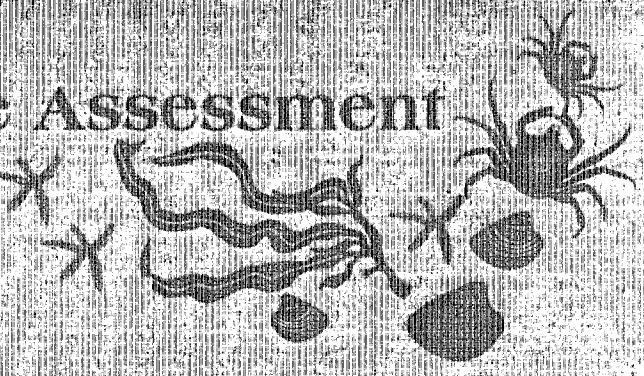
Shoreline Assessment Manual



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Shoreline Assessment Manual[1]

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1 Figures 4, 5, and 6 modified in this edition

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Acknowledgments

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1 The Shoreline Assessment Process

When spilled oil contaminates shoreline habitats, responders must survey the affected areas to determine the appropriate response. Though general approvals or decision tools for using shoreline cleanup methods may be developed during planning stages, responders must base specific cleanup recommendations on field data on the shoreline habitats, type and degree of shoreline contamination, and spill-specific physical processes. Shoreline surveys must be conducted systematically because they are crucial components of effective decisions. Also, repeated surveys are needed to monitor the effectiveness and effects of ongoing treatment methods (changes in shoreline oiling conditions, as well as natural recovery), so that the need for changes in methodology, additional treatment, or constraints can be evaluated.

This manual outlines methods for conducting shoreline assessments and incorporating the results into the decision-making process for shoreline cleanup at oil spills. Shoreline assessment is a function conducted under the Planning Section of the Incident Command System (ICS). Refer to the Field Operations Guide (FOG 1996) for the ICS Command Structure. Figure 1 shows where shoreline assessment fits into the Planning Section. Shoreline assessment team members are Technical Specialists who are trained and knowledgeable in their roles. They bring their agency's expertise to the team to collect the data needed to develop a shoreline cleanup plan that maximizes the rate of recovery of oiled habitats, while minimizing the risk of causing more damage from cleanup efforts.

Shoreline cleanup methods and cleanup priorities depend upon the...

- Potential human exposure, by direct contact or by eating contaminated seafood;
- Extent and duration of environmental impacts if the oil wasn't removed;
- Natural removal rates;
- Potential for remobilized oil to affect other sensitive resources; and
- Likelihood of cleanup to cause greater harm than the oil alone.

Trained team members conduct shoreline assessments

Therefore, *trained* team members must conduct shoreline assessments. The information must meet the requirements of the cleanup operation, in that it is timely and of uniform quality and content.

ICS Organization

In Figure 1, shoreline assessment teams are part of the Planning Section. They generate the information that Planning uses to direct Operations in shoreline cleanup. A Shoreline Assessment Coordinator manages the teams and synthesizes their field data into reports used by the Planning Section to develop the daily Incident Action Plan (IAP). The National Oceanic and Atmospheric Administration's (NOAA) Scientific Support Coordinator (SSC) can help identify and coordinate staff to form the teams and meet the data information requirements.

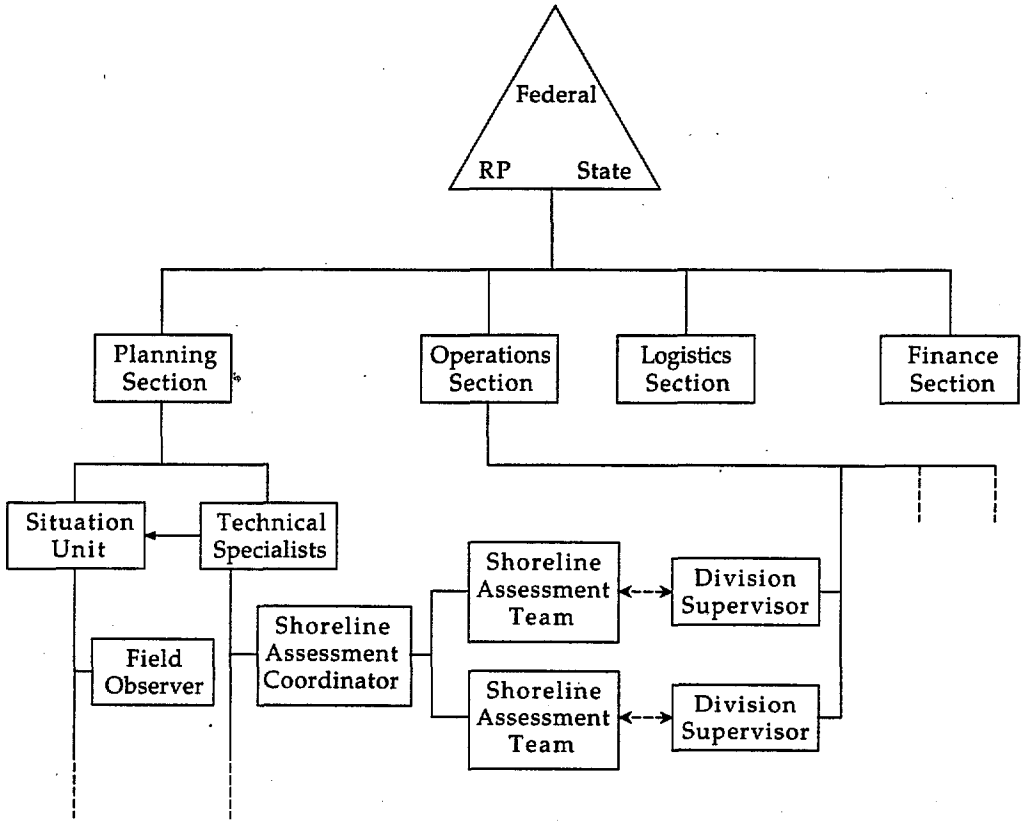


Figure 1.
The Unified Command Structure (UCS). Shoreline assessment teams, Technical Specialists under the Planning Section, collect information on shoreline oiling conditions to support cleanup decision-making. They can be involved in all phases of the cleanup until segments are signed off as complete.

Shoreline assessment supports the cleanup objectives and mandates of the response operations, as managed by the Unified Command. Appropriate staff from all stakeholders in the spill response are involved in this activity. Problems arose in the past when agency and responsible party representatives were unavailable to support the response operational needs because of their focus on natural resource damage assessment (NRDA) activities. Much of the information collected during shoreline assessments directly applies to natural resource damage assessments, and the data are readily shared. However, the shoreline assessment data must be

collected in a timely manner because it is necessary for operational decision-making. Experience has shown that the different objectives of NRDA and SCAT are best met when the field surveys for these activities are conducted separately. Agencies must therefore provide trained staff representatives with decision-making authority to participate in the process.

Information needs early in the spill

In the initial, emergency phase of a spill, there may be conditions when immediate information is needed on shoreline oiling in order to deploy cleanup contractors to problem areas. The Unified Command can direct Field Observers, who are organized under the Situation Unit, to gather such information. As well as knowing accepted terminology and cleanup guidelines, Field Observers need to understand key agency concerns for a spill. These concerns include the types of shorelines or resource issues that need to be visited or addressed by a shoreline assessment team before any cleanup activities, or the types of beaches susceptible to oil burial.

Because they communicate their information to other units in Planning and Operations, Field Observers submit their reports to the Situation Unit, which makes sure that the information is available to all other users in the UCS. (See Appendix C for an example of a form for Field Observer use.) Also, the Situation Unit could direct Field Observers to new areas as oil impact sightings come into the command center. Field Observers (sometimes called a Rapid Assessment Team) should:

Field Observers/ Rapid Assessment Team...

- Are two-person teams, usually representatives from the U.S. Coast Guard and the State lead agency, which can quickly deploy to problem sites;
- Verbally report to the Situation Unit, who then passes the information on to the appropriate units; and
- Become members of the shoreline assessment team, if appropriate.

At least one of the field Observers on the two-person team should have an operations background, with the other member SCAT-trained. Shoreline assessment varies from spill to spill, depending upon the spill's unique conditions and the information needs of the Unified Command. Use this manual as a field guide as well as a training tool: Chapter 7 outlines different types of shoreline assessment methods and guidelines for when they should be used. Planning speeds cleanup decision-making during a

spill. Chapter 8 outlines aspects of shoreline assessment and cleanup that should be incorporated into the Area Plan. The rest of the manual describes the organizational and technical aspects of conducting a shoreline assessment.

2 What Is a Shoreline Assessment Program?

- A systematic approach that uses standard terminology to collect data on shoreline oiling conditions and support decision-making for shoreline cleanup;
- Flexible in terms of the scale of the survey and detail of the data sets collected; and
- Multi-agency, with trained representatives from all interested parties, who have authority to make decisions:
  - Federal On-Scene Coordinator (FOSC)
  - Member of the NOAA Scientific Support Team
  - State On-Scene Coordinator (SOSC)
  - Resource managers (state and Federal agencies)
  - Responsible party (RP)
  - Land owners

SCAT: What's in a name?

SCAT stands for **Shoreline Cleanup Assessment Team**, a name first developed during the *Exxon Valdez* oil spill (Owens and Teal 1990). SCAT programs have been adopted in many areas, particularly Canada where SCAT manuals have been developed for the Atlantic Coast, Great Lakes, and British Columbia (Environment Canada 1992) The Texas General Land Office has incorporated SCAT teams into its response organization. However, SCAT has different connotations in different areas. Throughout this manual, we use "shoreline assessment" instead of SCAT. But, in practice, the terms are the same, as long as it is a process consistent with the basic objectives listed above.

3 Shoreline Assessment Team Responsibilities

- Describing shoreline types, oiling conditions, and physical setting;
- Identifying sensitive resources (ecological, recreational, cultural);
- Determining the need for cleanup;
- Recommending shoreline cleanup method(s);
  - recommending generic and site-specific constraints for cleanup activities;
  - determining the need for follow-up surveys if archaeological and cultural resources are present;
  - recommending cleanup priorities;
  - identifying safety concerns for cleanup operations;
  - monitoring cleanup effectiveness and effects, suggesting changes where needed;
  - determining when cleanup operations are no longer effective; and
  - conducting post-cleanup inspections prior to sign-off.

Teams should answer these questions

- Is cleanup necessary at this site?
- Which cleanup methods are appropriate or recommended?
- Which constraints are needed to protect sensitive resources?
- What is the priority for cleanup at this site?
- Are cleanup operations being conducted properly?
- Is the cleanup method no longer effective, or causing collateral damage? Do we need to try another method?
- Should cleanup operations be terminated at this site?

4 Roles on the Shoreline Assessment Team

Team Coordinator... The shoreline assessment team consists of a Coordinator (usually from the NOAA Scientific Support Team or their State or Responsible Party counterpart), Team Leader for each team, and team members. Roles and responsibilities follow the UCS.

1) sets schedules and priorities

- Coordinates shoreline assessment team response activities;
- Conducts the aerial reconnaissance survey to scope out the shoreline oiling issues;
- Ensures that all the teams have the necessary representation and members have the necessary training; and
- Develops the daily assignments for each team, depending upon the needs of the Planning and Operations sections to meet the Unified Command response objectives.
- Coordinates with natural resource damage assessment (NRDA) concerns on shoreline assessment, to optimize data sharing;
- Integrates the cleanup concerns of the various resource agencies and managers into the decision-making process; and
- Makes equipment and transportation arrangements for the shoreline assessment teams through the Logistics Unit.

2) leads cleanup guideline development

- Leads development of cleanup endpoints considering shoreline type, ecological sensitivity, recreational use, and aesthetic requirements; etc.
- Leads development of cleanup guidelines for implementing each cleanup method for the shoreline types impacted, based on agency concerns;
- Develops a survey and reporting schedule to produce survey results in time to be incorporated into the Incident Action Plan (IAP);

3) reports

- Makes sure that all teams use the proper terms and apply the guidelines uniformly;
- Receives reports from the field teams and synthesizes them into a daily summary in the IAP format; is accessible to the teams in the field if problems arise;
- Helps team reach consensus; reports dissenting opinions where consensus is not reached; and
- Briefs Planning and Operations chiefs on issues raised by the shoreline assessment teams, particularly where cleanup methods must be modified to increase effectiveness or decrease impacts.

Field Team Leader...

- Should be the most experienced person on the team;
- Manages the team while it is in the field conducting surveys;
- Completes the forms and sketches in the field;
- Guides the team toward consensus on cleanup recommendations, priorities, special constraints, etc. Notes dissenting opinions;
- Briefs the Coordinator on the survey results; and
- Reports cleanup issues identified by the team that need to be addressed.

Agency Reps (both State and Federal)...

- Help collect data on oiling conditions and special agency considerations;
- Are experts in resource sensitivity and priorities for response considerations;
- Recommend site-specific constraints or precautions to be followed during cleanup;
- Determine the need for cleanup, considering cleanup guidelines and endpoints;
- Recommend cleanup methods and priorities; and
- Identify the need for surveys by archaeological or cultural resource specialists.

Operations Representative...

- Is often the FOSC representative from the U.S. Coast Guard, either from the Marine Safety Office or one of the Strike Teams. Can also be provided by the RP representative or the State;
- At times may include the Division Supervisor when the team is in his/her area of responsibility (note dashed line in Figure 1 between the teams and the Division Supervisor);
- Helps collect data on oil conditions;
- Evaluates appropriateness of cleanup techniques; and
- Identifies logistical constraints and solutions, and estimates the level of effort needed.

Keep the same individuals on a team for the whole event. This ensures continuity in reporting and describing oil distribution and types of oiling

5 Shoreline Assessment Activities

The following sections describe the full range of activities normally conducted as part of the shoreline assessment process:

aerial reconnaissance survey

segmentation of the shoreline

pre-survey planning and team assignments

developing spill-specific cleanup guidelines

shoreline surveys

submitting reports to the Planning Section

post-cleanup inspections

final sign-off of cleanup activities

The degree to which each activity is implemented depends upon the complexity of the spill. Flexibility is important; activities should be modified as appropriate to the spill conditions.

5.1 Aerial reconnaissance survey

Objective

- Get an overall perspective on shoreline types and degree of contamination for a gross overview;
- Determine the areal extent of oiling on the shoreline; and
- Identify logistical constraints for shoreline access for both shoreline assessment and cleanup teams

Responsibility

- Usually conducted by the Shoreline Assessment Team Coordinator, though someone with local area knowledge can also be a valuable participant.

Methods

- Fly entire impact area at less than 400-500 feet and not more than 80-90 knots in helicopter or high-wing aircraft;
- Use GPS if available and topographic maps, nautical charts, and other maps identified in the Area Plan to record:
  - flight path, including date and time
  - objective descriptors of shoreline oiling conditions (use standard terms in Chapter 6*)
  - location of floating oil, which could change the shoreline oiling conditions
  - references to photographs/video taken
  - access points for survey teams, especially in remote areas

* Modify definitions for shoreline oiling conditions recorded during aerial mapping from those shown in the matrix in Chapter 6, page 29.

5.2 Segmentation of the shoreline

Objective

- Divide the shoreline into units, called segments, for recording and tracking survey data and making cleanup recommendations.

Responsibility

- Usually conducted by the Shoreline Assessment Team Coordinator, though someone with local area knowledge can also be a valuable participant.

Methods

- When paper maps are used, 1:24,000-scale topographic maps provide consistent coverage and show access from land. When working from boats, nautical charts may be preferred;
- Base maps can be generated from digital databases; make sure that they have enough detail and landmarks so the teams can locate themselves in the field;
- Remember that the scale on nautical charts is in nautical miles, not statute miles (which is the measurement on vehicle odometers). A nautical mile = 1.15 statute miles;
- Mark segments based on similarity of geomorphology (refer to ESI maps) and degree of oiling (ascertained from reconnaissance flight); local staff familiar with area should be involved;
- Segment boundaries should be readily recognizable in the field;
- Size segments appropriate to spill conditions and total area of impact. They often are 0.2-2 km long. New forms are completed for each segment, so the interval should not be so small that the number of forms required becomes unmanageable for the size of the spill. They should not all be the same length;
- Use divisions or names already in use by cleanup operations where appropriate. If possible, develop the segment naming scheme with Operations so it is most useful; and
- Pre-number segments with alphanumeric code (e.g., BI-9 for segment number 9 on Block Island; or 1-A for the first segment in cleanup zone 1). Remember that the spill responders may not be familiar with local geographic names.

Figure 2 shows an example map with segments delineated from the 1996 *Cape Mohican*, San Francisco, California spill. The scale of the maps should be a function of the complexity of the area and the length of the segments. Different scales can be used for different zones within the same spill-impact area. The final maps should be 8 1/2" by 11" to fit into field packs and be readily copied and faxed.

