

# TAP II™ 1.1

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*Office of Response & Restoration*

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# Chapter 1 Introduction

The Trajectory Analysis Planner (TAP II™) uses an innovative approach to give oil spill contingency planners accurate answers quickly. TAP II answers the crucial question in any Area Contingency Plan: *How do I develop a plan that protects my area against likely spills?*

How does TAP II do it?

With a few mouse clicks, you can see the probability that any oil spill will reach a specific segment of shoreline. TAP II analyzes statistics from potential spill trajectories generated by the oil spill trajectory model. The spill model predicts how an oil spill will spread and move within a local area. The model incorporates:

- the bathymetry and shoreline configuration of a particular body of water, including its channels, bays, and significant rivers;
- currents and winds; and
- shoreline characteristics that determine beaching and refloating of oil.

Then for each season, the model generates 500 individual oil spill trajectories from each of about 300 potential spill locations. The model then accumulates statistics for where, when, and how much oil impacts receptor sites, into data files for TAP II.

TAP gives you detailed maps

TAP II displays a map of a specific local area, including a major water body and the adjacent land. The map displays shoreline segments that represent the locations of shoreline resources such as seabird colonies or marine mammal hauling grounds, sites of particular socioeconomic value such as tourist beaches or large marinas, or areas where remediation measures would be difficult or expensive. You can use TAP II to evaluate the probable threat to any of these sites from an oil spill that originates at any point within the mapped water body.

## About This Manual

This manual is divided into five principal sections:

### 1 Introduction

This chapter briefly describes TAP II.

### 2 TAP II modes

This chapter describes each of TAP II's five modes:

*Shoreline Impact Analysis*, where you can learn the percentage of spills that could reach areas of concern;

*Site Oiling Analysis* shows you the amount of oil that could reach areas of concern;

*Response Time Analysis* shows you how far a specific percentage of an oil spill could travel over time;

*Shoreline Resource Analysis* lets you determine the probable cost to specific resources from a spill; and

*Threat Zone Analysis* shows you where the oil could come from.

### 3 Using TAP II for contingency planning

This chapter explains strategies for using TAP II modes to create and revise vessel and fixed-site area contingency plans.

### 4 Frequently asked questions

This chapter answers questions ranging from best uses for TAP II to uses for which TAP II is not suited.

### 5 Oil spill terms in TAP II

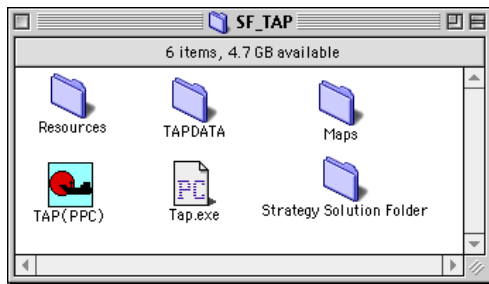
This chapter explains nomenclature in TAP II, including oil industry terminology.

## Installing TAP II

TAP II files are on two CDs. One CD (Region CD) contains the TAP II application and data for your region and the other CD (Tutorial) contains a tutorial and manual for TAP II. It is recommended that you go through the manual and the corresponding tutorial so that you can fully understand the capabilities and limitations of this application.

- 1 Copy TAP II's files from the **Region** CD to a folder on your hard drive. You should have at least 1 GB of memory available on your hard drive to accommodate TAP II and its corresponding folders and files.
- 2 Keep the TAP II application and the TAPDATA folder in the same directory.
- 3 Don't place the application file in the TAPDATA folder or place the application or TAPDATA folder in different locations.
- 4 Don't retile any file or folder name, or modify any data files.

The folder on your hard drive should contain the following files and folders:



**Maps (folder):** This folder contains one or more maps of the TAP II region including the receptor sites and their corresponding numbers. These files are in .pdf file format so you can open them on either a Macintosh or PC.

**Resources (folder):**

ESI\_bio\_data.SF.MHR  
ESI\_shore\_data.SF.MHR

These data were extracted from the Environmental Sensitivity Index. Bio and shore stand for biology data and shoreline data, respectively. SF is the abbreviation for San Francisco Bay. This could be SD for San Diego or KB for Kaneohe Bay, for example. The .MHR is the format for all resource files.

You can create other .MHR files using the Resource Manager (these files could contain booming strategies, number of skimmers, number of people, etc.)

**Strategy Solution Folder (folder):** This folder contains a stand-alone copy of a FileMaker Pro 4.0, Resource Manager (both the Macintosh and PC versions are in this folder). This application allows you to create or modify existing strategies for a particular TAP II region.

**TAP(PPC)** (Macintosh Application)  
**Tap.exe** (PC Application)

**TAPDATA (folder):** This folder contains season folders, text files and a base map file that support the operation of TAP II in a particular region. The following are a description of these folders and files:

**DAGINFO.TXT (text file):** This file is used for the shoreline interpolation scheme used in TAP II and for the interpolation between the various start sites throughout a region.

**SE.BNA (text file):** This is the base map file in .bna format that is used for a specific region. In this case, it is SF for San Francisco Bay.

**SITE.TXT (text file):** This file contains the global defaults used for each specific region. This file also contains the receptor site and start site information.

## System Requirements

Requirements	Macintosh	Windows
Operating System	System 8.1 or higher (Power PC)	Windows 95, NT, or 98 Pentium CPU running at least 200 MH
Hard Drive Space	1 GB	1 GB (recommended)
RAM	40 MB	40 MB
Color Monitor	Yes	Yes
Monitors Control Panel/ Thousands or Millions of colors		Display Control Panel/ Settings High Color (16-bit) or True Color (32-bit)

### **SUMMER (folder)**

**WINTER (folder):** Depending on the statistical correlation of the wind data, a TAP II region could have 1,2,3,4 or more "seasons." In our San Francisco Bay example, there are only two statistically correlated seasons.

The TAP II User's Manual is in a portable document format (PDF) file that allows you to print the manual yourself.

### How to Use PDF Files

To use PDF files, you first must download and install Adobe Acrobat Reader, a free application you can use to view or print PDF files.

Download a copy of Acrobat Reader for your computer system (Macintosh, UNIX, or Windows) using any Internet browser. You will see step-by-step instructions for installing the program. You can download a free copy of Adobe Acrobat Reader: at <http://www.adobe.com/products/acrobat/readstep.html>

When you click on the TAP II User's Manual (a PDF file), Acrobat Reader will automatically open and display the first page of the file. Use the scroll bar or hand tool to view other pages in the file. To print the file, choose Print from Acrobat Reader's File menu.

### Why PDF files?

It can be difficult to share documents created in a particular software application on a particular kind of computer with people who don't have copies of that software or who are using another kind of computer. But when a document is made into a PDF file, people using Macintosh, UNIX, Windows PC, or other computers can view or print that document, even if they don't have the software used to create it. Because PDF files are so portable, they are quickly becoming popular with Internet users.



# Chapter 2 TAP II Modes

TAP II is organized into five modes to help you answer questions to refine your plan.

Which shoreline locations have the highest probability of impact? How big is the area that may be affected?	<i>Shoreline Impact Analysis</i>
How quickly do I need to respond?	<i>Response Time Analysis</i>
How much oil can impact a shoreline location?	<i>Site Oiling Analysis</i>
Which resources will be oiled? Which assets will be affected?	<i>Resource Analysis</i>
Where could the oil come from?	<i>Threat Zone Analysis</i>

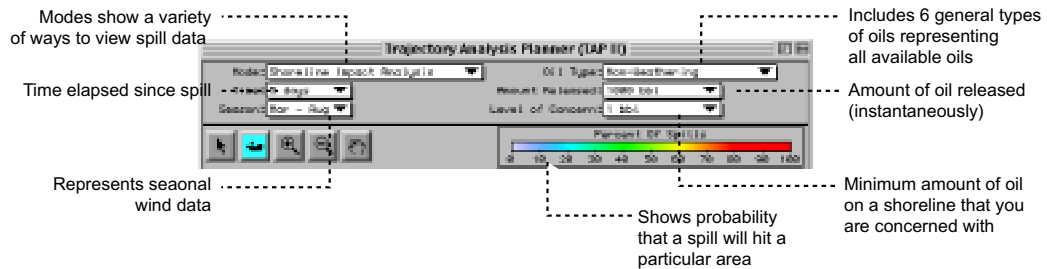
Depending on the mode, you can specify

- Season
- Product type spilled
- Level of concern (minimum amount of oil that you want to reach a particular receptor site before the spilled product becomes a concern)
- Threat time period (time interval that begins as soon as a spill starts and lasts as long as you specify)

