January 27, 2006

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ATHOS 1 NRDA: Response to Polaris Comments on DRAFT SHORELINE INJURY ASSESSMENT: *M/TATHOS 1* OIL SPILL

Dear Greg:

Thank you for providing comments on the Draft Shoreline Injury Assessment. You will find your original letter in Attachment A at the end of this document. It includes the Shoreline Assessment Team's (SAT) responses to your edits (in blue).

If you would like to discuss any of the responses in further detail, please contact Jim Hoff.

Sincerely,

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ATTACHMENT A

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December 15, 2005

Jim Hoff
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ATHOS 1 NRDA: General Comments on DRAFT SHORELINE INJURY ASSESSMENT: *M/TATHOS 1* OIL SPILL

Dear Jim:

The following letter represents comments from Polaris on the Shoreline report. We submit the relevant portions of the document as they appear in the original text with comments added.

1.0 INTRODUCTION

1.1 Background

Estimates of ecological service loss and rate of recovery were based on the degree of injury using field observations, literature values, and best professional judgment.

We still do not fully understand how best professional judgment constitutes "an observable or measurable adverse change in a natural resource or impairment of a natural resource service". Perhaps it should be stated that the basis for the assumptions of injury (judgment) are the past studies with observations and measurements, oil spill case histories, on-site observations and measurements, literature values and other sources. (will re-word)

1.2 Oil Characteristics

Based on these oil characteristics, the spilled oil is likely to have limited acute mortality resulting from exposure to the dissolved fractions in the water column, but significant physical impacts associated with smothering and fouling are possible. (will add) Also, this heavy oil will weather slowly and be highly persistent in the environment, as has been observed since the spill.

1.3 Habitat Equivalency Analysis

Natural resource trustees are authorized to act on behalf of the public to protect the resources of the nation's environment. Under the Oil Pollution Act of 1990, trustee agencies determine the damage claims to be filed against parties responsible for injuries to natural resources resulting from discharges of oil; *injury* is defined as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service." End Quotation". (will add)

2.0 METHODS FOR DETERMINING INJURY CATEGORIES AND AREAS

Estimates of the spatial extent of oiling to mainstem Delaware River habitats and associated tributaries were developed through the following multi-step process:

(a) Oil Distribution Mapping - Field observations of shoreline oiling from SCAT observations (will add "from SCAT surveys") incorporated into a GIS were used to identify exposed shoreline areas and estimate the degree of oiling (e.g., very light, light, moderate, or heavy);

An ArcInfo spatial database was created by the Environmental Unit to provide GIS maps of the degree of oiling for each shoreline segment. The SCAT data were compiled by the Environmental Unit into GIS maps created daily during the spill response. For shoreline injury assessment purposes, the SCAT data were translated into oiling categories based on guidance provided in the NOAA (2000b) Shoreline Assessment Manual. Page: 4
Irrespective of NRDA injury assessment, SCAT data were translated into oiling summary categories using guidance cited for response-related purposes as well. The report should probably note that the Environmental Unit (EU) decided to replace meters with feet on the SCAT matrix for determining shoreline oiling summary levels. This spill-specific modification was instituted to provide better understanding of "relative" oiling levels for exposed shorelines. (will address).
Consistent with that guidance, the oiling categories used for shoreline damage assessment purposes include very light, light, moderate, or heavy (VL, L, M, or H). Areas that were surveyed but had no oil were labeled as "clean." Areas with no oiling category indicate that the shoreline was not surveyed and that no observations exist for that area. The SAT modified the definition of three SCAT oil categories, as identified below: We don't necessarily disagree that 91-100% coverage within even a narrow band constitutes more than light or moderate oiling/injury within the oiled band, but the definition change is significant in that it triggers the assumption that the remainder of the intertidal zone (ITZ) below the oiled band was injured to some degree. A very narrow oiled band can trigger an injury to a very large area that lasts up to three years. We do not believe this is consistent with observations of chemical analytical data as discussed herein.

The SAT determined that an injury likely occurred to the intertidal zone or tidal flat seaward of stranded oil via a rising and falling tide and/or the runoff that occurred as a result of the cleanup effort. To determine how many of the segments with narrow bands were assigned a heavy or moderate oiling category and therefore triggered an oiling degree to be assigned to the intertidal zone or tidal flat, the following table was generated. This table shows the percent of shoreline segments (count of segments, not length of shoreline) assigned a heavy, moderate, light, and very light oiling degree that were recorded as having a narrow or very narrow band of oil. Note, the oiling degrees are based on three measurements: percent cover, oil band width, and average thickness (average thickness was not included in this table). The reason the count of segments was used as opposed to the length of shoreline was that the length was not always recorded in the Access database.

As Table 1 indicates, the issue raised above is relevant only to a small minority of shoreline segments. More specifically, with respect to shoreline segments assigned to the "heavy oiling" category, review of the Access database indicates that there was only one segment with either a very narrow (<0.5 ft) or narrow (>0.5 – 3 ft) oiling band that was assigned a heavy oiling category (Table 1 does not reflect this as the heavily oiled segment was discovered when matching the Access database and the GIS database, as discussed below).

With respect to shoreline segments assigned to the "moderate" oiling category, 12.3% of segments had oiling bands that were either very narrow or narrow. Within this 12.3% of segments, very narrow or narrow bands of oil with 91-100% cover made up 0.3 and 1.5% of all segments (or a total of 6 segments), respectively. The 6 segments include the single heavily oiled segment from above because it was defined as moderately oiled in the Access database. It is important to note that there were no tidal flats found in front of these segments and so these segments did not contribute to the tidal flat or lower ITZ oiling.