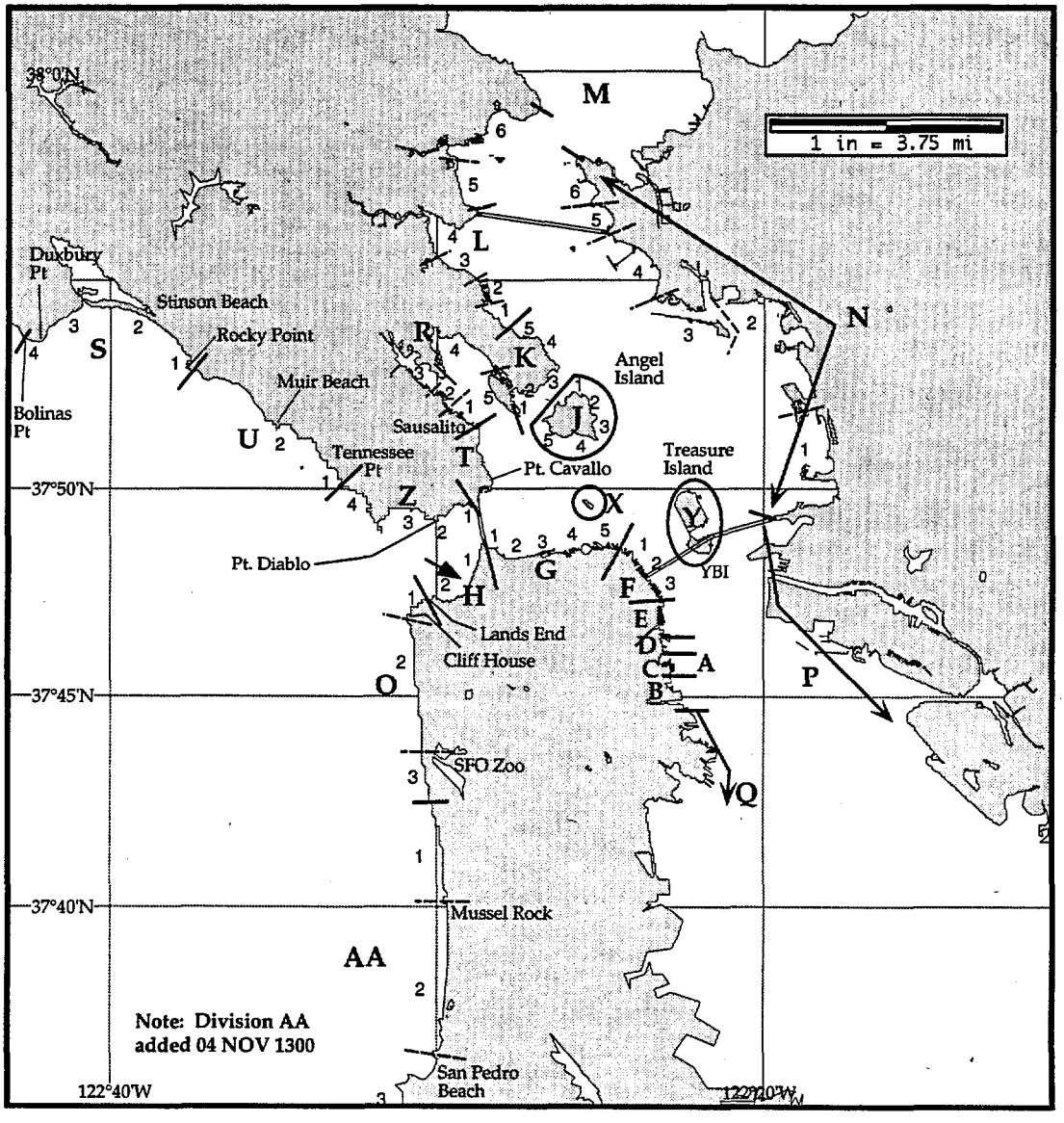
Figure 2.
Example map showing segmentation of the shoreline.

CAPE MOHICAN Incident

Shoreline Division& Segment Map
prepared by NOAA

Date/Time: 04 NOV 96, 1300

USE ONLY AS A GENERAL REFERENCE Graphics do not show precise amounts or locations of oil



5.3 Pre-survey Planning and Team Assignments

Objective

Determine areas to be surveyed, and logistical and team assignments.

Responsibility

The Shoreline Assessment Team Coordinator.

Methods

- Revise the standard shoreline oiling codes and forms if needed to fit spill conditions;
- Select base maps showing the segment boundaries and names;
- Form teams with appropriate membership;
- Ensure that all team members have the required safety training. Each team member must review and sign the site safety plan, and discuss specific safety concerns related to shoreline assessment activities;
- Determine logistical requirements for the teams and coordinate requests through the Logistics Section;
- Assign team leader;
- Assign survey areas (primary and backup) for each team, based on priorities, logistics, local expertise, and ownership;
- Distribute segment maps for primary and backup areas; distribute blank forms, codes, and sketch maps. See Chapter 6 for forms and codes;
- Distribute field equipment (see checklist in Appendix A);
- Brief team on survey objectives, logistics, and safety issues;
- Discuss cleanup options guidelines and criteria for priorities;
- Discuss reporting requirements and schedules; and
- On the first day, "calibrate" by having all team members visit a segment together and agree on how the oiling descriptors will be applied.

5.4 Developing spill-specific cleanup guidelines

Objectives

- Guide Operations in conducting a specific *cleanup method* to minimize adverse environmental impact;
- Provide Operations with environmental and safety constraints on conducting cleanup activities in a *specific habitat*; and
- Identify resource-specific constraints on cleanup activities.

Responsibility

- Shoreline Assessment Team Coordinator, Federal and state agency representatives, major land owners, and Team Leaders.

Methods

- With Operations staff, identify feasible cleanup methods. (Appendix B briefly describes current cleanup techniques);
- Evaluate proposed cleanup methods for their potential to affect habitats or resources;*
- Identify sensitive resources associated with the oiled shorelines that may be adversely affected by the proposed treatment methods (e.g., rich intertidal biota on rocky shores where low-pressure, ambient-water flushing will be used);
- Note archaeological or cultural resources along the shoreline or in nearby upland areas that could be disturbed by cleanup activities. Notify the State Historical Preservation Office (SHPO), if necessary;
- Write operational guidelines to minimize adverse impacts (e.g., restrict flushing operations to times when the rich biota zones are under water). Date the guidelines in order to track revisions;
- Develop detailed plans to monitor the effectiveness and/or biological effects of a method, if needed.
- Have the Shoreline Assessment Teams observe actual operations to confirm the method's use—and that the method is not more damaging than the oil alone and that it is needed; and
- Modify cleanup guidelines as needed if the oil changes as it weathers, making the technique ineffective, or when unacceptable impacts occur under actual use.

* The NOAA/API response manuals for freshwater and marine spills are good sources of information on cleanup methods, the applicable habitat types, guidelines on when the method should be used, and probable biological constraints and environmental effects. Consult these manuals when evaluating cleanup methods.

Responders can produce spill-specific cleanup guidelines more easily if planners covered the issues in the Area Plan, identifying cleanup methods for these special concerns ahead of time. However, the Shoreline Assessment Team Coordinator should form a work group to evaluate cleanup options and make recommendations on other issues that arise during a spill. Besides reviewing published studies and case histories, they can also look at on-site testing for effectiveness and environmental effects of the proposed method(s) under the spill's specific conditions.

5.5 Shoreline surveys

Objectives

- Collect data on shoreline types, oiling conditions, and ecological and human-use resources for specific segments;
- Reach agreement on cleanup recommendations for specific segments; and
- Confirm that recommendations are effective and beneficial to the environment (refer to the questions listed in Chapter 3).

Responsibility

- Each Shoreline Assessment Team

Methods

- Confirm segment boundaries;
- Conduct survey to identify shoreline types and extent of oiling;
- Using standard terms and code systematically describe the shoreline characteristics, surface oil conditions, buried oil conditions, and special considerations (ecological, recreational, cultural);
- If appropriate, sketch the segment, focusing on the oil distribution and special considerations;
- For spills of heavy oil, note presence of submerged oil in nearshore zone;
- Log and locate all photographs taken. Note the objective of the photograph;
- Collect oil and/or sediment samples based on identified needs;
- Discuss and agree upon cleanup recommendations and priorities; and
- Complete the surveys each day in time to meet reporting deadlines.

Shoreline Assessment Teams cannot direct cleanup contractors in the field. However, the teams can document unapproved cleanup methods or improper techniques. The Coordinator will contact Operations staff, including division or group supervisors in the area, if possible, to rectify the problem.

5.6 Submitting reports to the Planning Section

Objective

- Provide data needed to support shoreline cleanup decisions and operations.

Responsibility

- Shoreline Assessment Team Leader

Methods

- Check all data for accuracy, completeness, and legibility;
- Copy all forms, sketches, and field notes for field team as needed; keep originals on file;
- Summarize cleanup recommendations by segment;
- Debrief Planning/Operations staff on special issues, problems, recommendations; and
- Create summary maps identifying segments to be cleaned, degree-of-oiling categories, or other products as needed (see Chapter 6 for example formats for reporting the results to Planning, Operations, and the IAP).

5.7 Post-Cleanup Inspections

Objective

- Inspect the segments Operations declares are ready for sign-off before final approval.

Responsibility

- Each Shoreline Assessment Team

Methods

- Operations notifies the Shoreline Assessment Team Coordinator that a segment is ready for inspection
- Inspect the segment against agreed-upon cleanup endpoints (preferably the same team that did the original survey). The original field sketch can be very helpful in evaluating the effectiveness of the cleanup;
- Identify additional cleanup needed, using standard shoreline assessment terminology, forms, and sketches, or develop special forms for this purpose;
- Recommend segment for final inspection; and
- Recommend any longer-term monitoring or iterative procedures needed.

5.8 Final sign-off of cleanup activities

Objective

- Approve the termination of cleanup activities at each segment.

Responsibility

- The Sign-off Team (SOFT). Agencies must delegate sign-off authority to their representatives on the Team. We recommend that the same staff doing the shoreline assessments of an area be assigned to the SOFT if possible;

Methods

- A sign-off team is designated, usually with one member each from the FOSC, the SOSC, and the RP. Representatives from the resource agencies or land managers may be added for specific properties or resource concerns;
- The team reviews cleanup endpoint guidelines and develops procedures for interpreting them. The cleanup endpoint guidelines are revised as needed for the oiling and resource conditions at the time of final inspection;
- Operations notifies Planning that the segment has passed inspection by the shoreline assessment team and is ready for final sign-off;
- The sign-off team inspects the segment against the cleanup endpoint guidelines, approving those segments that meet the guidelines and recommending further cleanup for those segments which do not;
- There is usually a formal sign-off sheet for each segment, which each member signs; and
- The sign-off approval can specify maintenance activities (e.g., deploying sorbent booms to recover oil sheens as long as sheens are being released, or maintaining an area to remove tarballs as they wash ashore after storms), but it is important that criteria for ending the maintenance activity be clearly specified.

Figure 3.
General endpoints for shoreline cleanup. Use these guidelines to develop spill-specific cleanup endpoints for terminating active cleanup.

OIL EXPOSURE PATHWAYS	OIL EFFECTS	CLEANUP ENDPOINT	CONSIDERATIONS
I. Remobilization Potential (Sheening)	• Reoiling of sensitive areas • Ongoing exposure to water surface users (e.g., birds, mammals, people). Effects from: - direct contact - transfer to early life stages - ingestion from preening	• No longer generates sheens that will affect sensitive areas or wildlife	**Degree of Exposure:** • High exposure speeds removal, breaks up sheens • Sheltered area will sheen longer, episodically **Use:** • High use—higher cleanliness • Low use—more tolerant to natural removal of residues • Seasonal variations in presence of users • Sensitivity of resources to chronic exposure
II. Oil Coat/Cover/Stain **Ecological Concerns**			
• Potential for sheening	• Same as for sheening	• Same as for sheening	• Same as for sheening
• Sticks to organisms using surface	• Oiling of fur/feathers/feet • Habitat/food loss because of avoidance	• Oil removal/weathering so it is no longer sticky	• Timing: Oil will eventually • weather, become non-sticky
• Coat/smother biota/ vegetation	• Acute/sublethal toxicity	• Oil removal to allow recovery/recolonization without further disturbance	• Aggressive techniques have potential for causing greater ecological impacts than oil alone, delaying rather than speeding recovery
Human Health/Aesthetic Concerns			
• Rub off on people/ property	• Human health risk	• No longer rubs off with casual contact	• Don't do more harm than good
• Visual contamination	• Mostly aesthetic/economic	• Depends on substrate/use	• High use—higher cleanliness • Low use—more tolerant to natural removal
Cultural Concerns	• Aesthetic • Damage to artifact fabric	• Oil removal without causing further damage	• Very little past experience with most types of substrates and/or artifacts
III. Contaminated Sediments **Ecological Concerns**			
• Potential to release oil/ sheens	• Same as for sheening	• Same as for sheening	• Same as for sheening
• Direct contact by infauna/epifauna • Uptake in food web by other organisms	• Acute and chronic toxicity; sublethal effects	• Oil removal to allow recovery/recolonization without further disturbance	• Oil is usually more persistent in sheltered, sensitive areas where cleanup tends to be more disruptive
Human Use Concerns			
• Dermal exposure	• Shoreline closure	• No longer rubs off	**Use:** • High use—higher cleanliness • Low use—more tolerant to natural removal of residues **Sediment Removal:** • Potential for erosion • Replacement sources • Disposal options
• Visual/aesthetic	• Shoreline closure	• Oil removal to a stain	
• Seafood safety via food web uptake	• Seafood advisories	• Pass organoleptic testing	• Background sources of oil contamination

6 Shoreline Survey Terminology, Codes, and Forms

Field survey terms, codes, and forms

Using standard terminology to describe and report shoreline oiling condition is the basic foundation of shoreline assessment. Ambiguous words, such as "heavy" oiling, do not provide the necessary detail to document the oiling condition or the need for and type of cleanup to be conducted. Figure 4 lists the terminology and codes to be used by shoreline assessment teams. Reviewing these terms demonstrates the need for trained teams who can consistently apply these terms to the spill-specific conditions. Appendix C includes field estimator charts helpful for uniformly applying percent cover estimates. All team members must agree on how they will use these codes for a specific spill. Thus, a calibration field exercise, conducted jointly by all team members, is always necessary.

You need to modify these terms as appropriate for the spill. For example, most oiling descriptors have been developed for black oils. The Shoreline Assessment Team at the 1996 *North Cape* spill had to modify the terms for their spill of home heating oil (a light, refined oil that is essentially No. 2 fuel oil; Figure 5). Appendix C contains copies of all forms and codes.

You may need to report summary statistics on the number of shoreline miles by degree-of-oiling categories. Use the descriptors in Figure 3, if possible. However, if you must use terms such as heavy and moderate, use survey data to define them. Figure 6 shows a matrix that you can use to generate summary oiling descriptors, in terms of what is defined as heavy, medium, light, and very light for a specific spill. These summary descriptors are derived from a combination of the width of the oiled area and the surface oil distribution for each shoreline segment. The Shoreline Assessment Team Coordinator should complete this matrix when statistics and maps with summary oiling descriptors are needed. However, these terms should NOT be used by the Shoreline Assessment Teams during their field surveys. Terms such as heavy, moderate, light, and very light are *only* for final summaries and maps.

We have used a range of forms to record the observations of shoreline assessment teams. All of the forms refer to the standard codes and terminology in Figure 4. Figure 7 shows the Shoreline Oiling Summary Form, as modified from the *Exxon Valdez* SCAT surveys and used by Environment Canada (1992). This form is the most complicated and usually requires a high level of training in order to complete it properly. Operations staff also need specialized training to interpret the data, though they usually see summary reports.

Figure 4. Shoreline oil terminology/codes for spills of black oil.

Oil Distribution

C	Continuous	91 - 100%
B	Broken	51 - 90%
P	Patchy	11 - 50%
S	Sporadic	1 - 10%
T	Trace	<1%

Surface Oiling Descriptors - Width (modify for spill-specific conditions)

Very Narrow	< ___ m
Narrow	>__ -< ___ m
Medium	>__ -< ___ m
Heavy	< ___ m

Surface Oiling Descriptors - Thickness

PO	Pooled Oil (fresh oil or mousse > 1 cm thick)
CV	Cover (oil or mousse from >0.1 cm to <1 cm on any surface)
CT	Coat (visible oil <0.1 cm, which can be scraped off with fingernail)
ST	Stain (visible oil, which cannot be scraped off with fingernail)
FL	Film (transparent or iridescent sheen, or oily film)

Surface Oiling Descriptors - Type

FR	Fresh Oil (unweathered, liquid oil)
MS	Mousse (emulsified oil occurring over broad areas)
TB	Tarballs (discrete accumulations of oil <10 cm in diameter)
PT	Patties (discrete accumulations of oil >10 cm in diameter)
TC	Tar (highly weathered oil, of tarry, nearly solid consistency)
SR	Surface Oil Residue (non-cohesive, heavily oiled surface sediments, characterized as soft, incipient asphalt pavements)
AP	Asphalt Pavements (cohesive, heavily oiled surface sediments)
NO	No Oil
DB	Debris: logs, vegetation, rubbish, garbage, and response items such as booms

Subsurface Oiling Descriptors

SAP	Subsurface asphalt pavement (cohesive)
OP	Oil-Filled Pores (pore spaces are completely filled with oil to the extent that the oil flows out of the sediments when disturbed). May also consist of weathered oil, such as a buried lens of asphalt pavement
PP	Partially Filled Pores (pore spaces partially filled with oil, but the oil does not flow out of the sediments when disturbed)
OR	Oil Residue (sediments are visibly oiled with black/brown coat or cover on the clasts, but little or no accumulation of oil within the pore spaces)
OF	Oil Film (sediments are lightly oiled with an oil film, or stain, on the clasts)
TR	Trace (discontinuous film or spots of oil, an odor, or tackiness)
NO	No Oil (no evidence of any type of oil)

Sediment Types

R	Bedrock outcrops	S	Sand (0.06-2 mm)
B	Boulder (>256 mm in diameter)	M	Mud (silt and clay, < 0.06 mm)
C	Cobble (64-256 mm)	RR	Riprap (man-made permeable rubble)
P	Pebble (4-64 mm)	SW	Seawalls (impermeable)
G	Granule (2-4 mm)		

Figure 5. Shoreline oil terminology/codes for spills of light, refined oil.