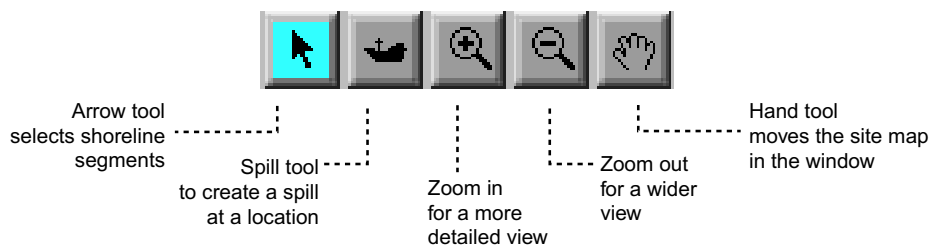
## Getting Started

Start TAP by double-clicking the program icon. Click on TAP II's initial screen to proceed to the main screen. TAP's main screen includes three components: a menu bar, a toolbar, and a map window. TAP II displays the map of your local area in the window. On the map, the coastline is represented by separate segments called receptor sites.

### TAP II Menubar



### TAP II Tools



# 1 Shoreline Impact Analysis: Which Areas Could Be Hit? Prioritizing for Protection

In Shoreline Impact Analysis, you view the percentage of spills (represented by color or gray scales) from the spill site that could reach your receptor sites. Each receptor site is color-coded to represent the percentage of modeled spills originating at that site that were above the level of concern (LOC, the minimum amount of oil you want to reach a particular receptor site before the spilled product becomes a concern).

Below, we'll use TAP II and a map of San Francisco Bay to determine how the shoreline receptor sites will be affected from a spill incident anywhere in the water.



## Tutorial: Shoreline Impacts from a Diesel Spill

In the following example you will set up a scenario for a 100,000-gallon diesel spill with a 100-gallon level of concern at each receptor site during a three-day spill in summer.

- 1 Select Mode > Shoreline Impact Analysis.

Mode:

- 2 Select Time > 3 days and Season > Mar - Aug.

Season:

Time:

- 3 Select Oil Type > Diesel.

Oil Type:

- 4 Choose Amount Released > Set Amount Released.
- 5 Type in 100000 and choose gallons from the popup menu. Click OK.

Amount Released:

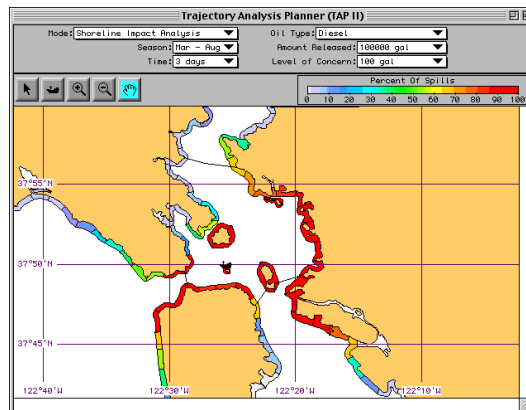
- 6 Choose Level of Concern > Set Level of Concern > 100 gallons.

Now you set a spill location.

- 7 In the toolbar, select the ship tool by clicking on the ship tool icon.

Click on the location of your spill site.

You may have to use the zoom in tool to accurately select the site. The main window should look something like this.



In a matter of a few quick steps, you can see which shoreline areas are impacted by a 100,000-gallon incident with each receptor site receiving 100 gallons or more of the spill product. The red areas indicate shoreline receptor sites that have been impacted by 80-90 percent of the statistical spills. The yellow-to-orange, 60-70 percent, and so on. The color bar in the upper right of the map window links the site color with the percent of spills.

This does not represent the amount of oil reaching the receptor sites, but rather gives you an idea of which areas are likely to be oiled.



For more precise numbers, move the mouse along the receptor sites. In the lower left corner of your computer screen TAP II gives you a running commentary of the percentage of sites that exceed your level of concern.



For more experience...

- Experiment with different types of oils (e.g., gasoline, medium crude, fuel oil #6) in the oil type pop up menu. (See the time series comparison of gasoline and Fuel Oil #6 below.)
- Notice the great difference between gasoline, a light product, with a high rate of evaporation, and fuel oil #6, a heavy product with greater persistence under most environmental conditions. Also, modify the time by clicking on the time pop up menu in the toolbar.
- Choose 1 day, 3 days, and 5 days.
- Experiment with changing the amount released, season, and level of concern.
- If the ship tool is highlighted, you can change the location of the ship by either clicking

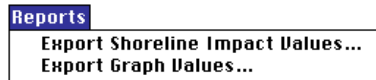
anywhere in the water or clicking directly on the ship and dragging it some where else.

- Change the location of the ship and see the difference in shoreline impacts.

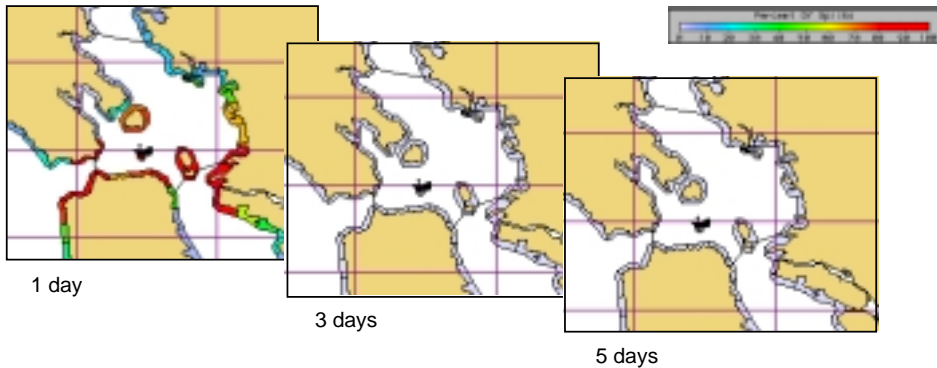
### Exporting the data:

You can also write out a file containing each resource site number and the percentage of the 500 modeled spills that exceeded the Level of Concern at that site. You can export this information to a spreadsheet where you can create customized charts and tables.

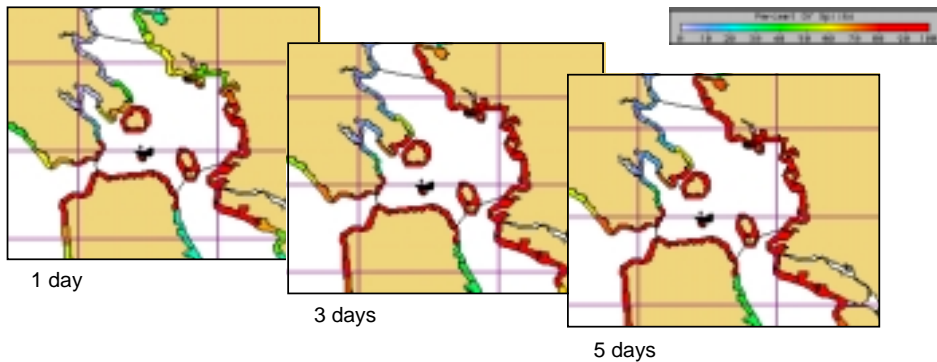
1 Choose Reports > Export Shoreline Impact Values...