The process of matching the Access database records to the GIS spatial database is time intensive and difficult due to the different structures of the two databases. Therefore, this task was only performed for the six records noted above, and not the remaining moderately oiled segments with very narrow or narrow oiled bands. We note that in many cases it was the thickness of oil that caused some narrow bands as well as lighter oiling segments to be assigned a moderate degree of oiling. A thicker oil on the substrate would likely have been cleaned using high-pressure or hot-water flushing, and the run-off would have affected the ITZ area. In addition, it is likely that some of these segments would not have had tidal flats seaward of the shoreline and, therefore, would not have contributed to the lower ITZ oiling, but each record would have to be manually reviewed to determine which segments did contribute to ITZ oiling versus those that did not.

Nevertheless, to account for the possibility that the degree of injury to adjacent ITZs would be reduced for the small minority of segments (approximately 10%) that were moderately oiled by very narrow or narrow bands, the SAT is willing to reduce the injury of the tidal flats in the very light and light oiling categories by a corresponding 10%. In our view this is a conservative approach, primarily because not all of the segments moderately oiled by very narrow or narrow bands have ITZs adjacent to them, but more complex adjustment approaches would be time consuming and unlikely to appreciably change the results, and therefore not cost effective.

Table 1. Oiling distributions using width of oiled band and oil coverage. Oil thickness was not shown in this table but it did contribute in determining the final oiling category (the percentages listed below are based on all three measurements: oil band width, oil coverage, and oil thickness). Not applicable (NA) indicates that the width and oil coverage could not have placed it in that oiling category. A dash indicates that the category did not contribute to oiling.

All Oiling Categories	**Width of Oiled Band**			
Coverage	< 0.5 feet	>0.5 - 3 feet	> 3 - 6 feet	> 6 feet
< 1%	4.8%	7.2%	2.7%	5.7%
1 - 10%	1.5%	9.0%	3.3%	11.0%
11 - 50%	0.6%	12.2%	4.2%	11.0%
51 - 90%	0.3%	7.5%	5.4%	9.3%
91 - 100%	0.3%	1.5%	0.9%	1.8%
Heavy Oiling	**Width of Oiled Band**			
Coverage	< 0.5 feet	>0.5 - 3 feet	> 3 - 6 feet	> 6 feet
< 1%	N/A	N/A	N/A	N/A
1 - 10%	N/A	N/A	N/A	N/A
11 - 50%	N/A	N/A	-	0.3%
51 - 90%	N/A	-	3.3%	6.3%
91 - 100%	N/A	-	0.9%	1.2%
Moderate Oiling	**Width of Oiled Band**			
Coverage	< 0.5 feet	>0.5 - 3 feet	> 3 - 6 feet	> 6 feet
< 1%	N/A	N/A	N/A	N/A
1 - 10%	N/A	N/A	0.6%	2.4%
11 - 50%	N/A	3.3%	3.9%	10.4%
51 - 90%	-	7.2%	1.8%	2.1%
91 - 100%	0.3%	1.5%	-	0.3%
Light Oiling	**Width of Oiled Band**			
Coverage	< 0.5 feet	>0.5 - 3 feet	> 3 - 6 feet	> 6 feet
< 1%	-	0.9%	0.6%	0.3%
1 - 10%	-	2.7%	2.4%	8.7%
11 - 50%	-	7.5%	0.3%	0.3%
51 - 90%	0.3%	0.3%	0.3%	0.9%
91 - 100%	-	-	-	0.3%
Very Light Oiling	**Width of Oiled Band**			
Coverage	< 0.5 feet	>0.5 - 3 feet	> 3 - 6 feet	> 6 feet
< 1%	4.8%	6.3%	2.1%	5.4%
1 - 10%	1.5%	6.3%	0.3%	-
11 - 50%	0.6%	1.5%	N/A	N/A
51 - 90%	-	N/A	N/A	N/A
91 - 100%	-	N/A	N/A	N/A

2.2 Review of the SCAT/ESI Data

Overall, these reviews and associated edits confirmed the accuracy of data used for shoreline injury assessment purposes. Edits made in response to the review of the SCAT forms, Access database, and GIS data are documented in Appendix B. In addition to the checks identified above, the SAT reviewed draft shoreline oiling maps and made changes to the oiling exposure in locations they or SCAT members within their respective agencies observed. Were RP or USCG SCAT team members consulted about these changes? Consultation occurred between state TWG members and state SCAT team members. All changes were listed in the Appendix of the report that was handed out before SAT meetings to be discussed at the meetings. All changes were also noted within the GIS (i.e. who made the change, why, and when) that were sent out to the SAT for review.

2.3 Determining Shoreline Habitat Types

Some shorelines consisted of a combination of more than one habitat type (i.e., sand beach occurring seaward of a salt marsh). When two habitat types were present along the mainstem of the Delaware River, it was assumed that the oil was distributed evenly between the shoreline types. This may not always hold true. The SCAT forms should indicate which of the two habitats were oiled. If both were oiled then it is an appropriate assumption, but it may not always be true. We are not sure how frequently this situation occurs, so may not make a big difference in final outcome, but it might bear double-checking. If two habitats were listed but there was no indication of which habitat was oiled, than it was assumed that the oil was distributed evenly between the two (for lack of better knowledge). If the oiling was described as having stranded on only one of the habitats, than that was reflected in the calculations.

The SCAT data reflect the areal extent of direct impacts from the final footprint of the stranded oil on the shoreline. However, both the temporary stranding of oil at low tide immediately following the spill and the chronic release of oil from the heavy and moderately oiled shorelines would have contributed to injury on the lower ITZ. Furthermore, moderately and heavily oiled shorelines often underwent intensive cleanup efforts including the use of high-pressure, hot-water flushing, and the runoff would have impacted the lower ITZ. Therefore, the lower ITZ (below the footprint of the stranded oil) along moderately and heavily oiled shorelines was treated as an injury category. As mentioned, the definition change including narrow bands as moderately or heavily oiled can significantly increase the injury area in the lower ITZ. (see page 4.) For the present calculations, the lower ITZ areas were included in the appropriate habitat category, but the ITZ values were shown in a separate column in the tables in Section 3.0.