Surface Oil Distribution (on sediments and nearshore water)

C	Continuous	91-100% cover
B	Broken	51-90%
P	Patchy	11-50%
S	Sporadic	<1-10%
T	Trace	<1%

Surface and Subsurface Oiling Descriptors - Thickness

SM	Smell	No visible oil; detectable only by smell
FL	Film	Feels greasy when sediments are rubbed
SH	Sheen	Visible sheen on water surfaces
CT	Coat	Visible coating of oil
PO	Pooled	Liquid oil accumulated on surface

Surface Oiling Descriptors - Color

None	Brown
Shiny	Yellow
Rainbow	Red

Surface Oiling Descriptors - Width

N	Narrow	< 1 m
M	Medium	> 1 m to < 3m
W	Wide	> 3 m; estimate width if possible

Sediment Types

R	Bedrock outcrops	**S**	Sand (0.06-2 mm)
B	Boulder (>256 mm in diameter)	**M**	Mud (silt and clay, < 0.06 mm)
C	Cobble (64-256 mm)	**RR**	Riprap (man-made permeable rubble)
P	Pebble (4-64 mm)	**SW**	Seawalls (impermeable)
G	Granule (2-4 mm)		

Sheen on Water Descriptors

	Approx. Layer-Thickness		Approx. Volume per Area	
	mm	inches	liters/km^2	gallons/nm^2
barely visible	0.00004	0.000002	50	40
silver sheen	0.00007	0.000003	100	75
first color trace	0.0001	0.000004	200	150
bright colors	0.0003	0.00001	400	300
dull colors	0.001	0.00004	1200	1000
dark colors	0.003	0.0001	3600	3000

Surface Oiling Descriptors - Width (modify for spill-specific conditions)

Very Narrow	< ___ m
Narrow	>__ -<___ m
Medium	>__ -<___ m
Heavy	<___ m

Use a summary oil descriptor to report the surface oil conditions along the shoreline on maps and tabular summaries. These descriptors are:

- Heavy
- Moderate
- Light
- Very Light

We have assigned these summary oiling descriptors based upon the Oil Category Width and the Surface Oil Distribution, as defined on the sheet on Shoreline Oil Terminology/Codes. The Shoreline Assessment Team Coordinator should obtain consensus on which combinations of oil width and distribution are used to define heavy, moderate, light, and very light oiling. These descriptors are only used in summaries and are not used in the field by the Shoreline Assessment Team.

Figure 6. Matrix for defining terms for shoreline oiling summaries (modified from Environment Canada 1992). Modify this matrix, especially the intervals for width of oiled areas, for your specific spill conditions.

		Width of Oiled Areas			
		Wide >6 m	Medium 3 - 6 m	Narrow 0.5 - 3 m	Very Narrow <0.5 m
Oil Distribution	Continuous 91 - 100%	*Heavy*	*Heavy*	*Moderate*	*Light*
	Broken 51 - 90%	*Heavy*	*Moderate*	*Light*	*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*

Figure 7. Shoreline oiling summary form, as developed by Owens and Teal (1990) and used by Environment Canada (1992). It is completed for the same conditions as Figure 8.

SHORELINE SURVEY EVALUATION FORM Page 1 of 1

1 GEN	Segment Name: North Beach, CC, TX	Survey Date: 30 July 1996	Survey Time: 1000 to 1100 (use military time)
	Segment ID: CC-1S		
	Surveyed From: (Foot) / Boat / Helicopter	Weather: (Sun) / Clouds / Fog / Rain / Snow	

2 TEAM	Team No. 1	Operations: T. Ray	
	OG : J. Michel	State: B. Martin	for: TGLO
	ECO : N/A	Federal: J. Perry	for: USFWS
	ARCH : N/A	Land Manager: N/A	for:

3 SHORE	Overall Classification for UITZ-select one	Sediment Beach:	Sediment Flat:
	Bedrock: Cliff ___ Platform ___	Boulder-Cobble __ Sand X	Boulder-Cobble __ Sand _
	Manmade: Permeable ___ Impermeable ___	Pebble-Cobble __	Pebble-Cobble __
	Marsh/Wetlands	Sand-Gravel __	Sand-Gravel __
	Secondary Shore Type: N/A	Backshore Type: developed - park	

4 LAND	Geomorphology	
	Slope: Low X% Med. ___% High ___% Vert. ___	Wave Exposure: Low (Medium) / High
	Estimated Segment Length: 350 m	Total Estimated Length Surveyed: 350 m
	Access Restrictions: None: good access via two parking areas at park	

5 OIL	Oil Category Width:		Total Pavement: 0 sq.m	by 0 cm
	Wide ___ m	Very Narrow ___ m	Patties/Tarballs ___ bags	Oiled Debris? Yes (No)
	Medium ___ m	No Oil ___ m	Debris/Amount: Logs ___	Vegetation ___
	Narrow 350 m	Unsurveyed ___ m	Trash ___	Other ___

6

SURFACE OIL	LOC	AREA LENGTH m	AREA WIDTH m	ZONE SU	ZONE UI	ZONE MI	ZONE LI	DIST	THICKNESS RO	THICKNESS CV	THICKNESS CT	THICKNESS ST	THICKNESS FL	TYPE FR	TYPE MS	TYPE TB	TYPE PT	TYPE TC	TYPE SR	TYPE AP	TYPE ND	SHORELINE SEDIMENT TYPE
FACE	1	42	1			X		B	X							X						sand
	2	45	2			X		P	X							X						sand
	3	150	1			X		S	X							X						sand
	4	40	1.5		X			T	X								X					sand
	5	130	3.5		X			S	X								X					sand
OIL	6	25	2.5		X			T	X								X					sand
																						sand
																						sand

Distribution (DIST): C = 100-91%; B = 90-51%; P = 50-11%; S = 10-1%; T = <1% Photo Roll # ____ Frames ____

7

SUBFACE	LOC NO.	TRENCHES SU	TRENCHES UI	TRENCHES M	TRENCHES LI	TRENCH DEPTH cm	OILED ZONE cm-cm	SUBSURFACE OIL CHARACTER OP	OP	FP	OR	OF	TR	NO	WATER TABLE cm	SHEEN COLOR	SURFACE-SUBSURFACE SEDIMENTS	CLEAN BELOW Y/N
SURFACE	1		X			15	0							X	15	-	sand	-
	2		X			15	0							X	15	-	sand	-
	3			X		10	0							X	10	-	sand	-
	4		X			20	0							X	20	-	sand	-
	5			X		10	0							X	10	-	sand	-
	6		X			20	0							X	20	-	sand	-
	7			X		10	0							X	10	-	sand	-

Sheen Color: B = Brown R = Rainbow S = Silver N = None

8 COMMENTS

High recreational use - it is a county park with swimming area.

Figure 8A is a shorter form that contains mostly blank spaces for entering field observations. This form is useful for medium-sized spills. The form in Figure 9 allows field teams to circle the appropriate descriptors, minimizing the need to fill in blanks and encouraging use of standard terms. This form is most useful when the oiling is very uniform or simple.

Customize these forms to the spill. In fact, forms are not always needed and are often not even included in the reports generated for Planning and Operations. They are useful as a trigger for reminding the Shoreline Assessment Team members of the types of observations they need to make during their surveys, as well as for detailed documentation of the shoreline oiling conditions. Operations is mostly interested in the final product of the survey: the recommendation for cleanup, the cleanup method to be applied, and any site-specific guidance on how to proceed. These are the priority results that must be transmitted to Operations.

Shoreline Terminology/ Codes

The Shoreline Terminology/Codes sheet in Figure 4 lists the common terms and abbreviations for describing the oil, sediments, and other features on the forms and sketch maps. The team walks the segment to collect field data while a team member records observations on the oiling conditions. It is very important to accurately measure or estimate the dimensions of each type of oil.

Show areas containing surface oil on a field sketch of the shoreline segment and describe them on the form. The oil locations, which you can designate by letters, are described systematically on the sketch. To investigate buried oil., dig trenches and record measurements of the degree and depths of subsurface oil Number each trench and show each location on the sketch. Use solid or open triangle symbols to distinguish oiled from clean trenches.

Figure 8A. Shoreline assessment form for a hypothetical survey. Figure 8B is the field sketch that would accompany the survey.

SHORELINE ASSESSMENT FORM for HYPOTHETICAL Spill Page 1 of 1

SEGMENT	Segment Name: North Beach, Corpus Christi, TX Segment ID: CC-1A	Date: 30 July 1995 Time: 1000 to 1100 am
	Surveyed From: Foot/Boat/ Helicopter/Overlook	Weather: Sun/Clouds/Fog/Rain/Snow

TEAM	Team No. 1			
	Name: J. Michel	for: NOAA	Name: J. Perry	for: USFWS
	Name: B. Martin	for: TxGLO	Name:	for:
	Name: T. Ray	for: USCG	Name:	for:

LAND	Shoreline/Sediment Types: Coarse-grained sand beach		
	Wave Exposure: Low/Medium/High	Total Segment Length: 350m	Length Surveyed 350m
	Location Description: Off Highway 181 just past main bridge		
	Access Restrictions: None; good access via two parking areas at park		

Description of oiling conditions √ Oil Length √ Width √ Type/Thickness √ Substrate Type √ Oiled Debris

SURFACE OIL:

Two zones of oil:

1) high zone of patties, 2-3.5 m wide with trace to patchy coverage, along almost entire segment

2) at high-tide line, 1-1.5 m wide zone of tarballs, with sporadic to patchy coverage over entire segment length

SUBSURFACE OIL: _ Extent _ Thickness Clean _ Thickness Oiled _ Intertidal Location
_ Sediment Type _ Oil Description _ Burial _ Penetration

None

Segment-specific considerations for cleanup operations

_ Environmental _ Cultural √ Degree of Recreational Use

High recreational use - it is a county park with swimming area

CLEANUP RECOMMENDATIONS

Manual removal of all oil deposits

Field sketches are important

The sketches are a very important component of the field survey data; they are better than photographs at depicting overall conditions. Sketches help reviewers put the tabular data on oiled area and type into perspective, which helps in decision-making. They document conditions better than photographs, videotapes, or statistics, and they allow better temporal comparisons. The sketches are particularly useful for spills where shoreline assessment teams change over time. They can be used during post-cleanup inspections of segments to identify the locations of oil that were to be removed: they become the

SKETCH MAP

Site Name NORTH BEACH, CORPUS CHRISTI BAY, TEXAS
Site No. CC-1A
Date 30 JULY 1995
Time 1100
Names MOH/JM/IB

Checklist

- ✓ North Arrow
- ✓ Scale
- ✓ Oil Distribution
- ✓ High Tide Line
- X Low Tide Line
- ✓ Substrate Types
- ✓ Trench Locations

Legend

1Δ
Trench Number.
No Subsurface Oil

2▲
Trench Number.
Subsurface Oil

#●→
#●
Photographs

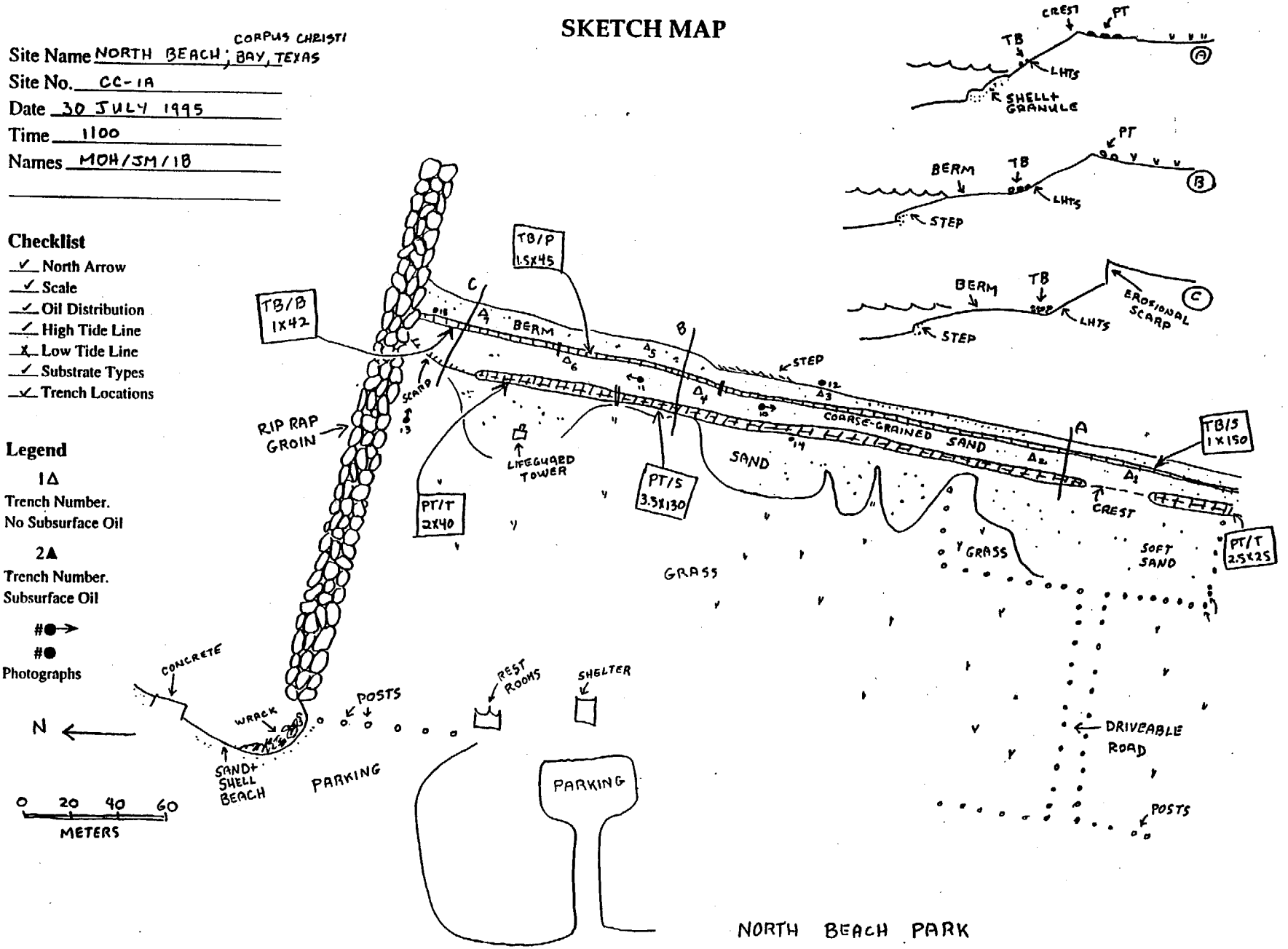
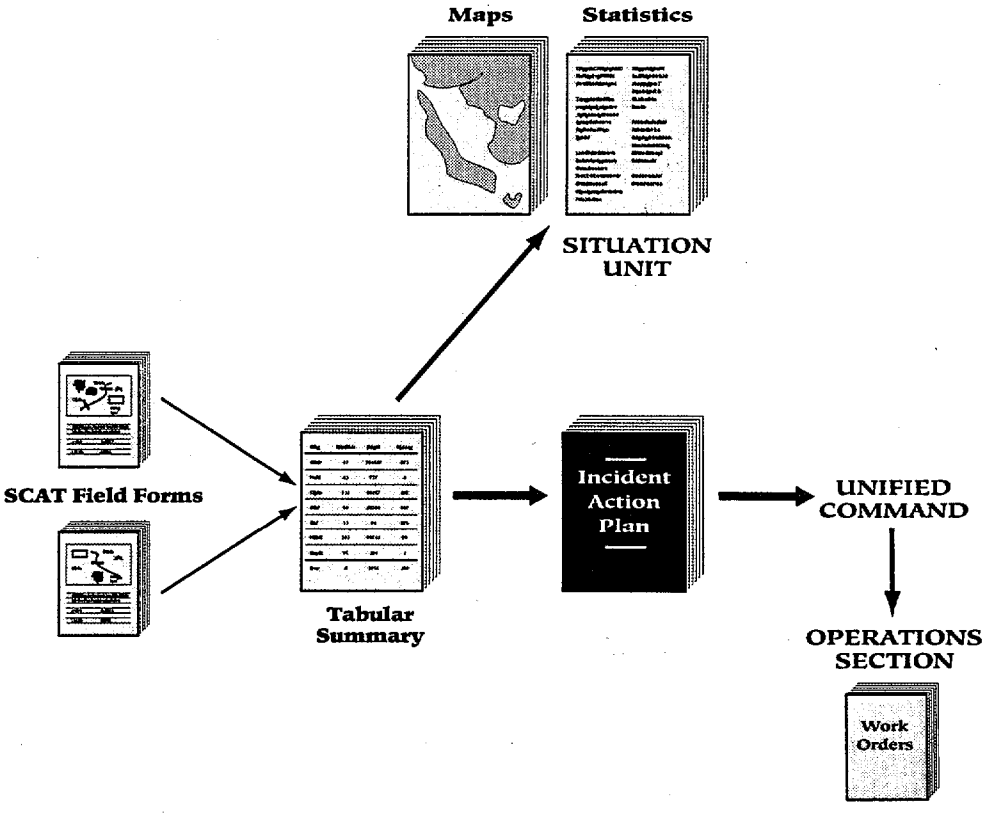


Figure 8B. Example shoreline assessment field sketch, showing how the symbology is used.

blueprint against which the effectiveness of the cleanup can be compared. Appendix D is a primer on drawing field sketches. Figure 8B is an example field sketch for the field form completed in Figure 8A.