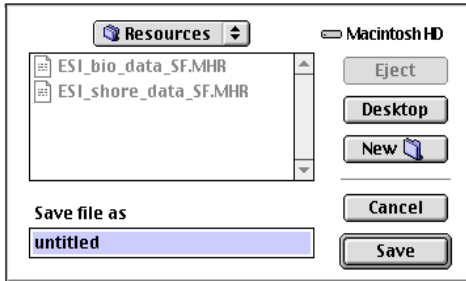
Gasoline



Fuel Oil #6



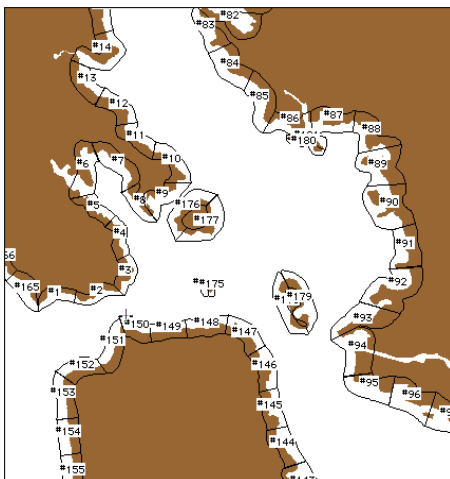
A dialog box like this appears.



- For this example, type in "North Alcatraz Shoreline Data" and click Save.

The file that is saved is a standard ASCII, tab-delimited text file. This file lists location, mode, time, season, oil type, amount released, level of concern, latitude and longitude of spill site, and the individual receptor sites with the percentage of spills exceeding the level of concern at each site. You'll be able to open this file with any word-processing, text editor, or spreadsheet program.

The data in the file are sorted by receptor site number. If you need to correlate these receptor site numbers to specific areas on the map, then you must look at the pdf map file on your CD. The map file for San Francisco looks like this:



The data should appear as follows:

```
TAP II Shoreline Impact File
Location: SAN FRANCISCO BAY
Mode: Shoreline Impact Analysis
Time: 3 days
Season: Mar - Aug
Oil Type: Diesel
Amount Released: 100000 gal
Level of Concern: 10 gal
SPILL:      37° 49' 55"N
            122° 25' 36"W
```

Site	% spills exceeding the LOC
#1	72
#2	97
#3	98
	.
	.
	.
#176	96
#177	98
#178	100
#179	99
#180	98
#181	95
#182	< 0.1
#183	< 0.1
#184	< 0.1
#185	< 0.1

From this table you can see that 98 percent of the 500 statistical spills reach receptor site #177. From the map you can see that this receptor site is located on the south shore of Angel Island.

## 2 Site Oiling Analysis: How Much Oil Might Hit

Shoreline Impact Analysis showed you which areas were likely to be oiled. Site Oiling Analysis provides a way for you to visualize how much oil these areas could be hit with. You select a spill site and a receptor site (the area you are planning to protect) to see a graph of the percentage of modeled spills that resulted in more than a given amount of oil impacting a site at a specific time that you specify.

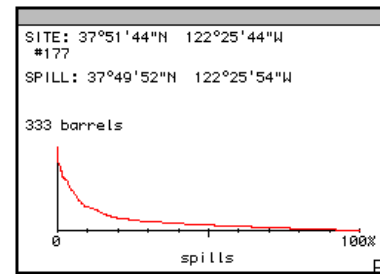
### Tutorial: How Much Oil is left On Day 5 of an Oil Spill?

In the following example, you will set up a scenario to find out how much of a 1,000-barrel spill of Fuel Oil No. 6 in Mar - Aug could reach your area by the fifth day after the spill.

- 1 Choose Mode > Site Oiling Analysis.
- 2 Choose Time > 5 days and Season > Mar - Aug
- 3 Choose Oil Type > Fuel Oil #6 and Amount Released > 1000 barrels.
- 4 Click on the ship tool and locate the spill site. The ship tool changes to the arrow tool. This tells you to use the arrow cursor to select any specific receptor site. As before, you might have to use the zoom in tool, to better make this selection.
- 5 Now, with the cursor, select a receptor site. The spill area in the map window will look something like this.



A small graph window in the main map window appears:



The graph window has the latitude and longitude of the site location, the number of the site (which in this example is 177) and the latitude and longitude of the spill incident.

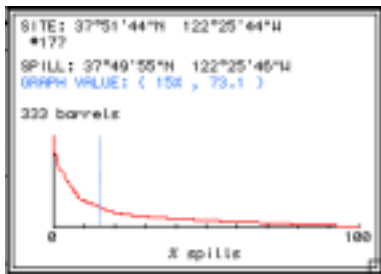
The graph displays the spills reaching that receptor site in descending order according to the amount of oil brought to the site. Each point on the x-axis represents the percentage of modeled spills that brought more than a given amount of oil to that receptor site. The highest value is displayed above the y-axis is the largest amount of oil brought to that site by any of the modeled spills.

For this example, at day 5 in Mar - Aug of a 1000-barrel spill of Fuel Oil No. 6, the worst spill to arrive has resulted in 333 barrels, or nearly 14,000 gallons, of oil reaching the beach. The zero at that point on the x-axis means that 0% of spills brought more than 333 barrels of oil to that site.

Note that this is the largest amount of oil that was brought to the beach by any of the simulations used to create the TAP II data set. It may not be the largest amount of oil that could possibly be brought to that site by a spill in the future. While the TAP II dataset includes a large number of simulations that well represent the range of possible trajectories, it is based on a finite oceanographic and meteorologic record, and could miss some extreme events.

To precisely read the values on the graph:

Notice a vertical, dotted line on the graph? You can drag this meter with the mouse to see the precise values on the graph. You can also click anywhere on the graph to see precise percentage and unit measures. Finally, you can track these numbers in the lower left of the map window; they'll change as you drag your mouse across the graph.



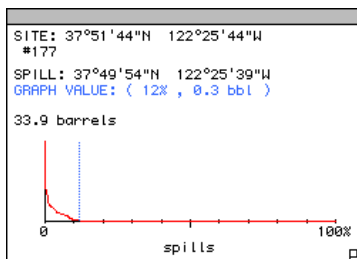
In the example above, 15% of the modeled spills brought more than 73.1 barrels to that site. This means that 85% of the spills brought substantially less than the largest spill discussed above.

Experiment with selecting different types of oil to see how each oil type behaves in the environment. For example, diesel fuel spilled on a summer day may have lots of oil at hour 6 but virtually nothing on day 5 because it has all evaporated and dispersed. The answer for crude oil will be very different.

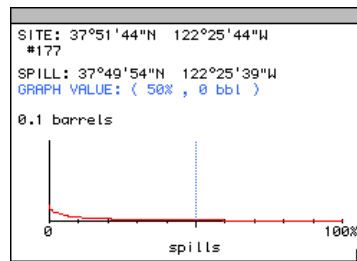
### Tutorial: Gasoline spill

Let's look at how other types of oil are affected by time.

- 1 Experiment further with this mode by clicking on different receptor sites. Looking at the maps below, notice the difference in the percent of spills reaching those areas.
- 2 Modify the time, season, oil type, and amount released and see how the graph changes.



6 Hours



3 Days

- 3 You can move the graph window anywhere within the main map window by dragging the cursor over the graph area, and while using the cursor is a hand, clicking while holding the mouse down.

### 3 Response Time Analysis: When Will it Hit?

TAP II allows the local area planner to determine how long it will take for an oil spill to reach various sensitive areas throughout a planning region.

Let's answer these questions:

*How long will it take for oil spilled on the north shore of Alcatraz Island to reach San Pablo Bay?*

*What is the arrival time of the spilled oil to the east shore of Treasure Island?*

#### Tutorial: A potential spill at Alcatraz Island

For this example, suppose you are planning for a 1,000-barrel spill of Fuel oil #6 released at the north shore of Alcatraz Island between March and August.

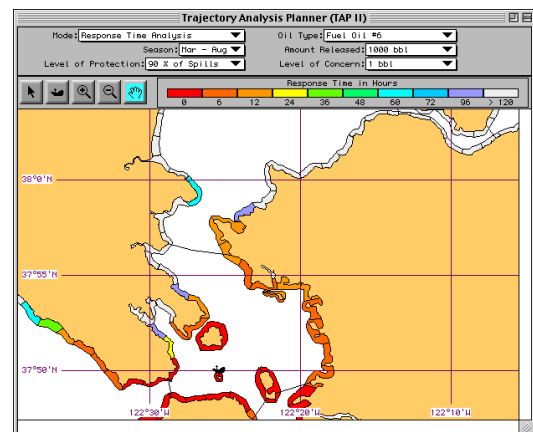
Use these maps for reference:



- 1 Choose Mode > Response Time Analysis.
- 2 Choose Season > Mar-Aug.
- 3 Leave the default Level of Protection at 90% of Spills. This means that, out of the total number of spills, you are preparing to be able to protect each site within the spill region from 90% of the spills that may occur. The time provided by TAP II for each site is the amount of time you have to respond at that site in order to get there before the oil 90% of the time.
- 4 Choose Set Oil Type > Fuel Oil #6 Amount Released > 1000 bbl, and Level of Concern > 1 bbl.