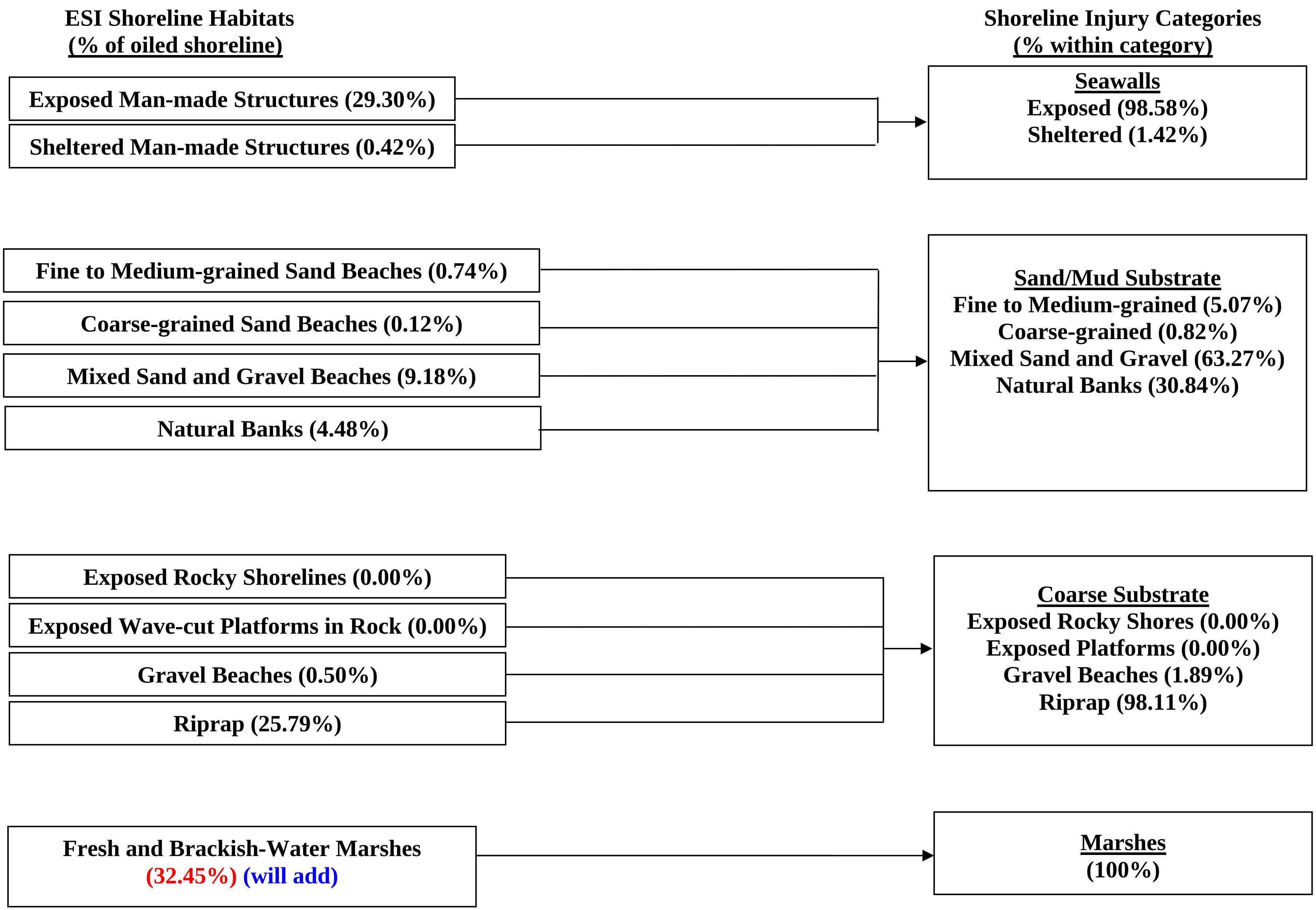


FIGURE 2. Distribution of shoreline types and injury categories as percent of total shoreline length oiled, excluding tidal flats which are represented as polygons and not included in the linear shoreline lengths.

2.4 Estimating the Area of Exposure

2.4.1 Oiled Band Width

Many of the SCAT forms contained information on the width of the oiled band, but this information was not available for all segments of the oiled shoreline. Therefore, some assumptions and extrapolations were necessary. For all oiled shorelines in the mainstem of the Delaware River, widths recorded on each SCAT form distinguished by oiling category were averaged together to produce a mean width for each oiling level: very light (3.57 ft), light (7.55 ft), moderate (8.11 ft), and heavy (13.36 ft). All widths for each oiling category were used with the exception of widths greater than 30 ft (11 total records). Was the averaging completed before or after the definition change? Before. However, there was only a small change in total acreage when the widths were recalculated based on the new definition:

Old acreage: 1804.18

New acreage: 1804.38

This small change in number does warrant a change in all the report tables and spreadsheets.

2.4.2 Segment Length

Finally, to calculate the total shoreline areas injured by the exposure category, the total length of shoreline within each exposure category was calculated. The length of oiled shoreline was obtained by overlaying the ESI habitats onto the maximum oiling maps and generating lengths using a GIS application. The results are shown in Table 3. The total length of shoreline surveyed was 556 miles, however the length of oiled shoreline was 279 miles (this number does not include tributary creeks; the length of shoreline with tributary creeks was 376 miles). This length (279 mi) differs from the total number of miles in Table 3 because of the shoreline segments that have two habitat types present along the mainstem. The lengths of these double shorelines are included twice in Table 3 to account for both habitats. Were the double shorelines included twice multiplied by half the respective width? Yes. But the areas were not double counted. The area was divided up between the two habitats.