The objective of the surveys should always be remembered: to collect the information needed by Operations personnel and decision-makers to formulate and approve shoreline treatment plans. An Operations Section manager or supevisor should be able to use the data to develop a detailed cleanup plan, including equipment and manpower needs, from these surveys. Government agencies should be able to use the data, along with natural resource information, to develop cleanup priorities, identify site-specific or temporal constraints, and understand and approve the proposed cleanup plan.

The shoreline assessment results need to be concisely and promptly reported to the Planning Section so that they can be incorporated into the IAP in a timely manner and distributed to other users:



Information flow and formats

- The Shoreline Assessment Team reviews the observations and cleanup recommendations for each segment for accuracy and completeness. Each team member signs each form.
- The Shoreline Assessment Team Leader compiles all of the survey forms for the day and submits them to the Team Coordinator. The Team Leader verbally debriefs the Team Coordinator on the results, issues, etc.
- The Shoreline Assessment Team Coordinator compiles the survey results into summaries by cleanup Division, in a format suitable for the IAP. The Coordinator then submits the IAP to the Unified Command for approval.

The Team Coordinator also verbally debriefs the Planning and Operations Chapter Chiefs on issues identified by the field teams. At this time, Operations can identify issues for the Shoreline Assessment Team to address.

The original field forms have to be summarized. Often two types of data summaries are needed: a tabular summary by segment or Division for the IAP, and graphic and tabular summaries for display by the Situation Unit. The Unified Command can specify the format of the tabular summary. Figures 10-11 show examples of reporting summaries used in the past. The types of data that should be included in any format are:

SCAT forms always contain this information

Date: For some spills, changing conditions will require repeat surveys, so the date of the survey is very important.

Segment Number(s), Name, Division Number: Use the appropriate terms to refer to the shoreline segment. Group segments by Division.

Summary of oiling conditions: The oiling condition can rapidly change. You need to describe the oiling condition when the cleanup recommendation was made. The cleanup supervisor can determine whether the cleanup is no longer applicable and request a new assessment.

Cleanup recommendations: Use standard terms, as listed in the cleanup guidelines.

Site-specific constraints: Clearly identify these as to location and refer to unambiguous conditions in the field (e.g., do not allow cleanup crews to enter marshes).

Figure 9.
Shoreline assessment form, with descriptors to be circled.

G	Segment Name:		Date:
E	Segment ID:		Time: to
N	Surveyed From: Foot / Boat / Helicopter / Overlook		Weather: Sun / Clouds / Fog / Rain / Snow

T	Team No.			
E	Name:	for:	Name:	for:
A	Name:	for:	Name:	for:
M	Name:	for:	Name:	for:

SHORELINE TYPE(S) PRESENT: Circle all that apply. Add P = Primary and S = Secondary shoreline type			
1A	Rocky Cliffs	6B	Riprap
1B	Exposed Man-made Structures	7	Exposed Tidal Flats
2	Wave-cut Platforms	8A	Sheltered Rocky Shores
3	Fine-grained Sand Beaches	8B	Sheltered Man-made Structures
4	Medium- to Coarse-grained Sand Beaches	9	Sheltered Tidal Flats
5	Mixed Sand and Gravel Beaches	10	Wetlands
6A	Gravel Beaches	___	Other_____

WAVE EXPOSURE: LOW / MED / HIGH DEBRIS OILED: Y/N: TYPE _____ VOLUME _____

SEGMENT LENGTH: ____ (m) ____ (ft) PERCENT OF SEGMENT OILED _____ %

OIL PRESENT IN: SUPRA / UPPER / MID / LOWER / SUBSTRATE TIDAL ZONE(S)

OVERALL DEGREE OF OILING: NONE / VERY LIGHT / LIGHT / MODERATE / HEAVY (SEE MATRIX)

CIRCLE ONE OR WRITE IN UNDER EACH COLUMN; SUMMARIZE FOR ENTIRE SEGMENT OR SUBSEGMENT:

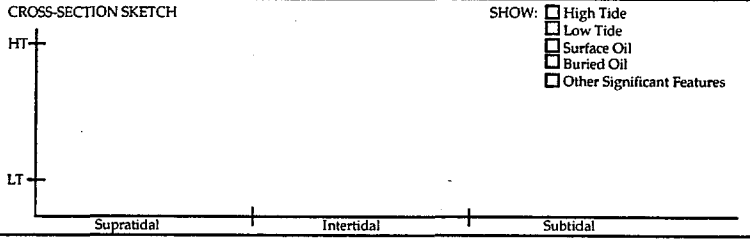
Oil Band Width		Surface Oil Cover (within the oiled band)	Surface Oil Thickness	Surface Oil Type	Sediment Penetration / Burial	
<0.3 m	<1 ft	<1%	Film	Fresh Liquid	<1 cm	Clean Layer
0.3-1 m	1-3 ft	1-10%	Stain	Mousse	1-5 cm	____ cm
1-3 m	3-10 ft	11-50%	Coat	Tarballs	5-10 cm	Oiled Layer
>3 m	>10 ft	51-90%	Cover	Patties	>10 cm	____ cm
___ m	___ ft	91-100%	Pooled	Asphalt Pavement		
			___ cm ___ in	_____ Other		

ENVIRONMENTAL ISSUES? Y/N CULTURAL ISSUES? Y/N RECREATIONAL ISSUES? Y/N

CLEANUP RECOMMENDATION / SPECIFIC CONSTRAINTS

CROSS-SECTION SKETCH

SHOW: ☐ High Tide ☐ Low Tide ☐ Surface Oil ☐ Buried Oil ☐ Other Significant Features



You can also graphically represent shoreline assessment data on maps and as statistical summaries. Use maps to show the distribution of oiled shoreline and the degrees of oiling. Figure 12 shows a shoreline oiling map prepared for the 1996 *Julie* N spill in Portland, Maine. Standardize definitions for the shoreline oiling categories (modify your definitions from Figure 6). Use computer mapping software to tabulate the number of kilometers (or miles) of shoreline by oiling degree and cleanup status. These are important measures for reporting the progress of the cleanup.

Figure 10.
Example shoreline assessment report from the 1996 Buffalo 292 spill, Galveston, Texas.

Operational Period: 3-21-96/2100 to 3-22-96/2100

Shoreline segments visited: (See attached maps for segment locations)

Fort Point (FP)
Big Reef Park (BR1, BR2, BR3, BR4)
South Jetty (BR5)
NE Pelican Island (PI)
Pelican Island, Sea Wolf Park (SP1, SP2, SP3)
Goat Island (GI1, GI2)
North Ferry Landing (NFL1, NFL2)

Shoreline segments requiring no cleanup action at this time (barring future impact).
Many of the segments visited by SCAT on 3-20-96 require no cleanup action at this time.

SP1 - Oily film and trace tarballs in swash zone. **RECOMMENDATION:** No cleanup recommended.

SP2 - Trace to sporadic tarballs in swash zone. **RECOMMENDATION:** No cleanup recommended.

SP3 - No oil present.

FP - One spot of rip-rap near Big Reef impacted. 10 yds long, broken <5% coverage 200 yards due west from interchapter of Seawall Blvd. and shoreline. **RECOMMENDATION:** No cleanup recommended, but watch for oiling on front and back of rip-rap with tidal change over next 2 days.

Shoreline segments requiring cleanup action. See attached reports for more detail.

BR1 - Reimpacted, sporadic mousse and tarballs with 10-15% coverage, no subsurface impact. No cleanup activity present. **RECOMMENDATION:** Revisit by cleanup crew doing manual recovery, revisit daily.

BR2 - Reimpacted, continuous to sporadic with 10% coverage of film, mousse, and tarballs, no subsurface impact. No cleanup activity present. **RECOMMENDATION:** Revisit by cleanup crew doing manual recovery, revisit daily.

BR3 - Continuous to patchy oiling with 20% coverage more evenly dispersed as compared to yesterday, no subsurface impact. Small cleanup crew (approx. 15 people) present. **RECOMMENDATION:** Continue cleanup.

BR4 - 10-15% coverage, continuous to sporadic, no subsurface impact. Cleanup activity in progress. **RECOMMENDATION:** Continue cleanup operations.

BR5 - Oil still leaching from South Jetty, snare being deployed and tended. **RECOMMENDATION:** Maintain snare on both south and north side of South Jetty with frequent tending to ensure effective capture of oil leaching from riprap.

EB - No oil, but some type of film is present on surface, (maybe organic), some snare is starting to float up on East Beach near the jetty. **RECOMMENDATION:** Visit by cleanup crew for manual recovery of snare and other oily debris washing up.

P1 - Trace to sporadic tarballs stranded in water and upper intertidal zone, film cover in wide to medium width with 100 yds of patchy tarballs trapped within, no subsurface impact. **RECOMMENDATION:** Manual removal with snare placed in swash zone.

SCAT was performed at low to mid tide. High tide may relocate observed oil.

202 ICS 3/80	Prepared by:	Approved by (Incident Commander):

NOAA is developing automated tools for managing and reporting shoreline assessment results. Key chapters of the field forms are entered into a database manager that can be used to generate various reports and then linked to computer mapping software. There are also commercially available software packages.

While it is clear that shoreline assessment teams should not direct cleanup contractors in the field, the team can meet with the Division Supervisor when conducting surveys in his/her division. The team can invite the Division Supervisor to:

Figure 11.
Example shoreline assessment report from the 1996 *Cape Mohican* spill, San Francisco, California.

SCAT Cleanup Priorities and Methods **Page 1**

SEGMENT NAME:	Ocean Beach
DIVISION:	O
OIL TYPE:	Tarballs
OIL EXTENT:	1 m wide by 4.7 miles long
OIL LOCATION:	The high tide zone along the entire length of Ocean Beach
CLEANUP TECHNIQUES:	Small crew needed with a lawn roller and sorbent pads. The roller wrapped in pads picks up the tarballs from the beach. Tarballs mixed with vegetative debris in wrack line. The federally threatened snowy plovers (birds) have been oiled. A National Park Service representative should be on-scene during cleanup. Recommend 1 crew for manual removal.

SEGMENT NAME:	Muir Beach
DIVISION:	S
OIL TYPE:	Tarballs
OIL EXTENT:	1 m wide by 1,600 m long
OIL LOCATION:	In the high tide swash of the sand beach
CLEANUP TECHNIQUES:	Manual removal of tarballs. Rakes, shovels, and plastic bags required. Need 6 men.

SEGMENT NAME:	China Beach
DIVISION:	H-2
OIL TYPE:	Tarballs
OIL EXTENT:	Entire length of beach
OIL LOCATION:	
CLEANUP TECHNIQUES:	Trace tarballs scattered on beach. No further cleanup required. Ready to be examined for sign-off.

- accompany them on their survey (which is unlikely for most spills because of time demands on the Division Supervisor);
- accompany them on a quick walk-through after the survey is completed, going over the team's recommendations; or
- meet after the survey to go over their recommendations.

Direct communication with the Shoreline Assessment Team gives the Division Supervisor immediate feedback and a better understanding of the agency concerns, the details of which are lost as the survey reports

are filtered through the IAP and the chain of command. However, this means that the Shoreline Assessment Team must be very concise during their debrief with the Division Supervisor and not burden that individual with unnecessary technical detail.

Automated Tools That Help Shoreline Assessments

Responders are testing and using various automated tools to support shoreline assessment activities. Using such tools during response should be based on their ability to support response objectives, rather than using them for the sake of technology. The most promising applications include:

Differential Global Positioning Systems (DGPS):
With the coast-wide availability of differential correction provided by the U.S. Coast Guard, DGPS units can be used to generate locational information for most types of field observations. They can be used to determine segment boundaries, measure oil dimensions, and locate buried oil layers. They are most effectively used when integrated with Geographic Information System (GIS) mapping applications.

Pen-based computers for field recording of observations: Shoreline assessment forms can be loaded onto rugged, waterproof and shock-proof, pen-based computers to allow direct entry of observations in the field. The Florida Department of Environmental Protection has found this system to be feasible (Rubec et al. 1996). NOAA has also developed a pen-based computer application for recording overflight observations of floating oil (Simecek-Beatty and Lehr 1996).

Wireless communications for data transfer:
Wireless communications can be used with field computers for near real-time transmittal of shoreline assessment data directly to the command center. This application is particularly useful for teams working in remote areas where a daily return to the command post to submit data would be inefficient. Cellular phones would also be used to debrief the field teams.

Where shoreline assessment data are available digitally, linking to GIS mapping technology becomes more realistic. Most GIS applications require significant staff and equipment resources, making them appropriate only under certain conditions.

Tanker JULIE N Incident

Shoreline Oiling Map
prepared by NOAA

Date/Time: 04 OCT 96, 1000

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil

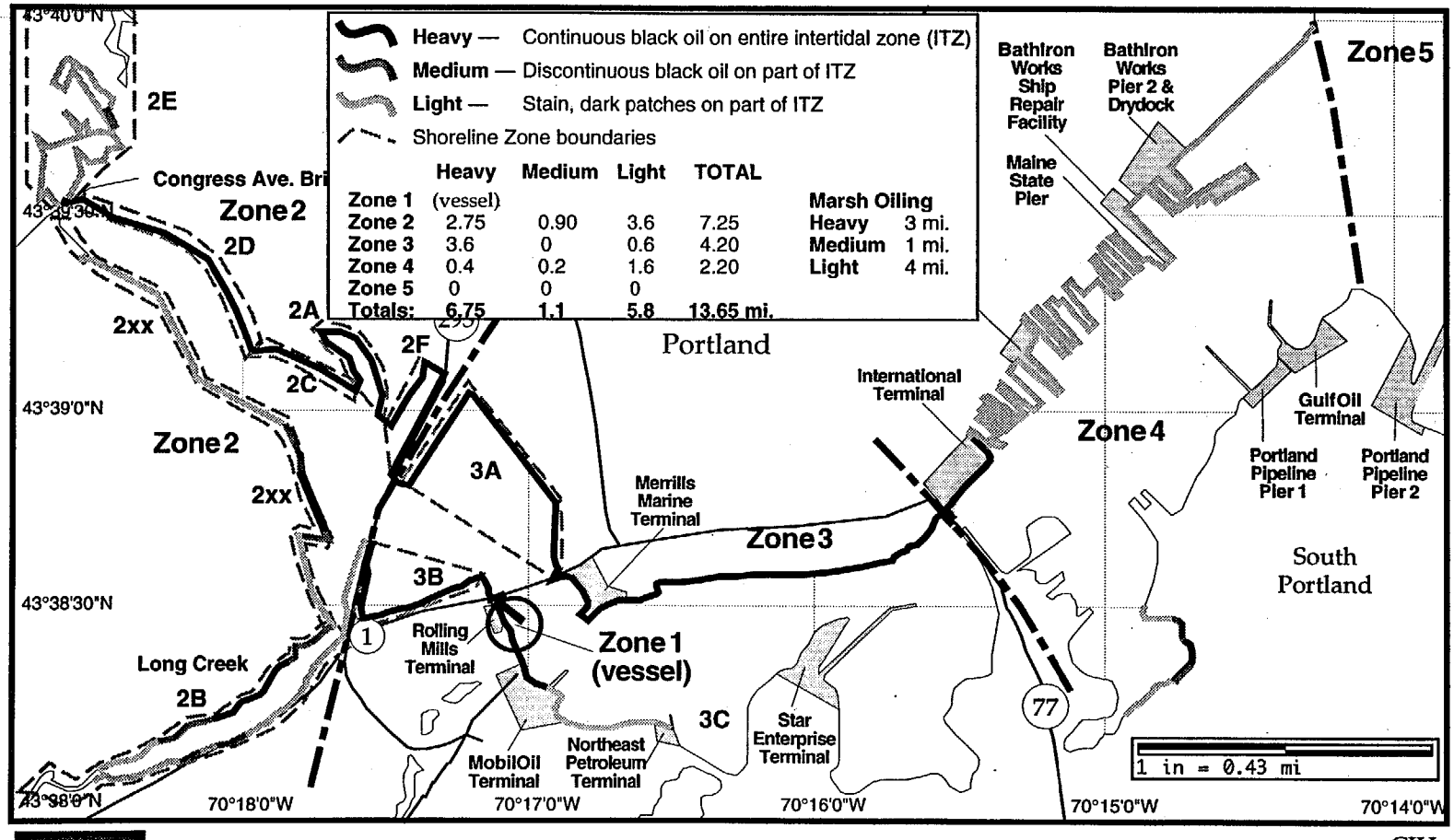


Figure 12. Example shoreline oiling summary map, from the 1996 *Julie N* spill in Portland, Maine.