You are considering that one barrel or more of oil would need to impact each site in order for a response to be required.

- 5 From the toolbar, select the ship tool and place the spill location just north of Alcatraz Island. The initial calculations might take a few seconds. The main window appears.



To find out how long it will take the spill to reach your area:

How long would it take the spilled oil to reach the southeast areas of San Pablo Bay?

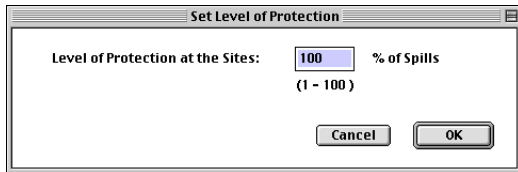
Look at the color bar above the main window. At a level of protection of 90 percent, it would take more than 120 hours (five days) for the oil to reach most of the shoreline in southeast San Pablo Bay. Only the receptor site above Richmond, in

orange, has an arrival time of 12 hours. The purple segment just to the north has an arrival time of 96 hours.

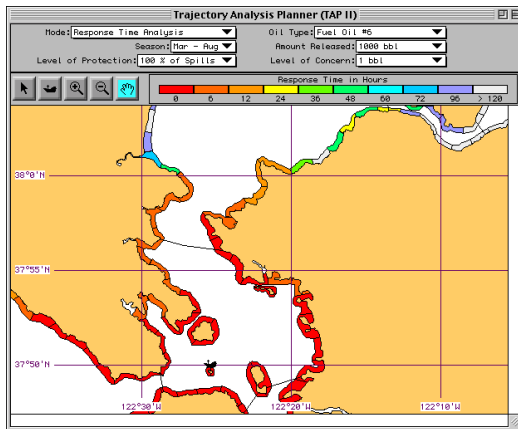
Let's modify the level of protection to 100 percent of the spills to see how the answers change.

- 1 Choose Level of Protection > Set Level of Protection.

You see a dialog box like this:



- 2 Change the 90 to a 100 and click OK. The main window should appear like this:



Notice the difference in the answers. The southeast shoreline of San Pablo Bay has changed: the point above Richmond now has a response time of 6 hours, and the site to the southwest has a response time of 0 hours (see circled area on map). Other sensitive sites have 12-hour, 24-hour, 40-hour to greater than 120-hour response times.

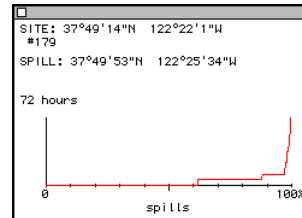
Note: it is up to you to decide whether this extra 10 percent of protection is cost-efficient. Remember that 100 percent means 100 percent of the 500 spill scenarios modeled for the TAP II dataset. It provides a reasonable upper bound for planning, but does not mean 100% of all possible spills. (See the FAQ for more information on TAP II accuracy)

- 3 Now set the Level of Protection back to 90 percent.

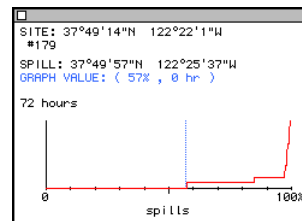
Level of Protection: **90 % of Spills** ▼

Let's answer the second question. How long would it take for oil to arrive on the eastern shoreline of Treasure Island?

- 4 Click on the arrow tool. Click on the eastern shoreline of Treasure Island. A graph appears:

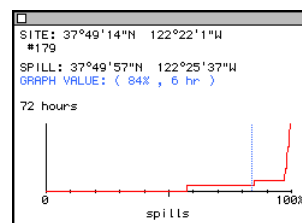


- 5 Click in the graph portion of the graph window to see the information in light blue.



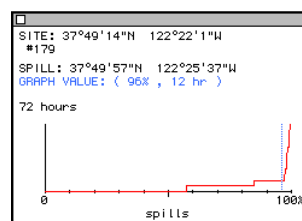
In this case, at a level of protection of 90 percent, 57 percent of the spills reach the eastern shoreline of Treasure Island between 0 and 6 hours.

- 6 Click again at 84 percent.



Between 84 and 58 percent, or 26 percent of the total spills reach the eastern shoreline of Treasure Island in 6 hours.

- 7 Click again at 96 percent.



Between 96 and 84 percent, or 12 percent of the total spills, reach that particular shoreline in 12 hours.

Based on a set level of protection, you can determine the response times over the entire shoreline of a TAP II region. You can also focus on a particular sensitive site to determine the arrival times of various percentages of the total spills. This will help you to decide which areas to protect first.

In order to make the graph window go away, you can either re-click on the receptor site you previously selected or click the small white square in the upper left hand portion of the graph window.

## 4 Resource Analysis: Which Resources are Affected?

In Shoreline Impact Analysis, you saw which shorelines would be hit, and in Site Oiling Analysis, you saw how much oil would be likely to hit them. Resource Analysis provides data on the quantity of a given resource impacted by the modeled spills, or the level of response required to adequately address the impacts of those spills.

You choose a spill site and a resource, and TAP II generates a graph that indicates the total costs of each of the modeled spills in terms of that resource. The values on this graph are the costs of oil impacting each site at greater than its level of concern (LOC), summed over all the sites for which the LOC is exceeded.

The cost of a site could be the number of nesting birds at that location, or the length of boom required to protect the site, or virtually any resource of interest, in any appropriate units. You can provide data about each resource in a standard text file format.

These data include the quantity of each resource associated with each receptor site, and the LOC for that site and resource. The LOC is expressed as the amount of oil that must reach the site for the resource to be considered impacted. These TAP II resource files (MHR files) can be generated by the Resource Manager application, or virtually any spreadsheet or database application. See the Resource Manager documentation for information on the file format. Because the information required is spatial, the locations of the receptor sites are provided and could be entered into a GIS system to generate resource files from virtually any GIS dataset.

Resource Analysis is a powerful tool for response shortfall analysis. Once a response plan for each sensitive location in a bay has been developed, the data from that plan can be entered into a resource data file, indicating, for example, the quantity of boom required to protect each sensitive site.

Because it is unlikely that every location included in a plan would need to be protected at the same time, you can use Resource Analysis to compute the total quantity of boom required to respond to any of the modeled spills in the database. The total costs can be computed for any of a number of different time frames, so that one could know

that one quantity would be needed within 24 hours, and more within three days, allowing time for long-distance transport of the equipment to the site.

While at first glance, Shoreline Impact Analysis and Resource Analysis appear to answer similar questions, they are fundamentally different. Although site A and site B may both be impacted by about 30% of the spills modeled, the two sites are probably not impacted by the *same* 30% of spills. In fact, it's possible that two given sites are never impacted simultaneously, so that you'd never need to protect both of them at the same time. The Resource Analysis mode computes the total cost of each spill individually, so that these two sites would not simultaneously contribute to the total cost.

### Example Resource Data:

For examples of resource data files, NOAA provides files generated from our Environmental Sensitivity Index (ESI) maps. These data include the quantity (meters) of each type of ESI shoreline found in each receptor site. Also included are biological resource types (shrimp, seals, gulls, terns, shorebirds, etc.) from the ESI data. The data indicate which receptor sites are habitats for various types of animals.

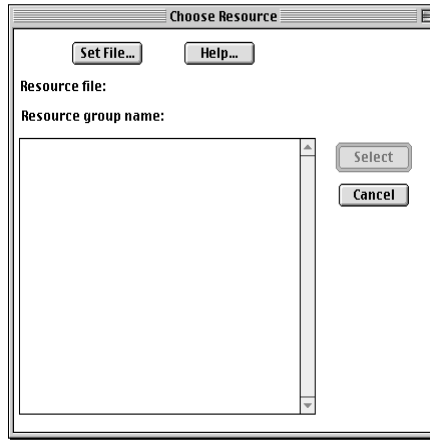
### Tutorial: Cumulative cost to riprap shorelines of an oil spill

Suppose that you want to determine the cumulative "cost" (in this case, meters of beach) of all the riprap beaches in the San Francisco Bay area for a 1,000-barrel spill of Fuel Oil #6 just north of Alcatraz Island five days after the initial release in the summer.