2.4.3 Area Calculations

The total area of each exposure category was determined using the following methods:

<u>Seawalls</u>

The area for each exposure category for seawalls was calculated using the length of the segment and the spring tidal range, according to the following formula:

A (Area) = L (Length of segment) * R (Spring tidal range)

The formula doesn't work where seawalls are part of a multiple habitat shoreline. In those cases it is appropriate to divide the spring tidal range in half. The approach described herein was developed and reviewed at TWG meetings on 26 July 2005 (when both Greg Challenger and Gary Mauseth attended) and on 23 September 2005 when Challenger attended. It was the same approach described in earlier drafts of this report that was reviewed by TWG members. Only 2.8

% of the shoreline had multiple habitats that included seawalls. The only habitat that was found in the multiple habitats with seawalls was riprap. The spring tide was divided in half when there were multiple habitats.

Figure 4 illustrates a cross sectional view of a hypothetical seawall shoreline and the measurements used in calculating the area. Although the oil formed a band along the high tide line, it was determined that the entire ITZ was impacted through intensive cleanup methods and oil runoff. Cleanup workers did not clean anything more than the absolute minimum, so if it wasn't moderately or heavily oiled, it didn't receive treatment. It is not appropriate to assign an injury to an entire tidal range for seawalls with bathtub rings. This approach was developed and reviewed at TWG meetings (26 July and 23 September 2005). It was the same approach described in earlier drafts of this report and reviewed by TWG members. Many of the seawalls with a narrow band were located in public areas and were cleaned for aesthetic reasons. The only way to clean the oil was high-pressure, hot-water flushing which would have runoff.

Sand Beaches/Flats

Sand beach area calculations include multiple components. First, shoreline oiling was calculated for each sand beach using the length of that segment and the average width of oiling by category from the SCAT forms, as shown in the following formula: Couldn't an average width vary widely between a sand beach and a flat? Yes, this is why eleven records that were >30 ft were not included when averaging the widths recorded on the SCAT forms because it was assumed these large widths represented tidal flats and not sand beaches. The area of the tidal flats was determined from the digital datasets that were received from USFWS, PADEP, and NJDEP.

The lower ITZ area was assigned an oiling category two levels below the oiled shoreline area. That is, if the exposure category for the original shoreline oiling was heavy, the oiled area calculated for the lower ITZ was assigned a light oiling level. If the exposure category for the original shoreline oiling was moderate, the oiled area calculated for the lower ITZ was assigned a very light oiling level. If the exposure category for the original shoreline oiling was light or very light, no oiled area was calculated for the lower ITZ. Figure 5 shows a cross sectional view of a hypothetical beach habitat and the measurements used in calculating the shoreline and ITZ areas. See previous comments related to definition change using a narrow band. We do not believe that moderate or heavy categories with a very narrow band of oil would have resulted in the same type of oiling to a lower ITZ than habitats with wide oiling bands. (see page 4)

This methodology was applied to all tidal flats with the exception of the tidal flats surrounding Tinicum Island and the tidal flats seaward of Fort Mifflin. These flats were assigned a heavy or medium oiling level based on SCAT surveys and forms. Some of these tidal flats were heavily and moderately oiled, but the oiling was not uniform. Applying it to the entire flat will overstate exposure. The PA side of Tinicum Island did not have substantial oil. There were some pockets of oil and pavement at the low tide line on tidal flats on the NJ side of Tinicum but we do not believe the entire width was heavily oiled. The assumption that all of the flats were moderately or heavily oiled should be examined very carefully because the total acreage in moderate or heavy oiling categories is about 340 acres for these two areas and only 130 acres for the rest of the shoreline combined. Most of the debit is likely to arise from these two areas with little substantiation.

This approach was described and reviewed at TWG meetings (on 26 July and 23 September 2005). The members of the SAT specifically addressed this area during the review of the shoreline oiling data and maps. SAT members that were present on Tinicum Island during the response observed heavy and moderate oiling across the entire flat. There were very lightly and lightly oiled flats on both the east, west, and north sides of Tinicum Island; in fact, most of the north side of Tinicum Island is mapped as light or very light, and there is only one small area of heavy. There are ample photographs of the south side of Tinicum Island that show thick oil extending over wide areas of the tidal flats and rolling across the flats at low water (see Figure 11, pg 30 of the *Shoreline Injury Assessment Report* for photos).

Coarse Substrate

The area for each exposure category for coarse substrates was calculated using the length of the segment and the average width of oiling by category from the SCAT forms, according to the following formula:

Very light oiling: A (Area) = L (Length of segment) * W (Oiled band width from SCAT forms)

Other oiling categories: A (Area) = L (Length of segment) * W (Shoreline width from field survey)

The shoreline width was used for light, moderate, and heavily oiled shorelines because clean-up activities (e.g., high-pressure, hot-water flushing) that took place in the heavier oiled areas may have affected the entire ITZ on the shoreline. Assuming active cleanup in all locations results in injury throughout the entire tide range is perhaps overly conservative. Some active cleanup did not involve flushing or other activities that would have resulted in lower ITZ impact. Some cleanup also occurs at tides that do not expose the lower ITZ. There is an assumption that for every coarse substrate shoreline the entire intertidal width (45 feet) was oiled due to hotsy operations, even though the average width of the oil band was 7.55 feet in lightly oiled areas, 8.11 feet in moderately oiled areas and 13.36 feet in heavily oiled areas. A review of clean up records to determine the percentage of the shoreline actually hotsy'd would greatly reduce the acres in the coarse substrate category. I could not find any information from the clean up records that give a percentage of the shoreline that was hotsy'd. These comments apply to other categories. After requesting the data available on all cleanup operations from ENTRIX and Polaris, Inc., we were given the Environmental Unit Documentation CDs, which tracked the clean-up progression. Unfortunately, there was no information from these data that gave the percentage of coarse substrate shoreline that was hotsy'd. This is an approach that was developed through a series of joint meetings and described in earlier drafts of the report. Figure 7 illustrates a cross sectional view of a hypothetical coarse substrate shoreline and the measurements used in calculating area.