7 The Flexibility of Shoreline Assessment Methods

The shoreline assessment process should be modified to fit the spill conditions; it should be as simple as possible, yet comprehensive enough to address all of the issues and concerns of shoreline cleanup. It must not be a large, slow process upon which Planning and Operations must wait for key data. When this occurs, Operations will get the information it needs on its own, and the work products of the shoreline assessment teams will not be used. Two types of shoreline assessment are outlined below, representing a range of complexity. Many spills will require some elements of both: detailed surveys of specific problem areas and application of general guidelines for cleanup of shorelines with simple cleanup requirements.

"Geographic" Shoreline Assessments...

This assessment approach generates site-specific recommendations on resource protection and cleanup methodology.

involve...

- Completing forms and sketches for each segment; and
- Making detailed cleanup recommendations unique to each segment, identifying specific locations to be cleaned.

use them for...

- Very small spills where all sites can be readily inspected by the same team;
- Very large spills where many teams are required;
- Sites where many different shorelines types have been oiled; and
- Areas where full documentation of oiling conditions is required, such as:
- Spill conditions where cleanup problems are not readily apparent (e.g., buried oil that has to be located by digging, and when repeated surveys are need to make sure that removal was complete)
- Areas with lots of resource constraints that need to be specifically identified in the field

"Topical" or "hot-spot" shoreline assessments

This assessment approach is based on the assumption that the Division Managers (division supervisors are responsible for directing the cleanup in a specific geographic area using several types of resources, such as task forces) can successfully implement spill-specific, but not site-specific, cleanup guidelines. Most often, this approach is appropriate when the degree of oiling is relatively uniform or uncomplicated, or when the shoreline is not particularly sensitive, such as man-made structures. The guidelines should be quite detailed to prevent confusion about their use. Terminology used in the guidelines should reflect that in local practice (e.g., use "seaweed" rather than "brown algae" or "*Fucus* " if that is what the cleanup workers call it). Figure 13 shows an example general cleanup guideline.

involve...

- Conducting familiarization surveys by the team to identify oiling conditions and cleanup issues for each shoreline type or resource of concern;
- Developing spill-specific cleanup guidelines for each shoreline type, to be implemented in the field by Division Managers;
- Meeting with Division Managers to make sure that they understand the cleanup guidelines, what leeway they have to implement them, and the key issues of concern to the resource agencies;
- Spot-checking cleanup operations for compliance with cleanup guidelines; and
- Responding to requests from Operations to resolve "hot spot" problems encountered during cleanup activities.

use them for...

- Small-volume spills that spread over very large areas (such as stranding of tarballs on Gulf of Mexico beaches);
- Man-made shoreline types, such as seawalls, with few site-specific sensitive resource issues; and
- Cleanup work that continues for very long times because of chronic re-oiling or seasonal changes in shoreline oiling.

Figure 13. Example cleanup guidelines for a shoreline type.

GUIDELINES FOR HOT-WASH OF OILED RIPRAP/BULKHEADS

Julie N Spill, Portland, Maine

October 4, 1996

- Water temperature of hot wash not to exceed 40°C
- Spray nozzle will be held at a distance of 6 inches or greater from the surface. All spraying/flushing will be into water for collection.
- No attached seaweed will be sprayed with hot water.
- Once the water level reaches the seaweed, hot water washing will be terminated.
- Once hot water washing is terminated, all released oil will be recovered immediately. Cold water flushing of the seaweed is allowed when oil has accumulated in it.
- Removal of heavily oiled seaweed will be allowed in specified areas to be identified by the shoreline assessment team. If seaweed is to be cut, the root attachment and a 12 inch stem will be left.
- Cold water flushing will be conducted until no more oil is mobilized.
- Hot wash will be repeated until no free oil is released by the hot wash and no more than a stain (can't be scraped off with a fingernail) remains on the surface.
- Sorbents will be deployed along areas where sheens are being released from the shoreline.

THESE GUIDELINES WILL BE REVISED, AS NEEDED, IN RESPONSE TO CHANGING CONDITIONS AS THE OIL WEATHERS.

Other shoreline assessments customized to spill conditions

Tarball assessments during the *Buffalo* 292 (Galveston)

The cleanup of the *Buffalo* 292 spill at Galveston, Texas in March 1996 was divided into two phases: the first 12 days of the spill, when much of the oil stranded along the upper Texas coast near Galveston; and the next several weeks, when tarballs spread to the mid- and lower-Texas coast, beyond Corpus Christi (Martin et al. 1997). During the first phase, a full, geographic shoreline assessment was effectively conducted. However, the approach changed when the spilled oil started to strand as tarballs on remote beaches with few structures, roads, or other landmarks to reference during surveys and communications. Instead of filling out forms and making sketches, the team:

- Established mile marker stakes at one-mile intervals on the beach; the operational zones and shoreline segments were then redefined in terms of the mile markers;
- Recorded the concentration and distribution of tarballs between the mile markers, using the standard terminology;
- Used surveyors' flags to mark buried oil locations for the cleanup crews;
- Reported the shoreline impact descriptions by cellular phone to the Command Post (they did not have to drive back for face-to-face briefings); and
- The Coordinator generated tabular reports that were submitted to Planning and then Operations.

Buried oil during the *Bouchard* 155 (Tampa Bay) and *Buffalo* 292 (Galveston) spills

Buried oil is a site-specific problem that must be delineated by labor-intensive digging to determine the areal extent of the buried layers. The presence of buried oil is noted on the form and delineated on a sketch map. However, depending on the skill of the sketcher and the complexity of the segment, cleanup crews may not be able to locate the buried oil from the forms and maps. Another approach, used during both the *Buffalo* 292 spill in Texas and the 1993 *Bouchard* 155 spill in Tampa Bay, is to provide the survey team with surveyor's flags to mark the location of buried oil to be removed.

8 Planning for Shoreline Assessments

Personnel: Define the Roles in the Area Plan

Plan ahead for shoreline assessments through the Area Committee. The Area Contingency Plan can identify the personnel, process, and logistics to be used for shoreline assessments before a spill. It can also pre-approve the use of cleanup methods for special problem areas. This kind of pre-planning should include:

- Identify Shoreline Assessment Team Coordinator (NOAA SSC or state counterpart)
- Identify a pool of state and Federal personnel who can represent their agencies' concerns and be available to do shoreline assessments for the duration of a spill

These personnel must be trained in shoreline processes, terminology, and cleanup methods

Process

- Adopt a Shoreline Survey Evaluation Form
- Develop a strategy for segmenting shorelines in your area on maps or charts
- Pre-approve the use of cleanup methods for each shoreline type. Form workgroups to identify special cleanup concerns (e.g., cutting of oiled seaweeds, use of shoreline cleaning agents, recovery of submerged oil), research the cleanup options, and make recommendations on their use for inclusion in the Area Plan.
- Develop general guidelines for cleanup endpoints
- Explain how to transition Shoreline Assessment Teams into Sign off Teams

Logistics

- Identify and acquire shoreline assessment equipment
- Identify the need for air boats, boats, or special vehicles, particularly in remote areas
- Identify the types of communications needed by field teams (e.g., radios, cellular phones)

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Appendix A: Shoreline Assessment Equipment Checklist

Survey Gear

- ❒ Maps or charts of the survey area
- ❒ Clipboards and rubber bands
- ❒ Pencils, erasers, waterproof markers
- ❒ Field forms (code sheets, shoreline form, sketch sheets, photo logs)
- ❒ Field estimation charts (sand size, gravel size, percent cover)
- ❒ Field notebooks (waterproof)
- ❒ Segment map sheets
- ❒ Base sketch maps, if available
- ❒ Shovels
- ❒ Camera (35 mm) and color print film (ASA 64 and 100); extra batteries
- ❒ Videocamera and video tapes, if required; extra batteries
- ❒ Photo scale (15 cm)
- ❒ Tape measure (30 m) and ruler
- ❒ Range finder
- ❒ Hand-held GPS
- ❒ Compass, preferably Brunton
- ❒ Field pack
- ❒ Communication device (e.g., radio or cellular phone)
- ❒ First-aid kit

Personal Gear

- ❒ Good rain gear
- ❒ Knee-high, rubber boots or hip waders
- ❒ Work gloves
- ❒ "Tar-off" towelettes or similar hand cleaner
- ❒ Hat
- ❒ Sunscreen
- ❒ Drinking water
- ❒ Personal Flotation Device (PFD) if traveling by water/helicopter
- ❒ Personal day pack

Appendix B: Brief Descriptions of Shoreline Cleanup Methods

Shoreline Cleanup Methods

Introduction

This section describes methods currently in use during cleanup of oil spills in marine environments and habitats. For each method the following is provided: a summary of the objective in using the method, a general description of the method, applicable habitat types, conditions under which the methods should be used (constraints commonly applied to the use of the method to protect sensitive biological resources), and the environmental effects expected from the proper use of the method. Some of the methods listed require special authorization for use during a spill; appropriate agencies must be contacted about the need for special approvals.

A problem which occurs after all major oil spills is that there is a large quantity of oily wastes and debris that is generated and must be dealt with as part of the response action. A cleanup strategy that minimizes the impact to all the sensitive aspects of the environment plus minimizes the amount of oily wastes is the most optimal overall. History has shown that oily wastes or debris that has been buried inappropriately can result in formation of leachates that contaminate surface and groundwater resources. Each cleanup option should be examined with the problem of waste generation and disposal in mind.

Natural Recovery

Objective	In order to minimize impact to the environment, no attempt is made to remove any stranded oil. It is also an option when there is no effective method for cleanup. Oil is left to weather naturally.
Description	No action is taken, although monitoring of contaminated areas is required.
Applicable Habitat Types	All habitat types.
When to Use	When natural removal rates are fast (e.g., the evaporation of gasoline or highly exposed coastlines), when the degree of oiling is light, or when cleanup actions will do more harm than natural removal.
Biological Constraints	This method may be inappropriate for areas used by high numbers of mobile animals (birds, marine mammals) or endangered species.
Environmental Effects	Same as from the oil alone.

Barriers/Berms

Objective

To prevent entry of oil into a sensitive area or to divert oil to a collection area.

Description

A physical barrier is placed across an area to prevent oil from passing. Barriers can consist of earthen berms or filter fences. When it is necessary for water to pass because of water volume, underflow or overflow dams are used.

Applicable Habitat Types

At the mouths of creeks or streams to prevent oil from entering from offshore, or to prevent oil from being released from the creek into offshore waters. Also, on beaches where a high berm can be built above the high-tide line to prevent oil from overwashing the beach and entering a sensitive back-beach habitat (e.g. lagoon).

When to Use

When the oil threatens sensitive habitats, it is the most effective tool to use in order to exclude oil from an area.

Biological Constraints

Minimize disturbance to bird nesting areas, such as shorebird nesting sites on beaches. Placement of dams and filter fences should cause excessive physical disruptions to the site, particularly in wetlands.

Environmental Effects

May disrupt or contaminate sediments and vegetation adjacent to the creek mouth. The natural beach profile should be restored, which may take months on gravel beaches.

Physical Herding

Objective

To free oil trapped in debris or vegetation on-water; to direct the movement of floating oil towards containment and recovery devices; or to push oil away from sensitive areas

Description

Plunging water jets, water or air hoses, and propeller wash can be used to dislodge trapped oil and divert or herd it to containment and recovery areas. May emulsify the oil. Mostly conducted from small boats.

Applicable Habitat Types

In nearshore areas where there are little or no currents, and in and around man-made structures such as wharves and piers.

When to Use

In low-current or stagnant water bodies, to herd oil towards recovery devices. In high current situations to divert floating oil away from sensitive areas.

Biological Constraints

When used near shore and in shallow water, must be careful to not disrupt bottom sediments or submerged aquatic vegetation.

Environmental Effects

May generate high levels of suspended sediments and mix them with the oil, resulting in deposition of contaminated sediments in benthic habitats.

Manual Oil Removal/Cleaning

Objective

To remove oil with hand tools and manual labor.

Description

Removal of surface oil by manual means (hands, rakes, shovels, buckets, scrappers, sorbents, etc.) and placing in containers. No mechanized equipment is used. Includes underwater recovery of submerged oil by divers.

Applicable Habitat Types

Can be used on all habitat types.

When to Use

Light to moderate oiling conditions for stranded oil or heavy oils that have formed semisolid to solid masses that can be picked up manually.

Biological Constraints

Foot traffic over sensitive areas (wetlands, tidal pools, etc.) needs to be restricted or prevented. There may be periods when shoreline access should be avoided, such as during bird nesting.

Environmental Effects

Minimal, if surface disturbance by crew movement and waste generation is controlled.

Mechanical Oil Removal

Objective

Removal of oil from water surface, bottom sediments, and shorelines with mechanical equipment.

Description

Oil and oiled sediments are collected and removed using backhoes, graders, bulldozers, dredges, draglines, etc. Requires systems for temporary storage, transportation, and final treatment/disposal.

Applicable Habitat Types

On land, possible wherever surface sediments are both amenable and accessible to heavy equipment. For submerged oil, used in sheltered areas where oil accumulates. On-water, used on viscous to solid oil contained within booms.

When to Use

When large amounts of oiled materials have to be collected and removed. Care should be taken to remove sediments only to the depth of oil penetration. This can be difficult when using heavy equipment on beaches or dredges on submerged oil. Should be used carefully where excessive sediment removal may erode the beach.

Biological Constraints

Heavy equipment may be restricted in sensitive habitats (e.g., wetlands, soft substrate) or areas containing endangered plants and animals. Will need special permission to use in areas with known cultural resources. Dredging in seagrass beds or coral reef habitats may be prohibited.

Environmental Effects

The equipment is heavy, with many support personnel required. May be detrimental if excessive sediments are removed without replacement. All organisms in the sediments will be affected, although the need to remove the oil may make this response method the best overall alternative. Resuspension of exposed oil and fine-grained oily sediments can affect adjacent bodies of water.

Sorbents

Objective

To remove floating oil by absorption onto oleophilic material placed in water or at the waterline.

Description

Sorbent material is placed *on the water surface*, allowing it to absorb oil. Forms include sausage boom, rolls, sweeps, and snares. Efficacy depends on the capacity of the particular sorbent, energy available for lifting oil off the substrate, and stickiness of the oil. Recovery of all sorbent material is mandatory. Loose particulate sorbents must be contained in a mesh or other material.

Applicable Habitat Types

Can be used on any habitat or environment type.

When to Use

When oil is free-floating close to shore or stranded on shore. The oil must be able to be released from the substrate and absorbed by the sorbent. Often used as a secondary treatment method after gross oil removal and in sensitive areas where access is restricted. Selection of sorbent varies by oil type; heavy oils only coat surfaces, requiring a high surface area to be effective, whereas lighter oils can penetrate sorbent material such as sorbent boom.

Biological Constraints

Access for deploying and retrieving sorbents should not be through soft or sensitive habitats or affect wildlife. Sorbent use should be monitored to prevent overuse and generation of large volumes of waste. Sorbents should not trap migrating wildlife such as turtles returning to sea, or fish coming in at high tide. Sorbents left in place too long can break apart and present an ingestion hazard to wildlife.

Environmental Effects

Physical disturbance of habitat during deployment and retrieval. Unattended or "orphan" sorbent material can crush or smother sensitive substrates.

Vacuum

Objective

To remove free oil pooled on the substrate or from relatively calm water.

Description

A vacuum unit is attached via a flexible hose to a suction head that recovers free oil. The equipment can range from small, portable units that fill individual 55-gallon drums to large supersuckers that are truck- or vessel-mounted and can generate enough suction to lift large rocks. Can be used with booms and herding to move the oil toward the suction head. Removal rates from substrates can be extremely slow.

Applicable Habitat Types

Any accessible habitat type. May be mounted on barges for water-based operations, on trucks driven to the recovery area, or hand-carried to remote sites.

When to Use

When free, liquid oil is stranded on the substrate, concentrated in trenches dug by responders, trapped in vegetation, or pooled on the water surface. Often used as a type of rudimentary skimmer to recover floating oil. Usually requires shoreline access points.

Biological Constraints

Special restrictions should be established for areas where foot traffic and equipment operation must be limited, such as soft substrates. Operations in wetlands need to be very closely monitored, with a site-specific list of restrictions. If used in vegetated areas such as wetlands, care must be taken not to remove vegetation or disturb plant roots.

Environmental Effects

Minimal, if foot and vehicular traffic is controlled and minimal substrate is removed.

Debris Removal

Objective	To remove contaminated debris from the shoreline or water surface. Could also include removal of shoreline debris in anticipation of oil stranding onshore.
Description	Manual or mechanical removal of debris from the shore or water surface. Can include cutting and removal of oiled logs.
Applicable Habitat Types	Can be used on any habitat or environment type where access is safe.
When to Use	When driftwood and debris are heavily contaminated and provide a potential source of chronic oil release, an aesthetic problem, a source of contamination for other organisms in the area, skimmer clogging problems, or safety problems for responders. Also used in areas of debris accumulation on beaches prior to oiling to minimize the amount of oiled debris to be handled.
Biological Constraints	Foot traffic over sensitive areas (wetlands, spawning grounds) needs to be restricted. May be periods when access should be restricted (spawning periods, influx of large numbers of migratory waterbirds).
Environmental Effects	Physical disruption of substrate, especially when mechanized equipment must be deployed to recover a large quantity of debris.