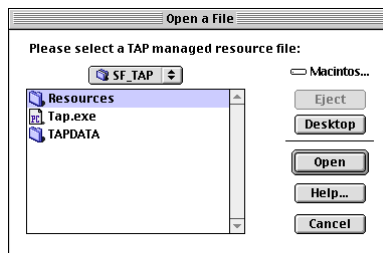
- 1 Select the Resource Analysis mode.
- 2 Select Time > 5 days and Season > Mar-Aug.
- 3 Select Oil Type > Fuel Oil #6 and Amount Released > 1000 barrels.
- 4 Select Resource > Choose Resource...

You see this dialog box.



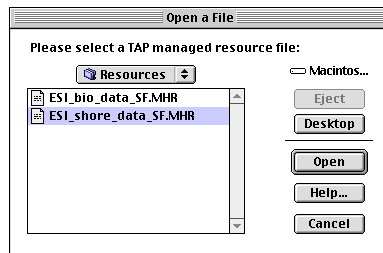


- 5 Click on Set File....
- 6 Open the Resources folder.



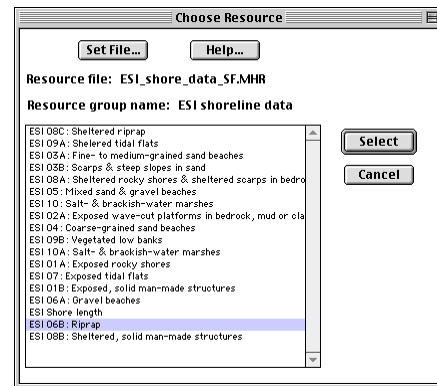
In this example, we've put the resource files in a folder titled "Resources" for easy access.

- 7 Click on ESI\_shore\_data\_SF.MHR. Click OK. You see a list of all the ESI shoreline data for San Francisco.



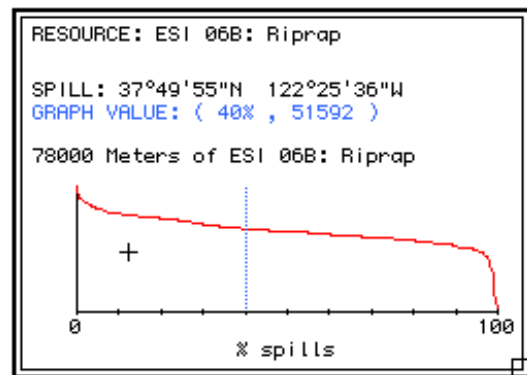
- 8 Double-click on ESI 06B: Riprap.

The graph on the map window now displays the meters of riprap affected by a 1,000-barrel spill of Fuel Oil #6 from March through August after five days from the initial release.



The graph shows in descending order (from worst to least) all the 500 spills and the meters of riprap affected by a 1,000-barrel spill of Fuel Oil #6 from March through August after five days from the initial release.

- 9 Click within the graph window at the 40 percent mark.



Note: the cursor will change to a plus to indicate when you can click and modify the percentage.

The graph itself displays in descending order the spills reaching that receptor site. You'll notice a vertical, dotted line on the graph. This is a meter that you can drag with the mouse to see the precise values on the graph. You can also click anywhere on the graph to see precise percentage and unit measures. Finally, you can track these numbers in the lower left of the map window; they'll change as you drag your mouse across the graph.

Hence, for the Riprap shoreline type at this location, the worst spill of the 500 spills modeled impacted 78,000 meters of riprap beaches. Also, about 40 percent of the spills are going to reach at least 51,592 meters of riprap shoreline. Notice that nearly all the spills at this location will reach a riprap shoreline.

### Exporting the Resource Analysis Data:

You can write out a file containing the data used in generating the graph in the map window. This file can be imported into a spreadsheet and used for other analysis, or to make customized charts and tables.

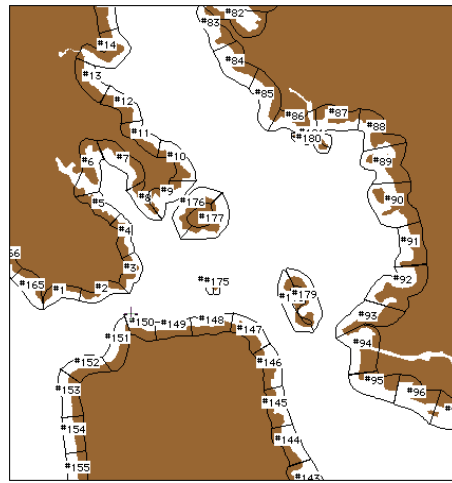
- 1 Choose Reports > Export Graph Values...



- 2 For this example, type in "Riprap Data" and click Save.

Inside your Resources folder there is a tab-delimited text file titled "Riprap Data." You can use any word-processing or spreadsheet application to open up this file. The file contains location, mode, time, season, oil type, amount released, resource type, spill latitude/longitude, graph value, and lists individual receptor sites with the percentage of spills that impacted that shoreline type. The data should appear as follows:

TAP II sorts the data by receptor site number. If you need to correlate these receptor site numbers to specific areas on the map, look at the .pdf map file on your CD. The map file for San Francisco should look like this.



The data should appear as follows:

```
TAP II Analysis Graph Points
File
Location: SAN FRANCISCO BAY
Mode: Resource Analysis
Time: 5 days
Season: Mar - Aug
Oil Type: Fuel Oil #6
Amount Released: 1000 bbl
Resource: ESI 06B: Riprap
RESOURCE: ESI 06B: Riprap
```

```
SPILL: 37° 49' 55"N 122° 25' 36"W
GRAPH VALUE: ( 40% , 51592 )
% spills      Meters of ESI 06B:
Riprap      Spill ID
0.2      77903 14
0.4      73924 271
0.6      71424 123
0.8      70380 93
1        70350 67
1.2      70152 110
1.4      69839 77
.
.
.
99.6     5035 307
99.8     3317 400
100      3053 125
```

In this case, 1% of the 500 hypothetical spills reach 70,350 meters or more of Riprap shoreline. Also, 99.6% of these 500 spills reach 5,035 meters or more of Riprap shoreline. The spill ID is the spill from the 500 statistical spills that created this value.

## 5 Threat Zone Analysis: Where the Oil Could Come From

In Shoreline Impact Analysis, you saw the areas likely to be oiled; in Site Oiling Analysis, you saw how much oil could reach these resources; and in Resource Analysis, you saw which resources (whether bird or boom) could be affected. Threat Zone Analysis helps answer the question: *Where might a spill occur that could threaten a shoreline location of concern?*

To find out, you select a receptor site of interest (perhaps a sensitive wetland), and is provided with a color contour map of the entire bay, indicating the likelihood of oil reaching the selected receptor site from any location in the bay. The map colors correspond to the percentage of modeled spills from each location in the bay from which the movement of oil to the selected receptor site is equal to or exceeds the LOC for that site. By repeating this analysis for a number of different receptor sites, you can better understand the geophysical processes that move oil in the entire area.

Tutorial: Where could oil be spilled so that it would threaten a sensitive site?

Imagine you are responsible for protecting a sensitive shoreline site near a waterway with heavily traveled vessel traffic lanes. You want to know where a spill might originate that would threaten your site.

Your site would require a response if more than 1 barrel of oil were to come ashore within five days of the start of a spill.

Use this map for reference.