Marshes

Many of the marshes on the mainstem are *Phragmites* dominated and separating the *Phragmites* from other marshes could ultimately give a better indication of service losses. No attempt was made to discriminate among wetland types (e.g., wild rice, *Phragmites*, or *Spartina)* present because the Trustees felt that it was not appropriate. A study completed in response to the Chalk Point oil spill indicated that the productivity of Phragmites habitat for fish and birds was comparable to other types of marshes (see Attachment B)

3.0 RESULTS

3.1 Estimate of Impacted Shoreline

Table 4 lists the oiling degree and area of oiling (in acres) for the seven tributary creeks in New Jersey. Zones were established when oiling degrees changed within a tributary. The total area potentially exposed from the tributary creeks was 1,899 acres. It is important to note that a lot of the area in tributaries is subtidal and not likely exposed. If we can estimate the tide range and beach slope in other categories, shouldn't we be able to estimate the subtidal portions of tributaries to exclude them from exposure. The approach used in determining injury to the tributaries was agreed on at the TWG meeting on 26 July 2005 and confirmed at the subsequent meeting. The following sentence was extracted from the 26 July meeting minutes: **We agreed to consider the tributaries in the oiled areas in NJ and DE as "systems" that mostly consist of open water, isolated wetlands, and an oiled wetland fringe along the shoreline. Each state is going to provide guidance on the upstream extent of oiling and degree of oiling (if different than shown on the maps).** The Aquatics TWG is not considering the tributaries in their injury assessment. The shallow subtidal areas were explicitly included in both the area and in the development of the injury curves.

Tables 5a-d show the total area calculated in each exposure category, for all states combined and each state individually. The oiling maps and the shoreline classification maps are found in Appendices C and D, respectively.

TABLE 5a. Total estimated area (acres) of exposed (will add) habitat across all states.

Habitat Type	Oiling Level	Shoreline (Acres)	Lower Intertidal Zone (acres)*	Tidal Flat (acres)**	Total By Habitat (acres)	Percent of Total Oiling
Seawalls	Very Light	8.66			8.66	0.48%
	Light	17.72			17.72	0.98%
	Moderate	30.46			30.46	1.69%
	Heavy	2.54			2.54	0.14%
Subtotals		**59.38**			**59.38**	**3.29%**
Sand/Mud Substrate	Very Light	7.39	55.69	752.70	815.78	45.22%
	Light	9.98	26.94	279.54	316.46	17.54%
	Moderate	9.94		205.48	215.42	11.94%
	Heavy	8.24		135.20	143.44	7.95%
Subtotals		**35.55**	**82.63**	**1372.92**	**1491.10**	**82.65%**
Coarse Substrate	Very Light	16.23			16.23	0.90%

	Light	66.08			66.08	3.66%
	Moderate	36.91			36.91	2.05%
	Heavy	18.01			18.01	1.00%
Subtotals		**137.23**			**137.23**	**7.61%**
Marsh	Very Light	51.83			51.83	2.87%
	Light	40.89			40.89	2.27%
	Moderate	17.22			17.22	0.95%
	Heavy	6.53			6.53	0.36%
Subtotals		**116.47**			**116.47**	**6.46%**
TOTAL MAINSTEM HABITATS					**1804.18**	**100%**
Tributaries	Very Light	583.25			583.25	30.71%
	Light	1216.08			1216.08	64.03%
	Moderate	99.90			99.90	5.26%
	Heavy	0			0	0
Subtotals		**1899.23**			**1899.23**	**100%**
TOTAL OILED TRIBUTARIES					**1899.23**	**100%**

* Lower ITZ values were only shown separately for the sand/mud substrate because they represented the majority of the injury for the sand/mud substrate category.

** Tidal flat acreage under the sand beach habitat includes flats from both sand beach and marsh habitat categories.

Can we break out the lower ITZ values from sand versus marsh? It would be interesting to note how many acres of injury were generated from the assumption that cleanup activities impacted the entire lower ITZ. Yes, the total marsh ITZ values (excluding vegetative flats or marsh polygons) that come from the marsh across all states was 284.2. Heavy = 2.6 acres; Light = 40.8; Very Light = 240.8.

Note: the area of the polygonal tidal flats seaward of the oiled marshes was used to determine the area of the lower ITZ area adjacent to marshes that would have been injured, and this value was added in to the total area of injury for sand beach/flats in the table above.

ASSESSMENT OF INJURY AND RECOVERY FOR INJURED HABITATS

4.1 Introduction

Determining the degree of initial injury and rate of recovery for shorelines is a complex process. The shoreline type, amount of oiling, exposure to natural removal processes, and duration of oiling can all affect the recovery of ecological services on an oiled shoreline. There are very few studies available that follow the full recovery of a coarse substrate, sand beach, or marsh shoreline, particularly for riverine settings. The recovery rates developed for the *M/T Athos 1 spill* focused on the visual observations of oiling, vegetative conditions, and the life histories of fauna associated with the intertidal and shallow subtidal habitats of the Delaware estuary (see summary table and references in Appendix E), as well as published studies of past spills and chemical analytical data from oiled shorelines during the spill. (will add) The percent of baseline services at key points in time were used to create the recovery curves for each injury category. These time inflections include:

1. Time – Initial Service Losses, immediately after the spill on 28 November 2004.
2. 0.5 yr after spill – Representing the termination of cleanup activities, start of recovery process.
3. 1 yr after spill – The end of the first growing season.
4. 2 yrs after spill – The end of the second growing season.
5. 3 yrs after spill – The end of the third growing season.
6. 4 yrs after the spill – The end of the fourth growing season.

The impacted areas along the mainstem and tributary creeks were surveyed twice, on June 7 and September 22, 2005, by members of the SAT to assess oiling conditions and habitat recovery. How was injury and recovery assessed during the visits? Site-specific observations were made on oiling conditions as the amount and extent of residual oil (e.g., on the sides and undersides of gravel and riprap) and re-oiling of surface sediments and vegetation. General observations were made on habitat recovery in terms of vegetative vigor (which was good in all areas, even where the vegetation shown evidence of recent re-oiling), algal cover on coarse substrates, and relative abundance of epibiota.

