAT field forms, sketches, and other information (photos, videotapes, etc.) and data, graphics, and tables generated during the incident will be provided by the SCAT Data Manager to the Documentation Section for retention. Only copies of these records will be distributed for use by stakeholders (i.e. RP, USCG, EPA, state agencies, etc.).

7. Spill Cleanup Endpoints Standards

All spills have a point at which active cleanup and removal gives way to the natural degradation of the oil. In most cases, this termination point is developed as through a process lead by the SCAT Coordinator (Cleanup Endpoint Advisory Group) and formalized by the Unified Command. In most cases, the endpoint will be assumed to have been reached when worker safety would be compromised or the remaining oil presents less of a risk to the community or the resources than the treatment methods available.

After the Operations Division Supervisor or Shoreline Supervisor considers that cleanup in a segment has been completed, the segment will be inspected by a Sign-Off team, that will (a) determine whether the cleanup criteria have been met and (b) make a recommendation to the Unified Command regarding that segment. The team will use the criteria outlined in Appendix F to make this determination. At the time of the inspection, the Land Manager or representative will accompany the team and an SIR form will be completed. The Land Manager or representative may add notes in the "COMMENTS" text block on the SIR.

If the SCAT team (in consultation with the land manager) determines that no oil is present in the segment or that the cleanup has met the end-point criteria, then the members of the SCAT team representing the UC will sign the SIR and forward a No Further Action recommendation to the UC for approval. Note that a determination that cleanup endpoints have been reached does not indicate that the segment is necessarily recovered or restored under the definition of the NRDA process.

If the SCAT team determines that a segment fails to meet the cleanup criteria the team will indicate this on the SIR. They will specify where work is still required in order for the segment to pass inspection and will forward the form to the Operations Section Chief via the SCAT Coordinator viand the EUL.

The SCAT signoff process is intended to be a consensus-based team assessment. If, however, the team members are not in agreement regarding whether or not the end point criteria are met, then a sheet listing the reasons for disagreement is attached to the SIR and forwarded to the UC for resolution.

SCAT Work Plan Appendix A - SHORELINE OILING SUMMARY FORM

PLACEHOLDER FOR NOAA Shoreline Oiling Summary Form

SCAT Work Plan Appendix B –
SHORELINE TREATMENT RECOMMENDATION FORM

Incident Name:____ **STR #:** __________

Shoreline Treatment Recommendation

Operational Permit to Work

Segment: (allow entry of local name)		**Survey Date:**
Start Lat:	**End Lat:**	
Start Long:	**End Long:**	**Length (m):**
Shoreline Type:	*Primary:*	*Secondary:*

Oiled Areas for Treatment (EU):

Cleanup/Treatment Recommendations (EU):

Recommendations/Staging and/or Logistics Constraints/Waste Issues (OPS):

Ecological Concerns:

Cultural / Historical Concerns (SHPO):

Safety Concerns (EU/OPS/SSO):

Attachments:	Segment Map	Sketch	SCAT Form	Fact Sheet	Other

Prepared by: ____________ **Date Prepared:** ____________

Date **Time**					
	To SOSC	**To Land Mgr**	**To SHPO**	**To EU Leader**	**To:**

Final Approval				**Submitted to OPS**	
	State OSC Rep	Federal OSC Rep	EU Leader		

*** When Treatment is completed, send a Segment Completion Report to SCAT ***

SCAT Work Plan Appendix C – SEGMENT INSPECTION REPORT FORM

1323

Segment Inspection Report

Incident Name:______________________________

Segment ID	
Date of Survey	
Time of Survey	
Tide Stage	
Weather	

SCAT Team (   ) Members

If no further treatment is required, each UC rep sign below

Name		Signature
	FOSC rep	
	SOSC rep	
	RP rep	

Inspection Completed Along Entire Segment? YES/NO

Treatment Endpoint Criteria:

Is treatment or further treatment required? (circle one)

YES – defined below specific treatment action (s) and specific locations within the segment where required. Provide sketches, maps, GPS coordinates to OPS.

NO – each UC rep sign appropriate signature box above.