Sediment Reworking/Tilling

Objective

To rework oiled sediments to break up surficial oil deposits, increase its surface area, and mix deep subsurface oil layers, which will expose the oil to natural processes and enhance the rate of oil degradation.

Description

The oiled sediments are rototilled, disked, or otherwise mixed using mechanical equipment or manual tools such as rakes and shovels. Along beaches, oiled sediments may also be pushed to the water's edge (surf washing) to enhance natural cleanup by wave activity. The process may be aided with high-volume flushing of gravel.

Applicable Habitat Types

On any sedimentary substrate that can support mechanical equipment or foot traffic.

When to Use

On sand to gravel beaches with subsurface oil, where sediment removal is not feasible (due to erosion concerns or disposal issues). On sand beaches where the sediment is stained or lightly oiled. Appropriate where oil is stranded above normal high water.

Biological Constraints

Avoid use on shores near sensitive wildlife habitat, such as fish-spawning areas or bird-nesting or concentration areas because of the potential for release of oil and oiled sediments into adjacent bodies of water.

Environmental Effects

Due to the mixing of oil into sediments, this method could further expose organisms that live below the original layer of oil. Repeated mixing over time could delay reestablishing organisms. Refloated oil from treated sites could contaminate adjacent areas.

Vegetation Cutting/Removal

Objective

Remove portions of oiled vegetation or oil trapped in vegetation to prevent oiling of wildlife or chronic oil releases.

Description

Oiled vegetation is cut with weed wackers, blades, etc. The cut vegetation is picked or raked up and bagged for disposal.

Applicable Habitat Types

Wetlands composed of emergent, herbaceous vegetation and floating aquatic vegetation.

When to Use

When the risk of oiled vegetation contaminating wildlife is greater than the value of the vegetation that is to be cut, and there is no less-destructive method that removes or reduces the risk to acceptable levels.

Biological Constraints

Operations must be strictly monitored to minimize the degree of root destruction and mixing of oil deeper into the sediments. Access in bird-nesting areas should be restricted during nesting seasons. Cutting only the oiled portions of the plants and leaving roots and as much of the stem as possible minimizes impact to plants.

Environmental Effects

Vegetation removal will destroy habitat for many animals. Cut areas will have reduced plant growth, and in some instances, plants may be killed. Cutting at the base of the plant stem may allow oil to penetrate into the substrate, causing subsurface contamination. Along exposed sections of shoreline, the vegetation may not regrow, resulting in erosion and habitat loss. Trampled areas will recover much more slowly.

Flooding

Objective

To wash oil stranded on the land surface to the water's edge for collection.

Description

A perforated header pipe or hose is placed above the oiled shore or bank. Ambient-temperature water is pumped through the header pipe at low pressures and flows downslope to the water. On porous sediments, water flows through the substrate, pushing loose oil ahead of it (or floating oil to the water's surface and transporting the oil down the slope for pickup). Oil is trapped by booms and is recovered by skimmers or other suitable equipment. On saturated, fine-grained sediments, the technique becomes more of a flushing of the surface.

Applicable Habitat Types

All shoreline types where the equipment can be effectively deployed. Not effective in steep intertidal areas.

When to Use

In heavily oiled areas when the oil is still fluid and adheres loosely to the substrate, and where oil has penetrated into gravel sediments. This method is frequently used with other washing techniques (low- or high-pressure, cold-to-hot-water flushing).

Biological Constraints

Special care should be taken to recover oil where nearshore habitats contain rich biological communities. Not appropriate for muddy substrates.

Environmental Effects

Habitat may be physically disturbed by foot traffic during operations and smothered by sediments washed down the slope. Oiled sediment may be transported to shallow nearshore areas, contaminating them and burying benthic organisms.

Low-Pressure, Ambient-Water Flushing

Objective

To remove liquid oil that has adhered to the substrate or man-made structures, pooled on the surface, or become trapped in vegetation.

Description

Ambient-temperature water is sprayed at low pressures (<10 psi), usually from hand-held hoses, to lift oil from the substrate and direct it to the water's edge for recovery by skimmers, vacuum, or sorbents. Can be used with a flooding system to prevent released oil from re-adhering to the substrate downstream of the treatment area.

Applicable Habitat Types

On substrates, riprap, and solid man-made structures, where the oil is still liquid. In wetlands and along vegetated banks where oil is trapped in vegetation.

When to Use

Where liquid oil is stranded onshore or floating on shallow intertidal areas.

Biological Constraints

May need to restrict use so that the oil/water effluent does not drain across sensitive intertidal habitats and mobilized sediments do not affect rich subtidal communities. Use from boats will reduce the need for foot traffic in soft substrates and vegetation. Released oil must be recovered to prevent further oiling of adjacent areas.

Environmental Effects

If containment methods are not sufficient, oil and oiled sediments may be flushed into offshore areas. Some trampling of substrate and attached biota will occur.

High-Pressure, Ambient-Water Flushing

Objective

To remove oil that has adhered to hard substrates or man-made structures.

Description

Similar to low-pressure flushing except that water pressure is 100-1,000 psi. High-pressure spray will more effectively remove sticky or viscous oils. If low water volumes are used, sorbents are placed directly below the treatment area to recover oil.

Applicable Habitat Types

On bedrock, man-made structures, and gravel substrates.

When to Use

When low-pressure flushing is not effective at removing adhered oil, which must be removed to prevent continued oil release or for aesthetic reasons. When a directed water jet can remove oil from hard-to-reach sites.

Biological Constraints

May need to restrict flushing so that the oil does not drain across sensitive habitats. Released oil must be recovered to prevent further oiling of adjacent areas.

Environmental Effects

May drive oil deeper into the substrate or erode shorelines of fine sediments if water jet is improperly applied. If containment is not sufficient, oil and oiled sediments may be flushed into offshore areas. Some trampling of substrate and attached biota will occur.

Low-Pressure, Hot-Water Flushing

Objective

To remove non-liquid oil that has adhered to the substrate or man-made structures, or pooled on the surface.

Description

Hot water (90°F up to 170°F) is sprayed with hoses at low pressures (<10 psi) to liquefy and lift oil from the substrate and direct it to the water's edge for recovery by skimmers, vacuums, or sorbents. Used with flooding to prevent released oil from re-adhering to the substrate.

Applicable Habitat Types

On bedrock, sand to gravel substrates, and man-made structures.

When to Use

Where heavy, but relatively fresh oil is stranded onshore. The oil must be heated above its pour point, so it will flow. Less effective on sticky oils.

Biological Constraints

Avoid wetlands or rich intertidal communities. Use should be restricted so that the hot oil/water effluent does not contact sensitive habitats. Operations from boats will help reduce foot traffic in soft substrates and vegetation. Released oil must be recovered to prevent further oiling of adjacent areas.

Environmental Effects

Hot-water contact can kill all attached animals and plants. If containment methods are not sufficient, oil may be flushed into downstream areas. Some trampling of substrate and biota will occur.

High-Pressure, Hot-Water Flushing

Objective

To mobilize weathered and viscous oil strongly adhered to surfaces.

Description

Hot water (90°F up to 170°F) is sprayed with hand-held wands at pressures greater than 100 psi. If used without water flooding, this procedure requires immediate use of vacuum or sorbents to recover the oil/water runoff. When used with a flooding system, the oil is flushed to the water surface for collection by skimmers, vacuum, or sorbents.

Applicable Habitat Types

Gravel substrates, bedrock, and man-made structures.

When to Use

When oil has weathered to the point that warm water at low pressure no longer effectively removes oil. To remove viscous oil from man-made structures for aesthetic reasons.

Biological Constraints

Use should be restricted so that the oil/water effluent does not drain across sensitive habitats (damage can result from exposure to oil, oiled sediments, and hot water). Should not be used directly on attached algae or rich intertidal areas. Released oil must be recovered to prevent further oiling of adjacent areas.

Environmental Effects

All attached animals and plants in the direct spray zone will be removed or killed, even when used properly. Oiled sediment may be transported to shallow nearshore areas, contaminating them and burying benthic organisms.

Steam Cleaning

Objective	To remove heavy residual oil from solid substrates or man-made structures.
Description	Steam or very hot water (170°F to 212°F) is sprayed with hand-held wands at high pressure (2000+ psi). Water volumes are very low compared to flushing methods.
Applicable Habitat Types	Man-made structures such as seawalls and riprap.
When to Use	When heavy oil residue remaining on a shoreline needs to be cleaned for aesthetic reasons, and when hot-water flushing is not effective.
Biological Constraints	Not to be used in areas of soft substrate, vegetation, or high biological abundance directly on or below the structure.
Environmental Effects	Complete destruction of all organisms in the spray zone. Difficult to recover all released oil.

Sand Blasting

Objective	To remove heavy residual oil from solid substrates or man-made structures.
Description	Use of sandblasting equipment to remove oil from the substrate. May include recovery of used (oiled) sand in some cases.
Applicable Habitat Types	On heavily oiled bedrock, artificial structures such as seawalls and riprap.
When to Use	When heavy oil residue remaining on the shoreline needs to be cleaned for aesthetic reasons, and even steam-cleaning is not effective.
Biological Constraints	Not to be used in areas of soft substrate, vegetation, or high biological abundance directly below or adjacent to the structures.
Environmental Effects	Complete destruction of all organisms in the blast zone. Possible smothering of downstream organisms. Unrecovered, used sand will introduce oiled sediments into the adjacent habitat.

Solidifiers

Objective

To change the physical state of spilled oil from a liquid to a solid.

Description

Chemical agents (polymers) are applied to oil at rates of 10-45 percent or more, solidifying the oil in minutes to hours. Various broadcast systems, such as leaf blowers, water cannons, or fire suppression systems, can be modified to apply the product over large areas. Can be applied to both floating and stranded oil. Can be placed in booms, pillows, sausages, etc. and used like sorbents, although this type of solidifier application has not been used operationally.

Applicable Habitat Types

All water environments, bedrock, sediments, and artificial structures.

When to Use

When immobilization of the oil is desired, to prevent refloating from a shoreline, penetration into the substrate, or further spreading. However, the oil may not fully solidify unless the product is well mixed with the oil, and may result in a mix of solid and untreated oil. Generally not used on spills of heavy oil because the product cannot be readily mixed into viscous oils.

Biological Constraints

Must be able to recover all treated material.

Environmental Effects

Available products are insoluble and have very low aquatic toxicity. Unrecovered solidified oil may have longer impact because of slow weathering rates. Physical disturbance of habitat is likely during application and recovery.

Shoreline Cleaning Agents

Objective

To increase the efficiency of oil removal from contaminated substrates.

Description

Special formulations are applied to the substrate, as a presoak and/or flushing solution, to soften or lift weathered or heavy oils from the substrate to enhance flushing methods. The intent is to lower the water temperature and pressure required to mobilize the oil from the substrate during flushing.

Applicable Habitat Types

On any habitat where water flooding and flushing procedures are applicable.

When to Use

When the oil has weathered to the point where it cannot be removed using ambient water temperatures and low pressures. This approach may be most applicable where flushing effectiveness decreases as the oil weathers.

Biological Constraints

The released oil must be recovered from the water surface (and will not chemically disperse into the water column). Use may be restricted where suspended sediment concentrations are high, near wetlands, and near sensitive nearshore resources.

Environmental Effects

The toxicity and effects on dispersability of treated oil vary widely among products. Selection of a product should consider the toxicity of the product.

Nutrient Enrichment

Objective

To accelerate the rate of loss of oil hydrocarbons due to natural microbial processes by supplementing with nutrients.

Description

Water-soluble nutrients are applied by a spray irrigation system, daily if the impacted area gets completely submerged by tides and waves and if maximum biostimulation is desired. Slow-release granular or encapsulated nutrients or oleophilic fertilizer require less frequent addition, but time-series monitoring of interstitial pore water nutrient levels is needed to ensure target levels are being maintained.

Applicable Habitat Types

On any habitat type with access and where nutrients are deficient.

When to Use

On moderate to heavily oiled substrates, after other techniques have been used to remove free product or residues too high to support significant biological activity; on lightly oiled shorelines where other techniques are destructive or ineffective; and where nutrients limit natural attenuation. Most effective on light to medium crude oils and fuel oils (asphaltenes tend to inhibit biodegradation). Less effective where oil residues are thick.

Biological Constraints

Use of ammonia-based fertilizers at highly elevated concentrations should be avoided because of the toxic effects of un-ionized ammonia to aquatic life. Nitrate is a good nitrogen source without the toxicity. Sodium tripolyphosphate is a better phosphorus source than orthophosphates because it is more soluble in seawater. If nutrients are applied properly with adequate monitoring, eutrophication should not be a problem. Only nutrient amendments that have been previously proven to be nontoxic and effective in either the laboratory or field should be used. Contact toxicity of oleophilic formulations may restrict areas of direct application. Toxicity test should be evaluated carefully, as other chemicals in the product could be more toxic to aquatic organisms in the presence of oil.

Environmental Effects

Physical effects from access by workers for application (unless nutrients are sprayed from a nearby barge or from the air).

Natural Microbe Seeding

Objective

To accelerate the rate of natural microbial degradation of oil hydrocarbons by adding high numbers of living microorganisms with oil-degrading abilities.

Description

Formulations containing specific hydrocarbon-degrading microbes and nutrients are added to the oiled area, based on the assumption that indigenous hydrocarbon degraders are low in number or those that are present lack the ability to degrade the oil effectively.

Applicable Habitat Types

On any habitat type where safe access is allowed and additional microbes are needed.

When to Use

On moderate to heavily oiled substrates, after other techniques have been used to remove free product or residues too high to support significant biological activity; on lightly oiled shorelines where other techniques are destructive or ineffective; and where existing microorganisms are not present or effective (unlikely). Most studies have shown microbe seeding to be ineffective for oil spills, compared to simple nutrient addition.

Biological Constraints

If the product contains fertilizers, use of ammonia-based fertilizers should be avoided because of the toxic effect of un-ionized ammonia to aquatic life. Nitrate is just as good a nitrogen source without the toxicity. If the product containing nutrients is applied properly with adequate monitoring, eutrophication should not be a problem. Toxicity tests should be evaluated carefully, as other chemicals in the product could be toxic to aquatic organisms. The release of genetically engineered microbes into the environment is still a controversial subject.

Environmental Effects

Physical effects from access by workers for application (unless nutrients are sprayed from a nearby barge or from the air).

In situ Burning

Objective

To remove oil from the water surface or habitat by burning.

Description

Oil floating on the water surface is collected into slicks at least 2-3 mm thick and ignited. The oil can be contained in fire resistant booms, or by natural barriers such as ice or the shore. On land, oil in the habitat is burned, usually when it is on a combustible substrate such as vegetation, logs, and other debris. Oil can be burned off nonflammable substrates using a burn promoter. On sedimentary substrates, it may be necessary to dig trenches for oil to accumulate in pools thick enough to burn efficiently. Heavy oils are hard to ignite but can sustain an efficient burn. Emulsified oils may not ignite or sustain a burn when the water content is greater than 20 to 40 percent.

Applicable Habitat Types

On most habitats except dry muddy substrates where heat may impact the biological productivity of the habitat. May increase oil penetration into permeable substrates. Use in marshes should be undertaken using special precautions. Not suitable for woody vegetation such as mangroves and hardwood swamps.

When to Use

On land, where there is heavy oil in sites neither amenable nor accessible to physical removal and it is important to remove the stranded oil quickly. In wetlands and mud habitats, a water layer will minimize impacts to sediments and roots. Many potential applications for spills in ice. There are many operational and public health limitations.

Biological Constraints

The effect of smoke on nesting birds and populated areas should be evaluated.

Environmental Effects

Temperature and air quality effects are likely to be localized and short-lived. Toxicological impact from burn residues have not been evaluated. On-water, burn residues are likely to sink. On land, removal of residues is often necessary for crude and heavy oils. Limited data on burning oiled wetlands indicate recovery of wetland vegetation will depend on season of burn, type of vegetation, and water level in the marsh at time of burn.