4.2 Seawalls

Approximately 59 acres of seawalls were oiled and affected by cleanup operations, with the majority of the habitat observed as moderately oiled (30 acres). Oil attached to the dry, rough surface of the seawalls along the Delaware River and persisted in a band above the high tide line. Shoreline cleanup consisted of high-pressure, hot-water flushing of the oiled band. The effluent from the flushing flowed down the seawall surface, affecting the entire intertidal zone of the seawall.

Few resources are affected during a seawall injury, as animals that attach to the substrate in fresh to brackish settings are sparse to moderate in abundance. Were moderately abundant organisms observed anywhere? Will be changed to sparse only. What are moderately abundant organisms? It is a relative term that varies widely by habitat. Seawalls support algal biomass and therefore contribute to primary production. A loss of production may occur with the oiling of macroalgae, and the detachment of insects and invertebrates removes a source of prey for fish that may feed along the seawalls.

The moderately and heavily oiled seawalls were estimated to have 0% services present immediately following the spill and within 6 months after the spill because of the initial oiling and the effects of high-pressure, hot-water flushing cleanup operations that were completed by May 2005. This assumes all seawalls were covered with oil until May 2005, and on June 1, 2005, were free of oil. It is likely that many seawalls were cleaned and recovered prior to May 2005. Specific information on cleanup activities for each seawall is not available. However, the documentation from the Environmental Unit provides enough detail to support the assumptions about the type and timing of cleanup. The cleanup prior to the winter was “gross removal” only and focused on mobile oil. Few seawalls were cleaned early in the response, and thus remained oiled until cleanup was completed in the Spring of 2005. We randomly selected 5 segments that contained seawalls that were classified as moderately oiled with a narrow oil band and researched the treatment recommendations and dates using the EU documentation data:

1. PA-3; Zone A; 2 ft band width; Moderate
2. NJ-2; Zone B; 2 ft band width; Moderate
3. NJ-4; Zone B; 3 ft band width; Moderate
4. PA-2; Zone H; 2 ft band width; Moderate
5. PA-1; Zone B; <1 ft band width; Moderate

The Cleanup Recommendation Maps produced in April 2005 for these segments indicated treatment by hotsy for all of them. We have attached the Cleanup Rec Map for PA-2 as an example, which indicates even narrow bands were treated by hotsy. We were not able to locate sign-off sheets for all of these segments, but all of the sign-off sheets in the EU documentation CD were dated in May 2005, indicating that most of the cleanup was completed by May 2005. So, it appears that May is a good endpoint for completion of the cleanup on seawalls. This response applies to all comments about the timing of cleanup completion.

Moderately and heavily oiled shorelines were characterized with an oil band up to 6 ft in width and an oil cover up to 90% or 100%, for moderate and heavy oiling, respectively.

Seawalls that were moderately or heavily oiled would have experienced a much higher loss of primary production as well as a loss of invertebrates that depend on the algae for food. One year following the spill, the loss of services was estimated to be at 15% of baseline (85% services present), reflecting the rapid recruitment of short-lived species. Services provided by seawalls were estimated to have recovered by two years following the spill. Injury to seawalls was calculated as 30.3 DSAYs across all states. Is there any evidence of continued injury following the regrowth of algae that occurs after the discontinuation of the cleanup? It is not unreasonable to assume that injury is ongoing based on oil still in the area (tarballs, sheens on the water). Based on the low toxicity of the oil from the studies of the aquatic group, we do not believe it is likely there was ongoing injury after the first year in any oiling category.

TABLE 6a. Recovery rate and total number of DSAYs lost for oiled seawalls (all states combined). Acreages were different in previous version of report. The EU's shoreline oiling database ws edited based on visual observations during the response effort. Oiled shoreline was added during the review process and acreage increased by 1.81 acres.

Oiling Degree	Acres	Services Present Post Spill				
		Previous acres	0.5 yr	1 yr	2 yr	DSAYS
Very Light	8.66	7.01	0.95	1		0.32
Light	17.72	17.72	0.85	1		1.97
Moderate	30.46	30.35	0	0.85	1	25.87
Heavy	2.54	2.49	0	0.85	1	2.16

Total	**59.38**					**30.32**

4.3 Sand/Mud Substrates

Approximately 1,491 acres (previous report indicates 1484 acres) (see below) of sand/mud substrates were estimated to have been exposed to oil at some point following (will edit) the spill. As shown in Figure 2, this category includes sand beaches, mixed sand and gravel beaches, and sandy and muddy tidal flats. On beaches, the viscous oil coated the sediments, particularly the gravel, and penetrated in to the sandy sediments only where accumulations were heavy. In spite of aggressive cleanup efforts that included both manual removal of oiled sediments and high-pressure, hot-water flushing of the coarser gravel sediments, small tarballs that readily spread into sheens continued to be released from heavily oiled beaches throughout 2005, as observed in the July and September 2005 site surveys.

This category also includes tidal flats where oil stranded directly on the flat during the spill (i.e., south side of Tinicum Island, Fig. 11a, and in front of Fort Mifflin) and those flats fronting moderately and heavily oiled shorelines, where the oil initially floated over the flats, but were chronically exposed to oil being released from adjacent shorelines. Figure 11b shows the small tarballs and associated sheens stranded on the tidal flat on the east side of Tinicum Island on 22 September 2005. Tarballs and sheens were observed on tidal flats during both site visits in 2005. This chronic oil exposure continued to affect the fauna and users of these habitats at least towards the end of 2005. Lightly oiled tidal flats represent 816 acres, or 55 % of the total acreage in this habitat category.