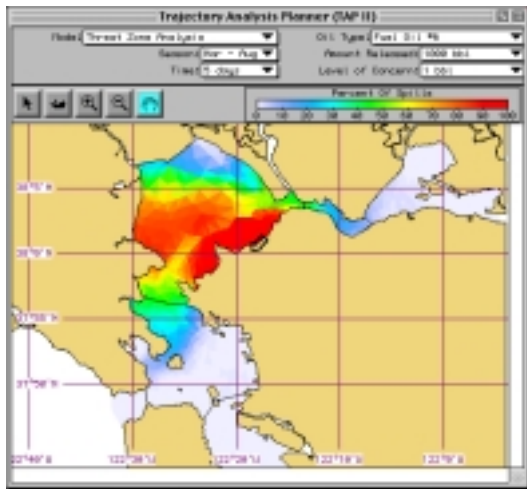
- 1 Select Mode > Threat Zone Analysis.
- 2 Choose Time > 5 Days and Season > Mar-Aug.
- 3 Choose Oil Type > Fuel Oil #6 and Amount Released > 1000 bbl.
- 4 Choose Level Of Concern > 1 bbl.

Before continuing, click on the arrow tool and move the cursor over the map and the receptor sites.

Note, the receptor site number appears in the lower left corner of the map window.

- 5 Choose a receptor site. Move the arrow tool over the receptor sites until you have found site #76. The site number is indicated by the text in the lower left corner of the map window. This is the Pinole Creek Marshes in the southeast region of San Pablo Bay. Click on this site. Depending on the speed of your computer, this drawing process might take a few seconds.

The threat zones in the map window look like this:



The red region indicates that 80 to 100 percent of the spills originating from within that area impacted the selected site with greater than the LOC of oil. The orange region indicates 65 to 75 percent, with the yellow indicating 55-65 percent and so on, according to the color bar on the top right of the map window. Hence, there is a higher probability that a 1000-barrel oil spill of Fuel oil #6 will reach the receptor site at Pinole Creek Marsh up to or exceeding the LOC of 1 barrel in 5 days if the spill occurred in the red region than the yellow region.

To see the exact numbers, move the mouse over the colored region. The values corresponding to the colors are displayed in the lower left corner of the map window.

For more experience:

- To see all of the shoreline receptor sites again, click on the highlighted receptor site with the arrow tool.
- Click near any shoreline segment and a new receptor site will be chosen, and the color contour map redrawn for that location.
- Modify the time, season, amount spilled, type of oil, and LOC to see how the contours change.
- In San Francisco Bay, during the summer, the winds are predominantly from the west. Choose Season > Mar - Aug. Choose a receptor site on the east shore, and then one on the west shore to see how this effects the threat zone of each location.

## 6 To see results for each modeled spill:

You can use the three remaining modes (Shoreline Impact by Spill, Response Time by Spill and Threat Zone by Spill) to view the results of each individual spill, rather than the accumulated statistics of all the modeled spills. Shoreline Impact by Spill, for example, shows you the shoreline impacts for each of the 500 spills at a particular location at a specific time. The difference between each spill is that it was started at a different time, and so was effected by different winds and currents.

Note: You can change the spill by clicking on the Spill Number pop up menu and selecting Set Spill Number... You can also navigate through the 500 spills by holding down the command key on the Macintosh, or the control key on Windows, and clicking the up and down arrow keys on your keyboard.

The Spill numbers given correspond to the numbers in the text file output by the reports menu. You can select the particular spill that caused the greatest impact to a given resource, as calculated by Resource Analysis mode, for example.



## Chapter 3 Using TAP II for Area Contingency Planning

In this chapter, you'll see how TAP II can help you develop and review Area Contingency Plans for fixed sites and vessels, as well as help you review existing plans. TAP II will do this by showing you:

- where oil could go;
- where it could come from;
- how long it could take to get there;
- how much oil could get there; and
- what the cost could be

This information helps you decide where to store equipment, what type of equipment you will need, and how much equipment you will need. You will also be able to develop and review large-scale protection strategies.

### Getting Started:

Whether you're developing a fixed site plan or a vessel plan, you begin at the same place.

- 1 Fill in the default parameters for oil type, amount released, the LOC amount, and the season to analyze.
- 2 Make the amount released the "worst case discharge" that you need to plan for.
- 3 The LOC is the minimum amount of oil impacting a receptor site that you will be concerned with. In selecting this value, consider the type of oil being spilled, the resources that could be impacted, and the size of the receptor site. TAP II will resolve oil mass or volume down to 1/1000 of your spill amount. This means that, if you discharge 10,000,000 gallons, the smallest LOC value TAP II will model is 10,000 gallons ( $10,000,000 / 1,000 = 10,000$ ).

You must select the percentage of spills that your plan will cover. TAP II allows you to see results from all 500 of the hypothetical spills that were modeled; it may not be reasonable to expect a plan to account for every spill that could occur.

## To Build or Review a Fixed Site or Vessel Plan

TAP II is an ideal tool for dealing with a fixed site plan such as a facility or lightering site. It will tell you what you can expect and when to expect it. With this information you can arrive at and review decisions concerning equipment and strategies.

For vessel plans, you can use TAP II in two ways to develop and review your plans. First, you can use TAP II to assess the risk to any sensitive section of shoreline from the traffic lanes by answering the question of where can oil come from to impact a sensitive area.

Second, you can use TAP II to examine spills from any location along the shipping route that has a high risk for accidents such as rocks, reefs, and high-traffic areas.

Where did the oil come from?

For fixed site plans, you know where an oil spill would originate that you are planning for. For vessel plans, you can use Threat Zone Analysis to assess the risk from vessel traffic lanes to any given section of shoreline. By clicking the arrow tool on a shoreline receptor site, you will get a set of contours that will give you an estimate of the probability of oil impacting the site that is spilled at any given location. You can use this information to identify and plan for high-risk zones along the vessel traffic route.

To plan for specific spills along the vessel route: Click the ship icon tool at several locations along the vessel route, making sure that high-risk areas for accidents such as rocks, shoals, and high traffic areas are included. For a fixed site plan, there will be only one spill location to consider.

Answer the following questions for each of the selected spill locations :

Where should equipment be stored?

- 1 Select Mode > Response Time Analysis
- 2 Select Level of Protection > 100%.

This means you will be looking at how long it takes the fastest of all 500 of the modeled spills used in TAP II to impact the receptor sites. This is a starting probability for the

analysis. Remember, this may not be a reasonable value to eventually plan for. You will have to decide after viewing the information. Note that this is 100% of the spills modeled, not 100% of all possible spills. While the 500 spills included span the possible spill space well, it is possible that an extreme event has been missed. (See FAQ #8)

The results show how long you have to respond to any spill before it impacts each of the receptor sites. For example, the areas labeled 24 hours mean that you can expect the first oil to arrive after 24 hours and before the next time period.

Use this information to decide and review where to store response equipment. The equipment should be stored close enough to be deployed within the times shown in order to protect against any spill before it comes ashore.

Now suppose that you don't have enough equipment to protect against all spills as shown. You need to prioritize. This can be done in several ways.

### Prioritizing method 1

- 1 Select the arrow tool.
- 2 Select Level Of Protection > 90%.

This will show you first-arrival times of oil for 90% of the spills instead of all of them. Now you can use this information to decide where to store equipment. This may be a reasonable compromise if you can't afford to protect against all spills. Experiment with different values for Level Of Protection to find the best compromise.

### Prioritizing method 2

- 1 Select Mode > Shoreline Impact Analysis.

This mode will give you a maximum estimate of the probability of finding oil at a receptor site at the time selected. For example, you would like to know where to store equipment to protect against spills that could impact after 6 hours.

- 2 Select Time > 12.

The 6-hour setting would show you where oil will be by hour 6, not after hour 6. The resulting picture will show you the probability of finding oil along any receptor site at hour 12. You pick out the highest probability areas from the Shoreline Impact Analysis that are within your 6-hour response time areas from the Response Time Analysis and prioritize areas to be protected by storing your equipment closest to those areas. By combining the Response Time Analysis with the Shoreline Impact Analysis, you will be able to select the areas that you must protect within the first six hours after a spill because they have the highest probability of being impacted after hour 6.

### What type of equipment should be stored?

The type of equipment that should be stored depends on how much oil you expect to impact the resources, the type and nature of the oil spilled, and the resources that you need to protect. You can use the Response Time Analysis, Site Oiling Analysis, and Resource Analysis modes to help decide what kind of equipment to store.

By selecting the Site Oiling Analysis and clicking along the shoreline receptor segments, you get graphs that display in descending order the spills reaching that receptor site. Each point on the x-axis represents the percentage of modeled spills that brought more than a given amount of oil to that receptor site. The highest value is displayed above the y-axis, and corresponds to the largest amount of oil brought to that site by any of the modeled spills.