Appendix C: Shoreline Assessment Forms, Codes, and Field Estimators

SHORELINE SURVEY EVALUATION FORM

Page __ of __

1 GEN	Segment Name: _____	Survey Date: _____	Survey Time: _____ to _____ (use military time)
	Segment ID: _____		
	Surveyed From: Foot / Boat / Helicopter	Weather: Sun / Clouds / Fog / Rain / Snow	

2 TEAM	Team No.	Operations:	
	OG:	State:	for:
	ECO:	Federal:	for:
	ARCH:	Land Manager:	for:

3 SHORE	Overall Classification for UITZ–select one	Sediment Beach:	Sediment Flat:
	Bedrock: Cliff ___ Platform ___	Boulder-Cobble __ Sand __	Boulder-Cobble __ Sand _
	Manmade: Permeable ___ Impermeable ___	Pebble-Cobble __	Pebble-Cobble __
	Marsh/Wetlands	Sand-Gravel __	Sand-Gravel __
	Secondary Shore Type:	Backshore Type:	

4 LAND	Geomorphology	
	Slope: Low ___% Med. ___% High ___% Vert. __	Wave Exposure: Low / Medium / High
	Estimated Segment Length: m	Total Estimated Length Surveyed:
	Access Restrictions:	

5 OIL	Oil Category Width:		Total Pavement: _____ sq.m by _____ cm	
	Wide ___ m	Very Narrow ___ m	Patties/Tarballs _____ bags	Oiled Debris? Yes/No
	Medium ___ m	No Oil ___ m	Debris/Amount: Logs _____	Vegetation _____
	Narrow ___ m	Unsurveyed ___ m	Trash _____	Other _____

6

SURFACE OIL	LOC	AREA LENGTH m	AREA WIDTH m	ZONE SU	ZONE UI	ZONE MI	ZONE LI	DIST	SURFACE OIL THICKNESS PO	CV	CT	ST	FL	SURFACE OIL TYPE FR	MS	TB	PT	TC	SR	AP	NO	SHORELINE SEDIMENT TYPE

Distribution (DIST): C = 100-91%; B = 90-51%; P = 50-11%; S = 10-1%; T = <1% Photo Roll # _____ Frames _____

7

SUBSURFACE	NO.	TRENCHES SU	TRENCHES UI	TRENCHES MI	TRENCHES LI	TRENCH DEPTH cm	OILED ZONE cm-cm	SUBSURFACE OIL CHARACTER OP	OP	FP	OR	OF	TR	NO	WATER TABLE cm	SHEEN COLOR	SURFACE-SUBSURFACE SEDIMENTS	CLEAN BELOW Y/N

Sheen Color: B = Brown R = Rainbow S = Silver N = None

8 COMMENTS

SHORELINE ASSESSMENT FORM for _____ Spill Page __ of __

G	Segment Name:		Date:
E	Segment ID:		Time: to
N	Surveyed From: Foot / Boat / Helicopter/Overlook	Weather: Sun/Clouds/Fog/Rain/Snow	

T	Team No.			
E	Name:	for:	Name:	for:
A	Name:	for:	Name:	for:
M	Name:	for:	Name:	for:

L	Shoreline/Sediment Types:		
A	Wave Exposure: Low/Medium/High	Total Segment Length: m	Length Surveyed m
N	Location Description:		
D	Access Restrictions:		

Description of oiling conditions _ Oil Length _ Width _ Type/Thickness _ Substrate Type
SURFACE OIL: _ Oiled Debris

SUBSURFACE OIL: _ Extent _ Thickness Clean _ Thickness Oiled _ Intertidal Location
_ Sediment Type _ Oil Description _ Burial _ Penetration

Segment-specific considerations for cleanup operations
_ Environmental _ Cultural _ Degree of Recreational Use

CLEANUP RECOMMENDATIONS

SHORELINE ASSESSMENT FORM

G	Segment Name:	Date:
E	Segment ID:	Time: to
N	Surveyed From: Foot / Boat / Helicopter / Overlook	Weather: Sun / Clouds / Fog / Rain / Snow

T	Team No.			
E	Name:	for:	Name:	for:
A	Name:	for:	Name:	for:
M	Name:	for:	Name:	for:

SHORELINE TYPE(S) PRESENT: Circle all that apply. Add P = Primary and S = Secondary shoreline type			
1A	Rocky Cliffs	6B	Riprap
1B	Exposed Man-made Structures	7	Exposed Tidal Flats
2	Wave-cut Platforms	8A	Sheltered Rocky Shores
3	Fine-grained Sand Beaches	8B	Sheltered Man-made Structures
4	Medium- to Coarse-grained Sand Beaches	9	Sheltered Tidal Flats
5	Mixed Sand and Gravel Beaches	10	Wetlands
6A	Gravel Beaches	___	Other_____

WAVE EXPOSURE: LOW / MED / HIGH DEBRIS OILED: Y/N: TYPE _____ VOLUME _____

SEGMENT LENGTH: _____ (m) _____ (ft) PERCENT OF SEGMENT OILED _____ %

OIL PRESENT IN: SUPRA / UPPER / MID / LOWER / SUBSTRATE TIDAL ZONE(S)

OVERALL DEGREE OF OILING: NONE / VERY LIGHT / LIGHT / MODERATE / HEAVY (SEE MATRIX)

CIRCLE ONE OR WRITE IN UNDER EACH COLUMN; SUMMARIZE FOR ENTIRE SEGMENT OR SUBSEGMENT:

Oil Band Width		Surface Oil Cover (within the oiled band)	Surface Oil Thickness	Surface Oil Type	Sediment Penetration / Burial	
<0.3 m	<1 ft	<1%	Film	Fresh Liquid	<1 cm	Clean Layer
0.3-1 m	1-3 ft	1-10%	Stain	Mousse	1-5 cm	_____ cm
1-3 m	3-10 ft	11-50%	Coat	Tarballs	5-10 cm	Oiled Layer
>3 m	>10 ft	51-90%	Cover	Patties	>10 cm	_____ cm
___ m	___ ft	91-100%	Pooled	Asphalt Pavement		
			___ cm ___ in	_____ Other		

ENVIRONMENTAL ISSUES? Y/N CULTURAL ISSUES? Y/N RECREATIONAL ISSUES? Y/N

_____ _____ _____

_____ _____ _____

_____ _____ _____

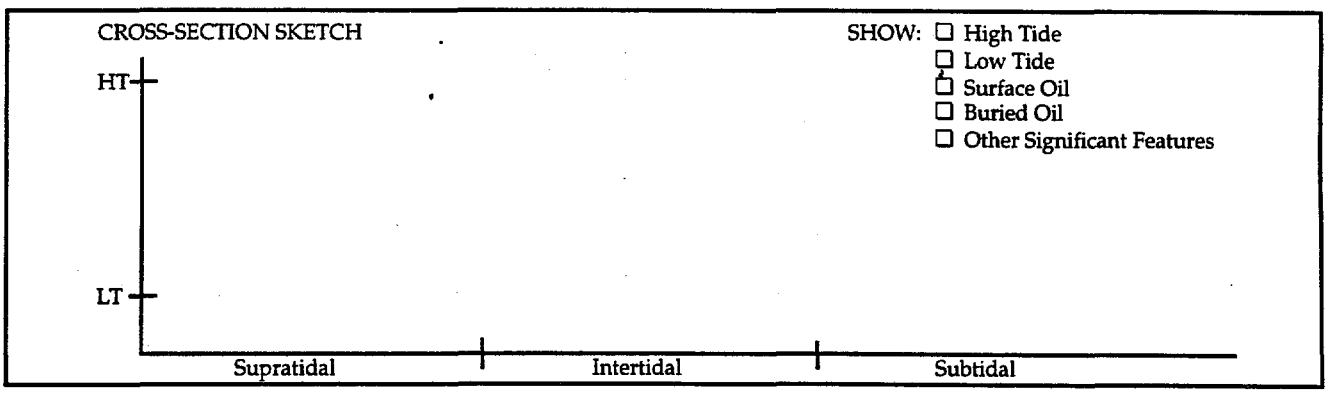
CLEANUP RECOMMENDATION / SPECIFIC CONSTRAINTS

_____

_____

_____

CROSS-SECTION SKETCH



SHOW:
- ☐ High Tide
- ☐ Low Tide
- ☐ Surface Oil
- ☐ Buried Oil
- ☐ Other Significant Features

Field Observer Form for Quick Shoreline Assessment

1.	Shoreline Area Name:	Zone	Division	Date:	Time:
Segment ID or location description:				Tidal Conditions (e.g.: high, falling)	
GPS Coordinates (if available)				Surveyed by: __Foot __Boat __Vehicle __Aircraft	
Team I.D.	Name: for:			Name: for:	

2. Any shoreline impact observed? (circle) Yes No
3. If "Yes", provide approximate length & width of impact. Length _____ Width _____
4. Was oil observed in the nearby water? (circle) Yes No
If 2 and 4 are "No," **STOP HERE.**

5. Impacted Shoretypes & Materials	Check below if Shore-type or Material is Present	TRACE <1%	OIL COVER ESTIMATION CHART SPORADIC 1%-10% · PATCHY 11-50% · BROKEN 51-90% · CONTINUOUS 91-100% 1% 10% 20% 30% 40% 60% 70% 80% 91%			
marsh/swamp						
tidal flat						
riprap						
sand or shell beach						
clay bluff						
dune						
bulkhead, manmade structures						
debris (trash, driftwood, etc.)						
other vegetation						

6. Oil Condition Check oil types present __Fresh Oil __Mousse __Tarballs (<10cm) __Tarpatties (>10cm) __Tar __Asphalt

7. Oiled Wildlife Check any observed impacted wildlife __birds __fish __invertebrates (crabs, etc.) __other?

3. Access Restrictions:

). Cleanup Recommendations & Other Comments (make flagging notes here):

Caution: presence of marsh or tidal flat requires visit by SCAT prior to undertaking any cleanup action.

SKETCH MAP

Site Name _____

Site No. _____

Date _____

Time _____

Names _____

_____

Checklist

____ North Arrow
____ Scale
____ Oil Distribution
____ High Tide Line
____ Low Tide Line
____ Substrate Types
____ Trench Locations

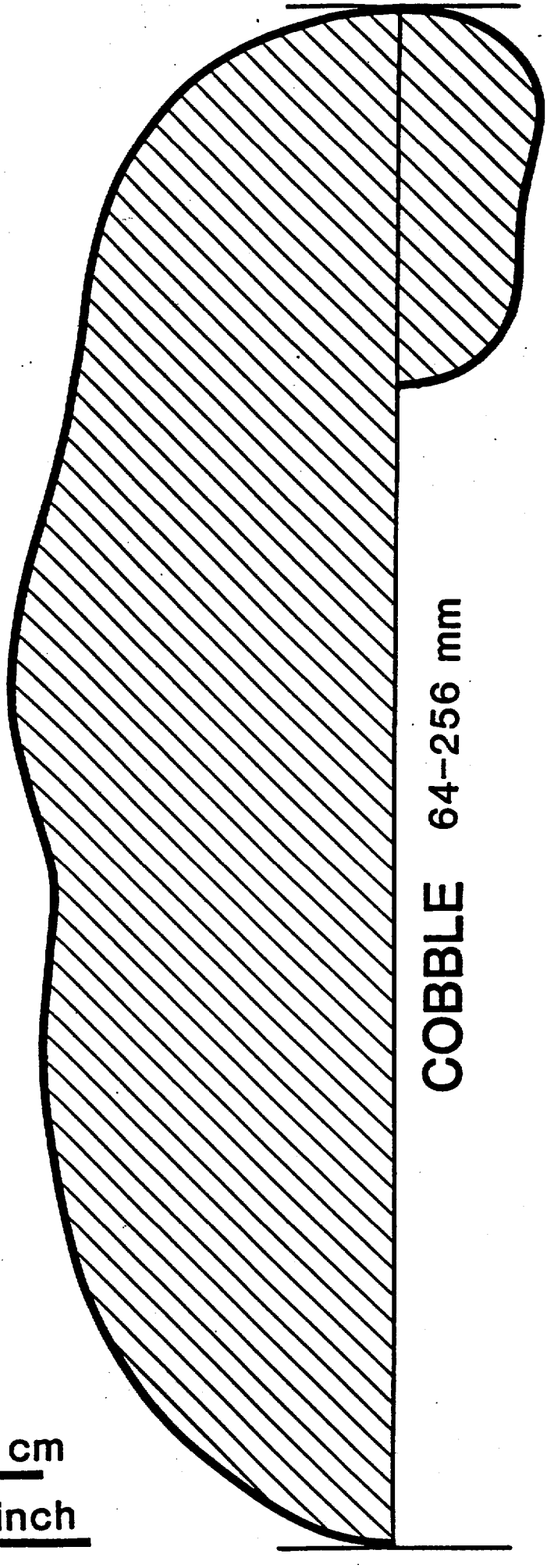
Legend

1△
Trench Number.
No Subsurface Oil

2▲
Trench Number.
Subsurface Oil

#●→
#●
Photographs

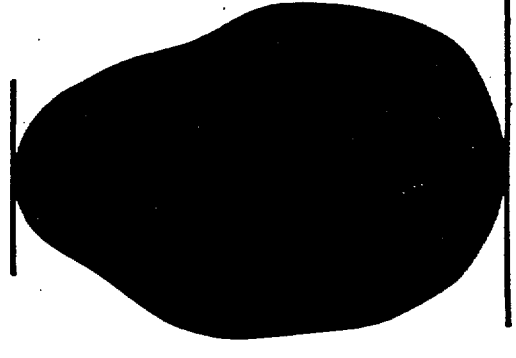
GRAIN SIZE
(After Wentworth, 1922)



SAND <2 mm

GRANULE
2–4 mm

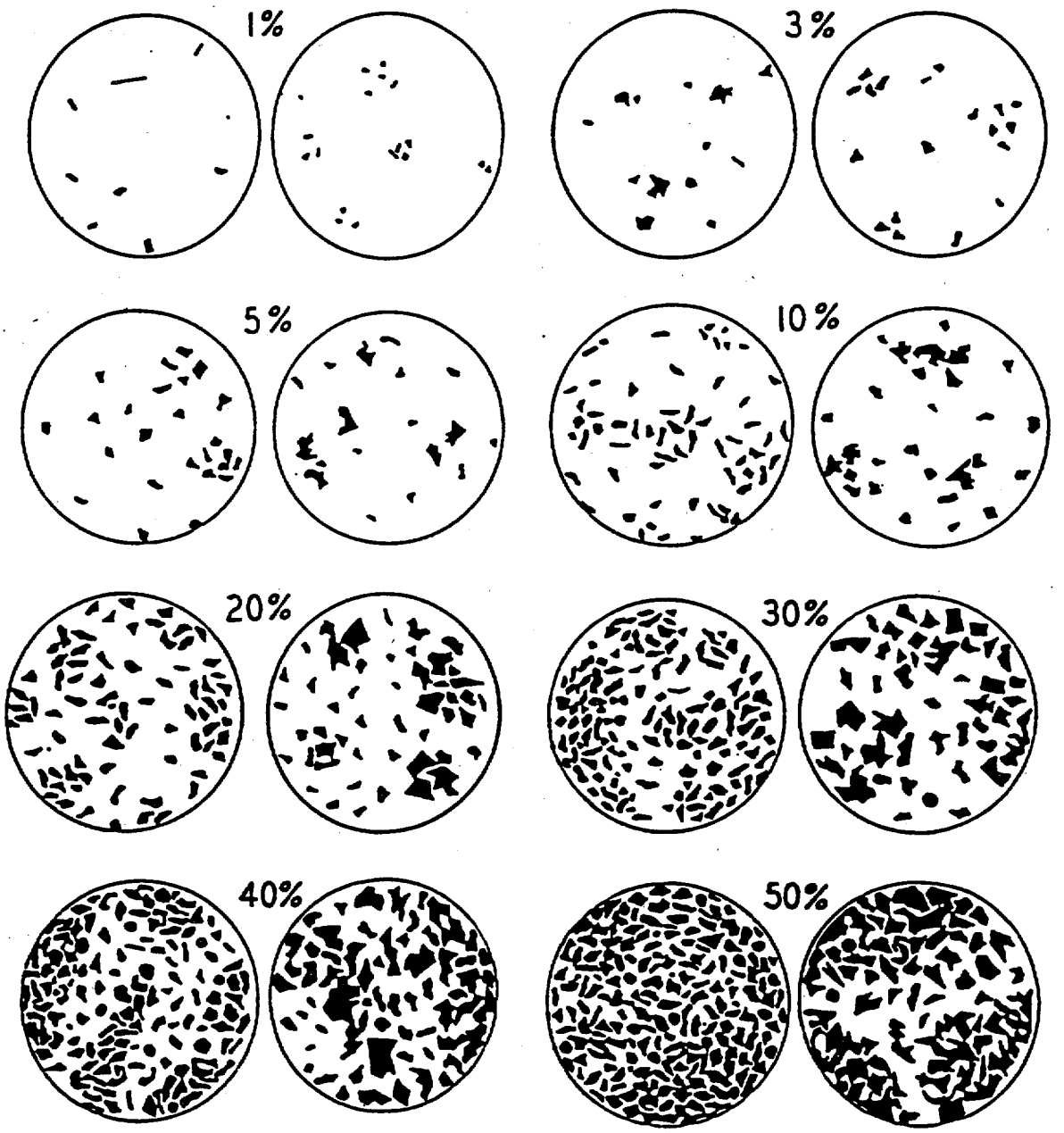
PEBBLE
4–64 mm



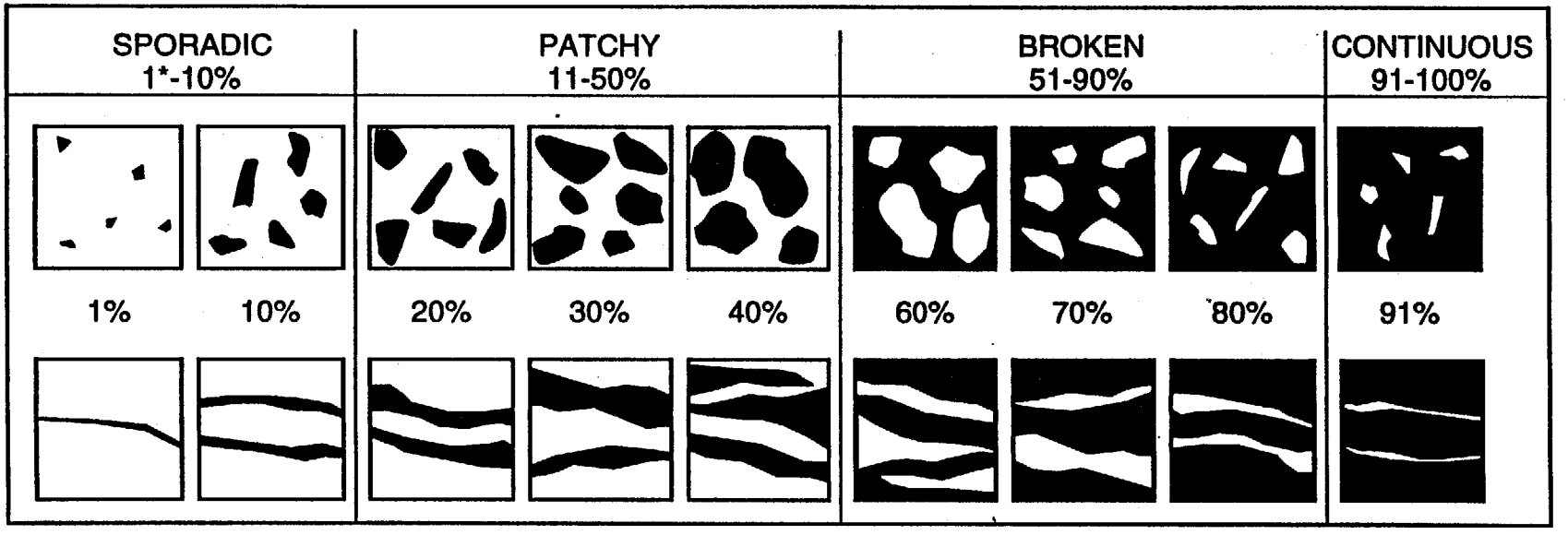
BOULDER >256 mm

Grain Scales: cont.