Sand/mud substrates provide important habitat for epifauna and infauna (see Appendix E). Macrofauna, such as shellfish, worms, and snails can be found on and in the sediments on sand/mud substrates in high abundance. Meiofauna colonize the interstitial spaces among the sand grains of the intertidal zone. Meiofauna contribute to the food chain by converting the energy content of dead seaweed and wrack into forms available for larger animals such as birds and fish (Basson et al., 1977). Birds and fish use the sand/mud habitats to feed on the abundant aquatic organisms. The initial smothering of epifauna and chronic oil exposures at least through 2005 is likely to impact the amount of food available for birds and fish.

Tables 7a-d show the HEA inputs for oiled sand/mud substrates and the number of DSAYs calculated from the number of acres exposed. The loss of services for very lightly and lightly oiled sand/mud substrates was estimated to be 50% of baseline (50% services present) for the first 6 months after the spill. This category is dominated by tidal flats fronting heavily and moderately oiled shorelines, that were constantly being exposed to oil slicks, droplets, and sheens being released from the shoreline until cleanup activities were terminated. One year following the spill, the loss of services for very lightly and lightly oiled sand/mud substrates was estimated to be at 25% of baseline (75% services present), based on the observations of oil droplets and sheens on all such tidal flats visited in September 2005, and the relatively short life history of most species associated with these habitats in the lower Delaware River. By the third year following the spill, services were expected to have recovered, assuming that the stranded oil would have weathered enough to prevent significant releases after year two, which would allow affected resources to recover by year three.

Moderately and heavily oiled sand/mud substrates were estimated to have had 100% loss of services (0% services present) 6 months after the spill. The stranded oil would have directly smothered and killed intertidal organisms; however, the constant release of oil exposed all intertidal organisms to the smothering effects. Furthermore, the intensity of cleanup required to remove the viscous, persistent oil would have affected any remaining organisms and restricted use until cleanup activities were terminated. These two categories were estimated to recover within three years as the lighter oil categories were, however, the services were estimated to take a longer time to return in the interim years (see Table 8a).

Injury to the 1,491 acres of sand/mud substrates that were oiled as a result of the spill was calculated as 1,162 DSAYs across all states. Figure 12 shows the recovery curves for each of the oiling categories for this habitat type. We believe injury to these areas is overstated as discussed below.

TABLE 8a. Estimated recovery rate and total number of DSAYs lost for oiled sand/mud substrates (all states combined). Why do acreage estimates differ from earlier reports? Edits from the SAT during the review of the EU's shoreline oiling database. Previous estimates of heavily oiled sand/mud were approximately 100 acres. This report represents a substantial increase. The SAT's addition of the heavily oiled flats on Tinicum Island caused the increase in this category.

Oiling Degree	Acres	Services Present Post Spill				
		0.5 yr	1 yr	2 yr	3 yr	DSAYs
Very light	815.78	0.5	0.75	0.95	1	488.05
Light	316.46	0.5	0.75	0.9	1	204.24
Moderate	215.42	0	0.5	0.8	1	278.06
Heavy	143.44	0	0.5	0.75	1	191.91
Total	**1491.1**					**1162.27**

Both the initial service loss and recovery rates appear overstated as evidenced from data collected during and after the spill. Moderately and heavily oiled areas will have unoiled portions that continue to provide services, even if minimal. In order for the initial loss to be 100%. No portion of the affected width of an oiled shoreline should be able to provide any services. In other words, if a 13 foot wide band of 1 mile of shoreline is moderately oiled with 50% cover, than 50% of the area may have 100% service loss, and 50% of the unoiled area may have some lesser service loss. As indicated on page 6 or 7 of the report, a moderately oiled shoreline width could have as low coverage of oil as 1-10%. This means over 90% of the area may have no oil on it. The service loss should reflect the average oil coverage, or the estimated unoiled acres (using average % coverage) should be subtracted from the 100% service loss category.

Based on samples and toxicity studies in the aquatic group, we also believe the initial service loss of lightly and very lightly oiled shorelines is overstated, and the recovery periods for all categories are overstated. Some of the sediment samples collected b y the aquatic Technical Working Group (ATWG) in Fall 2005 were collected in shallow water at high tide (intertidal zone samples), very little, if any evidence, of ongoing toxicity was observed in the samples. We understand these samples may have missed oil and it is hard to cover the entire area, but we are assuming the entire area is injured.

Intertidal samples collected by Polaris and NJDEP during the spill were collected in areas of sheen and tarballs. Unlike the subtidal samples, these samples targeted oiled areas and were selected to specifically to be representative of impacted intertidal zones. Sheen and tarballs were observed within several samples, and at nearly every sampling location in the spill area. Based on the ATWG analysis of chronic and acute toxicity, the ATWG estimated that 10 ppm Polynuclear Aromatic Hydrocarbons (PAHs) constituting the sum of National Status and Trends (NST) PAHs resulted in approximately a 25% service loss. Only one intertidal sediment sample resulted in a value of more than 10 ppm NST PAH (12.5 ppm NST PAH) (Table 3 from Toxicity Memorandum, 19 December 2005). This sample (SED-WOOD-01_ contained very high levels of pyrogenic PAHs not found in the ATHOS oil. A comparison of this sample to the source oil is shown below.
The Shoreline Technical Working Group (STWG) is claiming over 1000 acres lost 50% services when the chemical analytical data from these locations do not lend support to service loss in the month following the spill. The STWG is also claiming three years to recover when evidence of ATHOS-related toxicity was not present in the samples following the first month. While several intertidal samples showed evidence of AHOS oil, the concentrations were not sufficient to result in estimated acute or chronic toxicity. We believe the initial loss and recovery of the very light and light categories of all intertidal habitats should be adjusted downward substantially. At the very least, this report should be withheld until completion of the ATWG analysis of oil and sample toxicity.

The same comments apply to the categories below.