Comments:

FOSC ____________ SOSC ____________ RP ____________

SCAT Work Plan Appendix D – PHOTO CONTENT/LOG

SCAT PHOTO LOG FORMAT

These standards should be reviewed and confirmed during each incident by the Data Manager.

Item	Format	Example
Date	Date	dd mmm yyyy
Time	Time	24 hour
Team	Team	N or L
Location Name *	Location Name *	text
Segment Number	Segment Number	LLL-NN
Ops Division *	Ops Division *	N or L
Latitude	Latitude	dd.ddddd
Longitude	Longitude	ddd.ddddd
Waypoint *	Waypoint *	NNN
Subject	Subject	text

* optional

NOTES:

1. Ensure the GPS is on with the "trackline" active. For aerial tracks, use a 5-second fix, for ground/walking use about a 30-second fix. **DO NOT SAVE THE TRACKLINE TO THE GPS** – download tracks to a computer file each day; if you save to the GPS then the track fixes are averaged and so we lose the ability to sync the times of the track fixes to the photos with OziExplorer
2. Ensure GPS and camera times are in sync
3. Take photo of GPS time at least twice a day
4. **The purpose of the photographs is to document the character of any oil observed within a segment**. Do not take too many photos of the oiled zone or location as one or two good photos only are necessary for documentation.
5. If there is **no oil** found within in segment then only take one or two photos. Preferably take a photo alongshore approximately at the High Water Level to record the general character of the segment.
6. Photography would be required if any cultural resources are identified (see Appendix H).
7. **WAYPOINTS**: Not necessary to take a waypoint at every photo location, but is valuable for specific items of interest that are photographed (such as the start and/or end of an oiled area or a pit in which oil is found).
8. **SCALE**: For distant or panorama shots always try to have a person in the middle distance for scale. For close-up shots always use a scale (the back of the field note book scale is preferred rather than a pencil or a coin!!)

SCAT PHOTO LOG   INCIDENT NAME:

Time	Date	Team	Location	Segment	Ops Div	Lat	Long	Waypoint	Subject

SCAT Work Plan Appendix E –
POTENTIAL TREATMENT TECHNIQUES

The following table was developed for shoreline treatment advisory group discussions with the intent to provide guidance on the treatment methods that would be appropriate for the areas affected by the oil. This list is not intended to be exhaustive or exclusive and additional treatment and cleanup methods may be considered. Some of the techniques included in this table as options may not be appropriate techniques for a given response. They are presented as an example.

Segment	Character	Oiling Conditions	Possible Treatment Strategy-Tactics
Various	Mixed-sediment (sand-pebble-cobble) beaches	Heavy surface oiling: Continuous or discontinuous thick band in upper ½ of intertidal zone	• Manual removal • Vacuum pooled oil • Deluge – With pressure and higher than ambient temperature water • Following gross oil removal – consider tilling and material removal
Various	Mixed-sediment (sand-pebble-cobble) beaches	Heavy sub-surface oiling: Continuous or discontinuous thick buried oil band in upper ½ of the intertidal and the supratidal zones	• Manual removal • Vacuum pooled oil • Deluge – With pressure and higher than ambient temperature water • Following gross oil removal – consider tilling and material removal
Various	Mixed- sediment beaches	Moderate-Light-Very Light Oiling: Stain or coat on pebbles and cobbles	• Deluge – With pressure and higher than ambient temperature water • Tilling and material removal
Various	Mixed-sediment beaches with backshore vegetation	Oiled edge vegetation with occasional patches of oil on top of the beach	• Manual removal • Deluge – Low pressure deluge with ambient temperature water • Following gross oil removal – consider tilling and material removal in non-vegetation areas

Various	Salt Marsh	Predominately march fringe oiled vegetation	• Manual removal • Deluge – Low pressure deluge with ambient temperature water
Various	Fine-sediment beaches		• Manual removal • Vacuum pooled oil • Deluge – Low pressure and higher than ambient temperature water • Following gross oil removal – consider tilling and material removal
Various	Boulder/Bedrock		• Manual removal • Deluge – With pressure and higher than ambient temperature water

SCAT Work Plan Appendix F –
SELECT TREATMENT END POINTS

The following are EXAMPLES ONLY of endpoints. Incident specific endpoints should be inserted here to replace these when developed.