Comparison Chart For Visual Percentage Estimation (After Terry and Chilingar, 1955).



OIL COVER ESTIMATION CHART



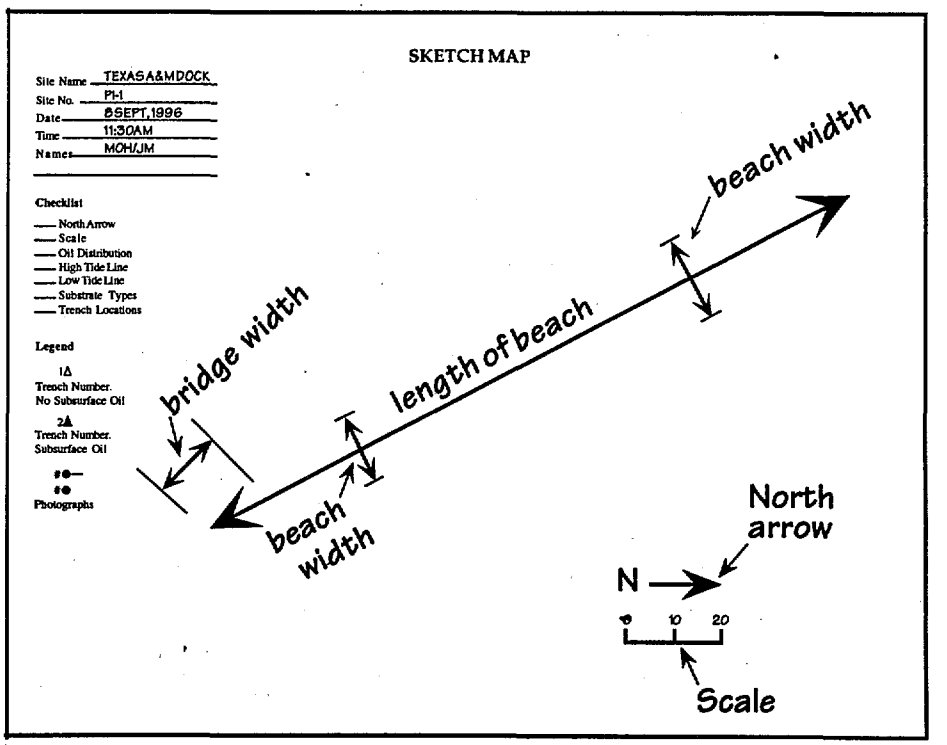
*TRACE = <1%

Appendix D: A Primer on Drawing Field Sketches

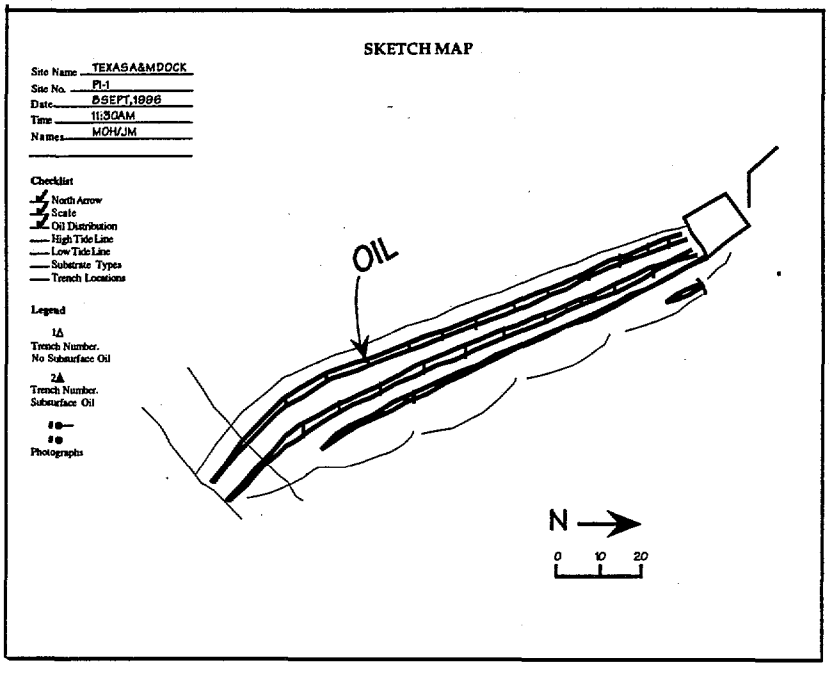
The field sketch is an important component of the SCAT process for two principal reasons: (1) it provides a focused picture of the oil distribution within the entire segment, or subsegment, on a single piece of paper (or image); and (2) it adds discipline to the field observation process, because it forces the person doing the sketch to make detailed mental notes of all the relevant features.

Step 1 Once you arrive at the segment, imagine yourself held aloft 200 feet by a balloon as you quickly walk around the entire segment. This will give you the mental overview of the spatial distribution of all the relevant features in the segment that should be included in the sketch.

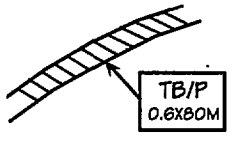
Step 2 Determine the dimensions of the segment and dig trenches to look for subsurface oil. Divide duties among the team members (e.g., one to sketch, one or two to pace or tape distances). Pace (or tape) the length and width of the intertidal zone and the size of some of the more conspicuous features, such as groins or seawall segments. Using a pencil, lightly sketch these measurements on the field sheet, as shown below. Orient the longest dimension along the long axis of the paper. Add scale and north arrow (use English or metric units, as dictated by the situation).



Step 3 Lightly sketch in the outline of the intertidal zone or habitat being surveyed. Show in final form (i.e., heavy pencil marks) the areal distribution of the oil, using a hatched pattern. The oil distribution should be the most conspicuous feature on the sketch.



Step 4 Identify critical elements of the sketch, using the following symbology:



— This oiled zone has tarballs in a patchy distribution. It averages 0.6m in width and is 80 m long. All oiled zones should be labeled in this fashion, using the standard codes and terminology.

1 Δ — Trench with no subsurface oil

2 ▲ — Trench with subsurface oil

#● — Location of photographs taken.
#● Arrow points in direction photographer was looking. No associated arrow means a ground photograph (sediment surface or trench). Frame number next to the dot.

Step 5 Fill in the rest of the details of the sketch, showing highlights of the morphology (e.g., beach berms, tidal channels); conspicuous features, such as fences, large logs, and seawalls that would help identify the site; zones of vegetation; and access points, such as roads and parking areas.

Step 6 (Optional) Where appropriate, draw a topographic cross-chapter of the intertidal zone, showing significant topographic breaks (e.g., beach berm crests) and oiled zones.

Step 7 Make sure form is completely filled in with site location, date and time of survey, and names of survey team members. Review checklist on left side of form.

Figure D-1 is an example of a completed beach sketch. Figure D-2 is an example of a field sketch map for a detailed survey of subsurface oil at the *Exxon Valdez* spill site. The exact location of the subsurface oil was surveyed in and identified with permanent markers (i.e., stakes just above high-tide line), because of the expense of removing the overburden.

SKETCH MAP

Site Name Texas A&M Dock
Site No. PI-1
Date 8 Sept, 1996
Time 11:30 am
Names MOH/JM

Checklist

- X North Arrow
- X Scale
- X Oil Distribution
- X High Tide Line
- X Low Tide Line
- X Substrate Types
- X Trench Locations

Legend

1Δ
Trench Number.
No Subsurface Oil

2▲
Trench Number.
Subsurface Oil

#●→
#●
Photographs

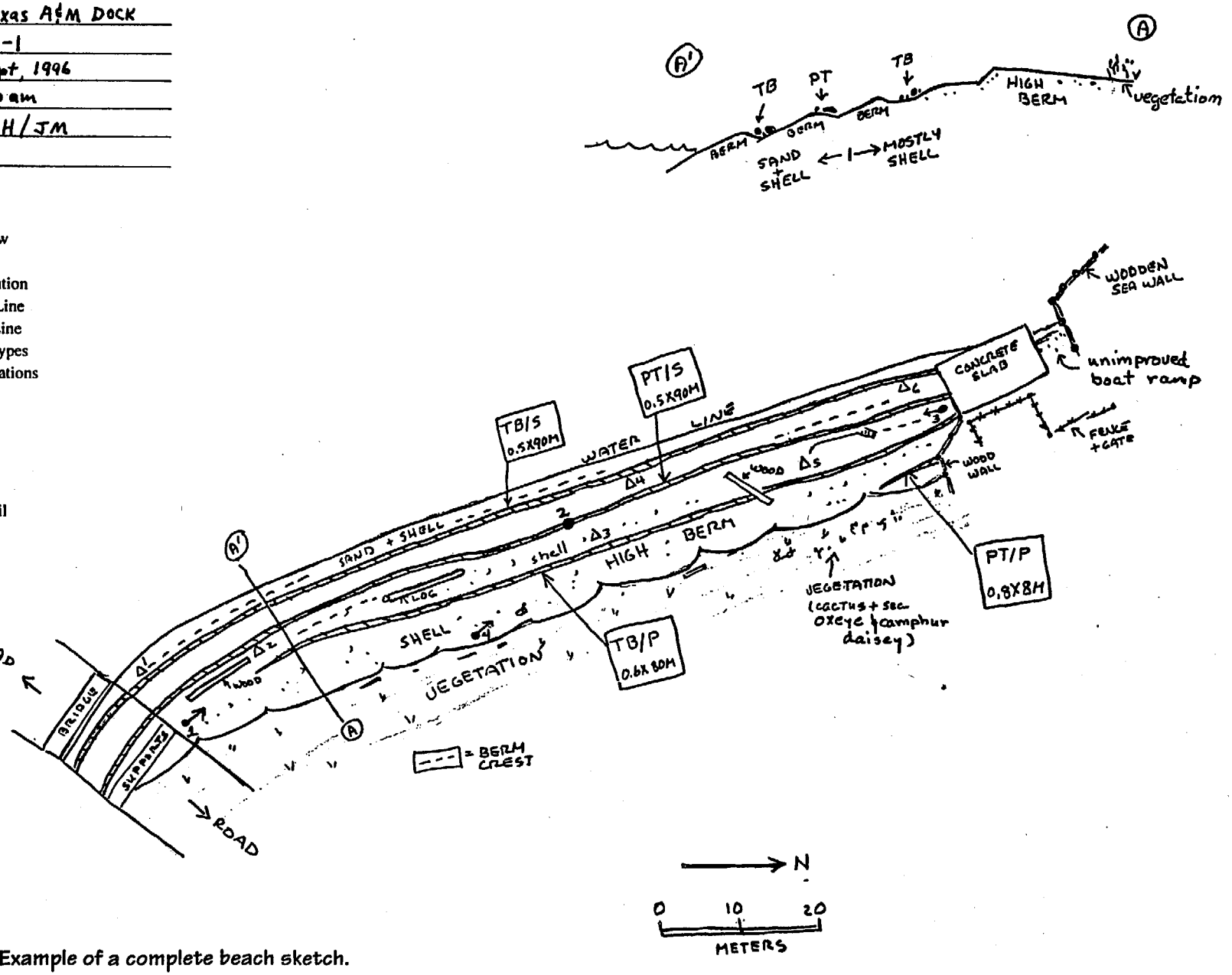


Figure D-1. Example of a complete beach sketch.

SKETCH MAP

Site Name Point Helen, PWS, AK
Site No. KN-405A (near NOAA's sta N-1)
Date 4 June 1991
Time
Names T. Kelly (Exxon); M. Crammer; B. Trimm (Exxon); M. Hayes (NOAA)

Checklist

- X North Arrow
- X Scale
- X Oil Distribution
- ___ High Tide Line
- ___ Low Tide Line
- ___ Substrate Types
- X Trench Locations

Legend

1Δ
Trench Number.
No Subsurface Oil

2▲
Trench Number.
Subsurface Oil

#●→
#●
Photographs

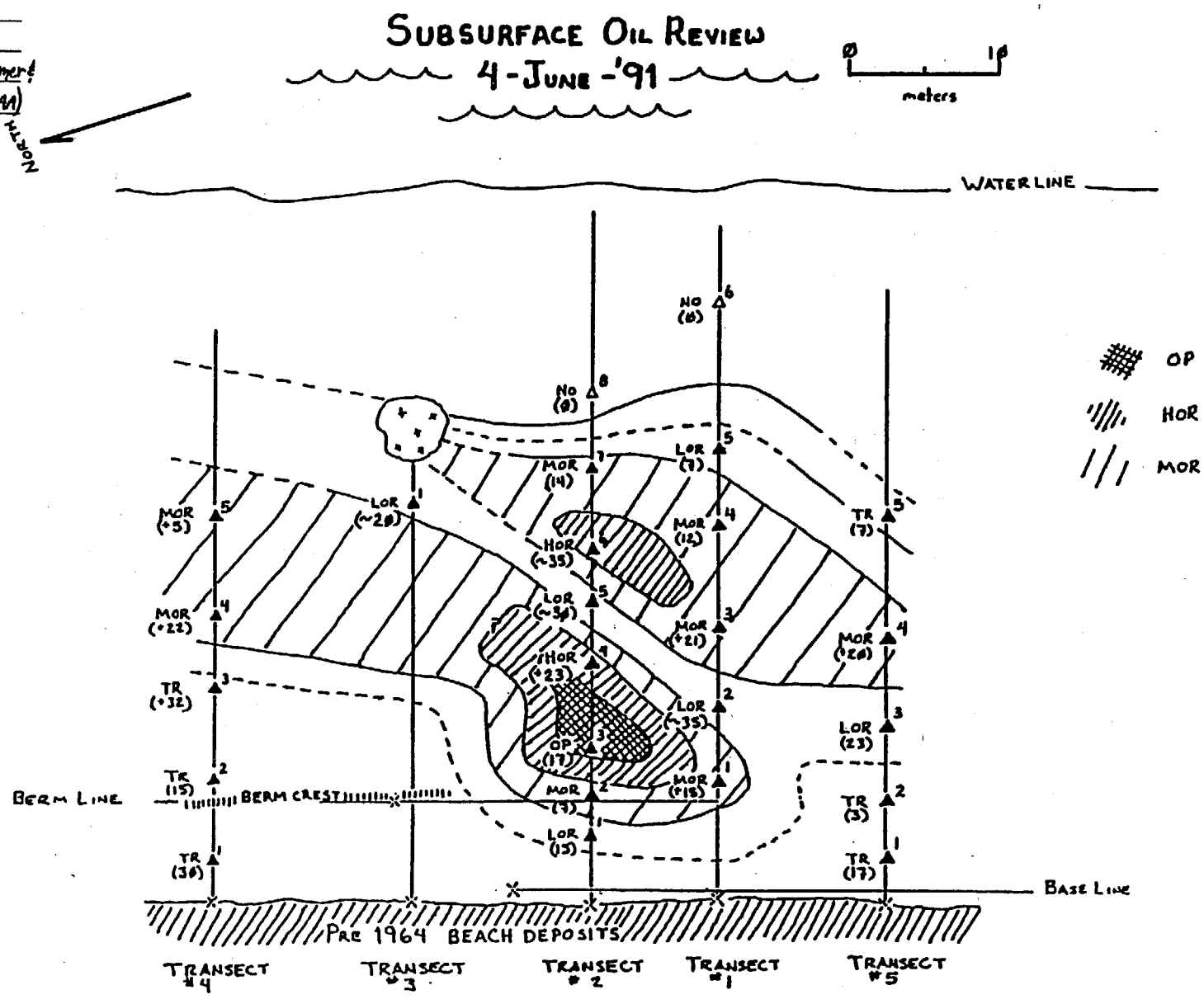


Figure D-2. Example of a field sketch map for subsurface oil survey at *Exxon Valdez*.