The nature of the oil that you need to plan for depends on how weathered the oil will be when it's cleaned up. For example, the equipment needed to deal with light fuels such as gasoline and jet fuel will be very different than what will be needed to deal with emulsified crude oil or weathered tarballs. By the using the Response



Time Analysis mode you can determine how long it will take the oil to impact the resource and by using this information in an oil fate model such as NOAA's ADIOS model, you will get an idea of what type of oil to expect.

The last part of the analysis, the resources that need to be protected, can be determined by using the Resource Analysis mode. This mode will help you decide if you need to store equipment for rocky headlands, marshes, or sandy beaches. This in turn will dictate what type of equipment you will need, and what type of protection and cleanup strategies you need to have in place.

### How much equipment should I store?

The amount of equipment that you store is based on the number of resources to be protected and the amount of oil you can expect to impact them. Use the Resource Analysis and Site Oiling Analysis modes to help you decide and review how much equipment you will need.

Select the Resource Analysis mode to check how much of each type of shoreline will be impacted by any one spill. Similarly to Site Oiling Analysis, Resource analysis presents a graph of how much of the given resource is impacted by each of the modeled spills. Each point on the x-axis represents the percentage of modeled spills that impacted more than that amount of shoreline.

The number above the y-axis indicates how much shoreline was impacted by the one "worst" spill. If you expect to plan for the "worst" spill, you will need enough equipment to protect against this "worst" spill. You need to choose a level to protect against. It may not be reasonable to plan to protect against all possible spills.

Resource Analysis is a powerful tool for response equipment shortfall analysis. Once a response plan for each sensitive location in a bay has been developed, the data from that plan can be entered into a resource data file, indicating, for example, the quantity of boom required to protect each sensitive site (See the Resource Manager documentation for how to do this). Because it is unlikely that every location included in a plan would need protecting at the same time, Resource Analysis can be used to compute the total quantity of boom required to respond to any of the modeled spills in the dataset. The total costs can be computed for any of a number of different time frames, so that one could know that one

quantity would be needed within 24 hours, and more within 3 days, allowing time for long-distance transport of the equipment to the site.

While, at first glance, Shoreline Impact Analysis and Resource Analysis appear to answer similar questions, they are fundamentally different. Although site A and site B may both be impacted by about 30% of the spills modeled, the two sites are probably not impacted by the same 30% of spills. In fact, it's possible that two given sites are never impacted simultaneously, such that protecting both of them simultaneously would never be required. The Resource Analysis mode computes the total cost of each spill individually, so that these two sites would not both contribute to the total cost.

### To see how much oil you can expect at any given time:

Site Oiling Analysis will tell you how much oil you can expect at any given time. This, in turn, will determine how much protection, cleanup, and disposal equipment you should plan for. For example, if the Site Oiling Analysis indicates that a hatchery could be impacted by a large amount of oil, your plan may call for multiple layers of boom to be used to protect the hatchery.

### What type of strategies will be effective?

You can use TAP II to develop and review large-scale protection strategies as part of your ACP. TAP II will show you what to expect and when to expect it. The Shoreline Impact Analysis, Site Oiling Analysis, and Response Analysis modes will help you determine what to expect, and the Response Time Analysis mode will tell you when to expect it.

For example, if a fish hatchery in a bay is threatened, you could develop a strategy to use two layers of boom at the entrance to the bay and several more layers of boom closer in to the fish pens and water intake areas. Another example of a

strategy is to boom the middle of the bay instead of along the shoreline. This could both require less boom and be implemented more quickly.

By entering your strategies (see the separate manual on the Resources Manager) into the Resource files for the Resource Analysis mode you can get an indication of how often your response strategy will be triggered for any given spill source.

**A word of caution.**

TAP II doesn't know how long it will take to implement a strategy or how effective the strategy will be. For example, if you have a strategy to boom off a harbor, TAP II will not know the difference between a spill inside the harbor or one outside the harbor. TAP II will say that the strategy to boom off the harbor will be triggered for both cases even though it will be futile to protect the harbor from a spill inside the harbor by booming the entrance. TAP II will also not tell you whether you have enough time to implement the strategy or whether it's even feasible, given local weather conditions.

## Chapter 4 Frequently Asked Questions (FAQs)

### 1 What do I use TAP II for?

TAP II is a statistical planning tool for oil spills. It analyzes the results from about 100,000 modeled oil spills that could have occurred over a 10 to 15-year period and helps answer the following planning questions:

- Where should equipment be stored?
- How much equipment should be stored?
- What type of equipment should be stored?
- What would be the cost of having a spill?
- What type of protection and cleanup strategies would be effective.

### 2 How is TAP II different from GNOME?

GNOME (General NOAA Oil Modeling Environment) is an oil spill trajectory model that will show you where oil from one particular oil spill will go, given one particular set of oceanographic and meteorologic conditions. TAP II is a program that will take results from about 100,000 individual oil spill trajectories and give you probabilities and statistics of where any oil spill might go.

### 3 How do I use TAP II during an oil spill?

TAP II was not designed for use during an oil spill. However, it will tell you the probability of where oil could go from any spill. If you have no information about a spill except where it occurred, TAP II's Shoreline Impact Analysis will give you the best analysis. However, if you have any details about the spill and the environment (e.g., winds, tides, currents), an oil spill trajectory model such as GNOME will be more helpful to narrow the probabilities of where the oil will go.

### 4 How do I run my worst-case scenario with TAP II?

Instead of giving you the results of The Big One that is unlikely to occur, TAP II allows you to plan for 50%, 75%, or 90% of all possible spills. From any given spill location, TAP II will look at the results from 500 different spills in each season and tell you how quickly oil can get to certain areas, the most oil you can expect, and the cost of the oil impacts.

### 5 Why is TAP II's statistical planning better than "worst case" scenario planning?

With TAP II you can plan for a range of probabilities: 50%, 75%, 90% of all possible spills, instead of planning for a single scenario that is unlikely to occur or may occur only very rarely. There are two reasons why planning for a "worst case" scenario is an ineffective approach.

First, it is very difficult to select a worst case. For example, the worst case oil spill for hotel owners will be different than a worst case scenario for the birds. A worst case scenario for nesting birds will be different than a worst case scenario for rafting birds. A worst case scenario for spawning fish will be different than a worst case scenario for human health issues. There is no single worst case scenario.

Second, there are very small odds that a spill will unfold like a predetermined worst case scenario. If you plan for a worst case scenario, you will be planning for something that will probably never happen.

It is a false assumption that, if you can deal with a worst case scenario, you can deal with any spill. For example, suppose you pick a worst case scenario that moves oil to the west and impacts an endangered species. You plan for that by storing your protection equipment to the west, near the endangered species habitat. Now what happens when a spill moves oil to the east? Can you move all the protection equipment to the eastern shore in time to protect a harbor or tourist beach?

### 6 Can I get TAP II for other areas of the world?

Not easily. We have a priority list of U.S. ports for which we will do TAP II. There are no foreign ports on the list yet. If you have a port that you wish added to the list, let us know via email at [tap@hazmat.noaa.gov](mailto:tap@hazmat.noaa.gov). It takes us about three to four months to complete an area. In the future we hope to reduce that time to about one month depending upon the availability of data.

### 7 How can I use TAP II for my own areas of interest?

To learn how to create a TAP II dataset, you will have to come to our office in Seattle for training. If you are interested in scheduling such a session, please let us know at [tap@hazmat.noaa.gov](mailto:tap@hazmat.noaa.gov).

#### 8 How accurate are TAP II's answers?

We are not sure.

The answers are as accurate as the data and the assumptions used to generate the statistics. The availability of data along with the assumptions used for the model runs will vary from place to place. Typically, for areas like San Francisco Bay that are tidally dominated and well documented, the answers will be more accurate than for offshore shelf areas where data on coastal currents and winds are sparse at best.

Typically, the data used span about 10 years. This means that events that occur every summer will be accurately represented in the statistics, but events that occur on a longer time period such as a one hundred year storm will not be represented properly.