VEGETATED SHORELINES

Surface Oil (light patchy)

- Tarballs, tar patties and tar mats removed Oiled sand and gravel removed or cleaned to a light patchy (<20%) coverage of coat (CT)
- Oiled cobbles and boulders removed or cleaned to light patchy (<20%) coverage of coat (CT)
- Oiled vegetation removed, to a light patchy (<10%) coverage of coat (CT)

Subsurface Oil

- Subsurface oiling is unlikely given the density and stability of sediments common to these shorelines types, nevertheless, subsurface oil, if discovered, will be evaluated by SCAT and Unified Command to determine if cleanup should occur.

Constraints

- Avoid damage to unoiled roots of vegetation
- Limited foot traffic in the vegetation
- No mechanical equipment in vegetation
- Avoid destabilization of bank

MIXED SEDIMENT/GRAVEL/COBBLE – STEEP CLIFF BACKSHORE

Surface Oil

- Tarballs greater than 2cm in diameter and all tar patties and tar mats removed
- Oiled sediment and gravel removed or cleaned to a light patchy (<20%) coverage of coat
- Oiled cobbles and boulders removed or cleaned to patchy (<20%) coverage of coat
- Oiled vegetation removed, to a light patchy (<20%) coverage of coat

Subsurface Oil

- Tar patties and tar balls greater than 5cm in diameter removed
- Buried tar mats or oiled lens removed or cleaned to light (20%) partially filled pore spaces

Constraints

- Avoid damage to unoiled roots of vegetation
- Avoid destabilization of backshore
- Probably foot traffic only

MIXED SEDIMENT/GRAVEL/COBBLE – LOW BACKSHORE

Surface Oil

- Tarballs greater than 2cm in diameter and all tar patties and tar mats removed

- Oiled sediment and gravel removed or cleaned to a light patchy (<10%) coverage of coat
- Oiled cobbles and boulders removed or cleaned to light patchy (<10%) coverage of coat
- Oiled vegetation removed, to a light patchy (<10%) coverage of coat

Subsurface Oil
- Tar patties and tar balls greater than 5cm in diameter removed
- Buried tar mats or oiled lens removed or cleaned to light (<20%) partially filled pore spaces

Constraints
- Avoid damage to unoiled roots of vegetation
- Avoid destabilization of backshore

FINE SEDIMENTS/SAND/GRAVEL

Surface Oil
- Tarballs greater than 1cm in diameter and all tar patties and tar mats removed
- Oiled sand and gravel removed or cleaned to a patchy (<20%) coverage of coat
- Oiled vegetation removed, to a light patchy (<20%) coverage of coat

Subsurface Oil
- Tar patties and tar balls greater than 2cm in diameter removed
- Buried tar mats or oiled lens removed or cleaned to light (<20%) partially filled pore spaces

Constraints
- Avoid damage to unoiled roots of vegetation

BOULDER/BEDROCK

Surface Oil
- Oiled boulders removed or cleaned to light patchy (<20%) coverage of coat
- Oiled vegetation removed, to a light patchy (<20%) coverage of coat

Constraints
- Minimize damage to unoiled roots of vegetation

OILED SHORELINE DEBRIS

- Small trash and oiled debris, such as containers and plastics, with greater than 10% coverage of oil, will be removed
- Large oiled debris, such as fishing equipment, with greater than 10% coverage of coat will be cleaned or removed
- Oiled seaweed and marine vegetation will be removed to a light patchy (20%) coverage of coat
- Oiled logs and woody debris will be cleaned or removed to a light patchy (20%) coverage of coat. Oiled sections may be removed from unoiled sections

Constraints

- Minimize damage to unoiled vegetation and roots and large woody debris.

SCAT Work Plan Appendix G – PERMIT SUMMARY

Various permits are required for SCAT operations. SCAT personnel have collaborated with Permits personnel in the Environmental Unit to procure the following permits:

INSERT PERMITS HERE

All necessary permits, for the current phase of operation, have been procured.