The data and assumptions used for a particular location are documented in the location-specific technical documentation that is available for each TAP II area.

The accuracy of the answers are also affected by assumptions made concerning the evaporation and dispersion of the oil, how the oil interacts with the shoreline, and how the currents and winds are represented in the model runs.

#### 9 Why doesn't TAP II have more oil types?

To keep the interface simple, TAP II focuses on six types of oils. These six have evaporation and dispersion properties that span the evaporation/dispersion properties of most oils that would be encountered during a spill. TAP II does include a non-weathering oil, however. This type of oil does not age or evaporate throughout the entire threat time period.

#### 10 Why are the months grouped together?

The monthly groupings represent statistical seasonality in the wind data. You cannot change this or reanalyze the data with a different set of months.

#### 11 Can I pick different times than the time shown on the menu?

No. In order to change the times, the data files that TAP II uses have to be regenerated. We selected times that represent the time scales relevant for the area. Small areas were analyzed on a smaller time scale than larger areas.

#### 12 How are the data files for TAP II created?

Each data file represents 500 independent trajectories that start from one location at different times in the 10-year wind and current record. To generate these files for several hundred start sites within a region, we have 12 Macintosh computers set up on a rack all running at the same time.

It usually takes about 1-2 months to gather all the wind and current data and setup the model runs. The model runs take about 2-3 weeks followed by about 1 week of quality control.

#### 13 What does the OPA (Oil Pollution Act) require for ACPs?

"Oil Pollution Act (OPA) requires that each Area Committee (AC) prepare an Area Committee Plan (ACP) which, when implemented, shall be adequate to remove spills ranging from most probable to worst case discharge, and to mitigate or prevent a substantial threat or release from a vessel, offshore facility or onshore facility operating in the Area.

"OPA required the ACPs to address the following information:

A description of the area covered, including sensitive areas.

Detailed description of the responsibilities of the owner/operator and the federal, state and local agencies in removing a discharge and in mitigating or preventing a substantial threat of a discharge.

A list of equipment, to include fire fighting, dispersants, and other mitigating devices.

A list of personnel available to an owner/operator or federal, local and state agencies.

Procedures for obtaining an expedited decision regarding the use of dispersants.

A description of how the plan is integrated into other response plans.

A detailed annex, prepared in consultation with National Oceanic and Atmospheric Administration (NOAA) and U.S. Fish and Wildlife Service (USFWS), to provide a coordinated, immediate and effective protection, rescue and rehabilitation of, and minimum risk to fish and wildlife resources and habitat.

"The Oil Pollution Act of 1990 amended section 311 of the Federal Water Pollution control Act to require the preparation and submission of oil spill

to be used to develop a planning document and not establish a performance document or standard.”

“The emphasis in reviewing response plans should be on ensuring that the owner or operator has gone through the planning process to prepare facility personnel to respond, to the maximum extent practicable, to an actual or threatened discharge of oil. OPA 90 identifies a number of elements considered key to effective preparedness. These include: identifying properly trained personnel, prearrange private response resources, and a system to allow the timely and efficient activation and employment of equipment and personnel...The Coast Guard’s objective however, is to see if the owner or operator has realistically prepared for the different spill scenarios...”

“During this preliminary review, the following items must be checked...(3) identifies the worst case discharge scenario, (4) identifies the resource [is] ... available to respond to a worst case discharge (although at this time, the response capability of the resources is not evaluated)...”

#### “Vessel Response Plan Review”

“...Further, due to the transitory nature of operations, the geographic specific appendices in the vessel’s response plan are not as detailed as in the geographic information section within a facility plan. For these reasons, more reliance will be placed on the Area Contingency Plan (ACP) for guidance on resources at risk and other response considerations in the event of an oil spill involving a vessel.”



## Chapter 5 TAP II Glossary

Oils react during an oil spill depending on how their physical characteristics react to weather, water, and shoreline conditions. The six types of oil listed below span the evaporation/dispersion properties of most oils that would be encountered during a spill.

### Amount Released

Amount of oil that is released instantaneously. Basically, the oil is released within 15 minutes for the model runs. TAP II does not allow continuous releases.

### Level of Concern (LOC)

This is the minimum amount of oil on a shoreline segment that you will be concerned about. We use 1,000 particles to represent the oil. This means that the smallest increment of oil we can resolve is 1/1000 of the total amount that you spill. For example, if you spill 10,000,000 (10 million) gallons like the Exxon Valdez did, the smallest amount of oil we can track is  $10,000,000 / 1,000 = 10,000$  gallons. So if you ask for a Level of Concern of 1 gallon, or 10 gallons, or 100 gallons, or 1,000 gallons, or 10,000 gallons, TAP II will still compute the answer using 10,000 gallons.

### Non-Weathering

The term non-weathering is used by the Oil Type popup menu to describe a pollutant that does not evaporate or disperse into the water column. This can be used to study the potential movement of objects other than oil or it can be used to get a conservative estimate of how oil will move.

Note, the model runs were done with the assumption that the pollutant would interact with the wind and waves like oil. If you use TAP II's non-weathering option for non oil products (i.e. garbage, flotsam) you should keep this in mind as a potential source for error.

### Percent of Spills

The percent of spills term is used to describe the color bar in the Shoreline Impact Analysis and Threat Zone Analysis. It is computed from the 500 random, hypothetical spills from several

hundred start sites. For example, if a receptor site is color coded as being in the 90% of spills range, it means that about 450 of the spills ( $90\% * 500$ ), brought oil to the receptor site.

### Receptor Site

In TAP II, the entire shoreline was broken down into individual receptor sites. A receptor site is an area that was used to keep track of how much oil impacted that region as each spill was modeled. All the receptor sites are about the same size, so that a given amount of oil in each site means about the same thing. Receptor sites are sometime located in sensitive offshore regions, such as coral reefs.

### Resource

A resource is something that is linked to one or more receptor sites. This is used by the Resource Analysis Option. Examples of resources are beach type (i.e. marsh, rock headlands), biological critters (nesting turtles, crabs), economic assets (hotels, tourist beaches), and response equipment (booms, sorbent pads, boats).

### Response Time

The response time used in the Response Time Analysis mode indicates how many hours you have to respond before oil arrives. For example, if the contour indicates 12 hours, then you can expect oil to impact the receptor site sometime after 12 hours.

### Season

The seasons were selected by analyzing the wind statistics. Monthly correlations were done on approximately 10 years of wind statistics. From this analysis seasons were picked out. There are two seasons for some areas and four seasons for others.

### Time

This is the time setting that you use to represent time lapsed since the spill (all spills in TAP II are assumed to be instantaneous). The time setting is used to determine how much oil is evaporated and dispersed into the water column as well as to determine how far the oil has moved.

## Oil Types

### Light Refined Products

Light oils such as gasoline, jet fuels, and diesel tend to be problem pollutants for only a few hours to a few days because they evaporate into the atmosphere quickly and disperse into the water column easily. These light refined products are often fire hazards and cause fish kills due to their volatility and solubility.

#### Gasoline

All types of gasoline including leaded, unleaded, premium, regular

#### Kerosene/Jet Fuel

All Jet Fuels (JP-1 through JP-8)  
All Fuel Oil #1s

#### Diesel

All Fuel Oil #2s  
Home heating oil

### Heavy Refined Products

Heavy refined products such as Intermediate Fuel Oils (IFO) and Bunker C (Fuel Oil #6) tend to persist in the marine environment for weeks. These oils are not as toxic to the marine organisms as the lighter oils but they tend to be a threat to beaches and birds that can be impacted from the floating oil for weeks.

#### Fuel Oil #4

IFO 180  
IFO 280  
IFO 380

#### Fuel Oil #6

Bunker C.

Note there are some #6 oils that will sink, especially in fresh water. TAP II does not deal with these oils.

### Crude Oil

Crude oil is a mixture of heavy and light oils. Often, they will have the toxicity of the lighter refined products early in a spill and the persistence of the heavier refined products later in a spill.

Try using several of the modes and compare the results between gasoline and #6.

#### Medium Crude

Most Crude oil including Alaska North Slope Crude and Arabian Medium Crude

### Non Weathering

Conservative products that don't evaporate or disperse

Weathered tarballs

Garbage (tires, Styrofoam, etc)



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