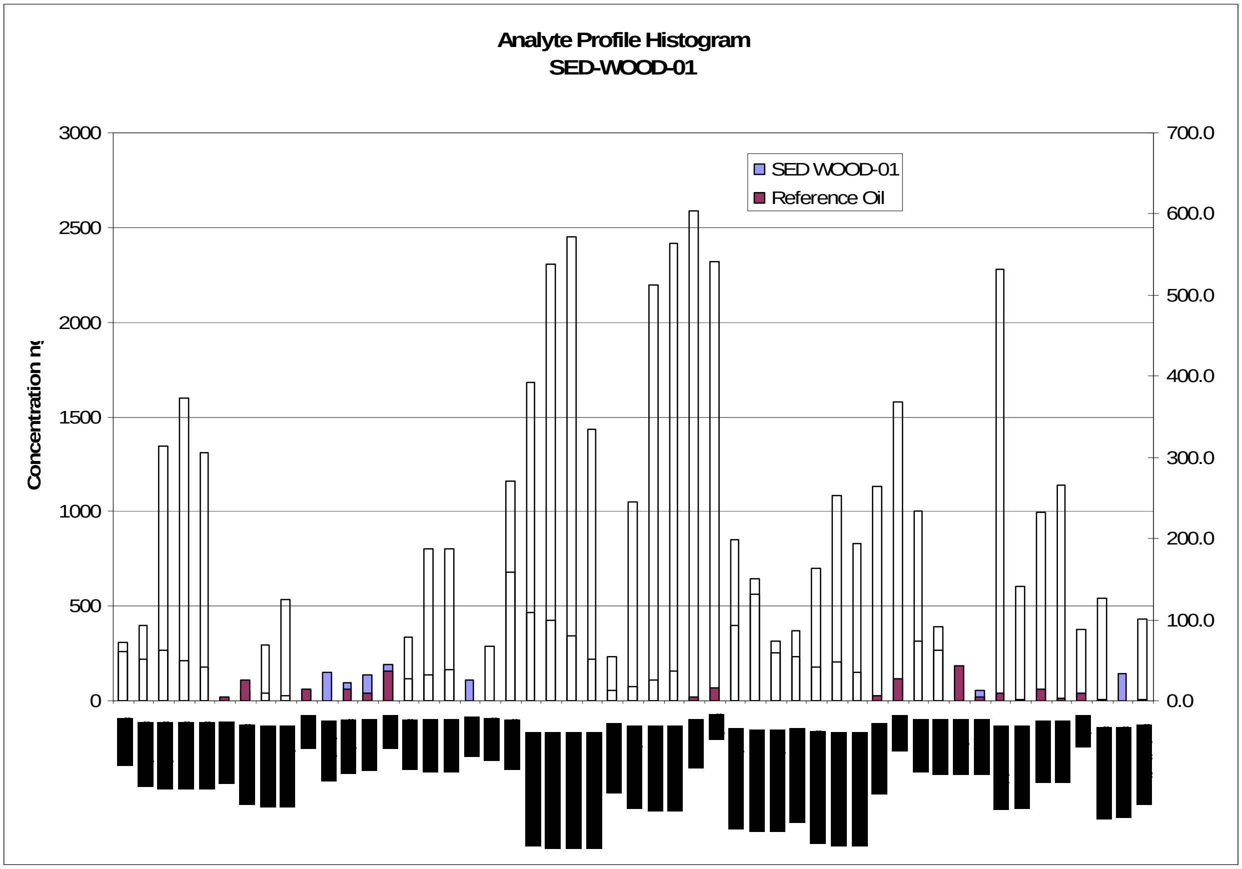
Now that the PAH data from the Aquatics TWG are available, a discussion of these data will be included in the report. However, chemical toxicity was not considered to be a significant pathway of exposure and injury. Note the following statements in the report:

> Based on these oil characteristics, the spilled oil is likely to have limited acute mortality resulting from exposure to the dissolved fractions in the water column, but significant physical impacts associated with smothering and fouling. Also, this heavy oil will weather slowly and be highly persistent in the environment, as has been observed since the spill (p. 2).

> The stranded oil would have directly smothered and killed intertidal organisms; however, the constant release of oil exposed all intertidal organisms to the smothering effects. Furthermore, the intensity of cleanup required to remove the viscous, persistent oil would have affected any remaining organisms and restricted use until cleanup activities were terminated (p. 29).

> These recovery estimates were based on direct smothering effects of the oil and the short life history of fauna associated with these mostly man-made habitats. (p. 35)

It is important to note that estimates of lost services were primarily based on visual observations of oil persistence (as coat on hard substrates) and continuing exposure to oil re-mobilization as sheens and oil droplets during the September 2005 field visit and the coating/fouling properties of this type of oil, rather than the toxicity associated with PAH bound to sediments. Since this represents a time period 10 months after the spill, the injury to the shoreline was extended for longer than one year. The oil has low chemical toxicity but significant physical toxicity because of its persistence and re-mobilization during the natural recovery process through 2005.



4.4 Coarse Substrate

Approximately 137 acres of coarse substrate were oiled as a result of the spill (previous report indicates 134 acres), (changes during the SAT's review of the shoreline oiling caused the increase of injured acres, see edits in Appendix B) with the majority consisting of light oiling (66 acres). This habitat was dominated by riprap, and oil adhered to the rough surfaces on the riprap on the surface for all oiling categories and with depth where the oil was moderate or heavy. Cleanup of riprap proved to be very difficult because the oil was highly adhesive and often heavily coated not just the rock surface but all sides. Most riprap underwent intensive high-pressure, hot-water flushing, but even this technique was not effective at removing oil that had coated the riprap below the surface layer. Where possible, the riprap blocks on the surface were turned over to attempt cleaning of all sides, but deeper blocks remained heavily oiled. In September 2005, tarry oil layers and oil droplets were observed in all heavily oiled riprap areas visited (see examples in Fig. 13). Release of the oil remaining in the riprap is likely a source of the oil droplets and sheens observed throughout 2005.

The same comments about service loss and recovery rate apply to this habitat.

TABLE 9a. Estimated recovery rate and total number of DSAYs lost for oiled coarse substrates (all states combined). (will edit)

Oiling Degree	**Acres**	**Services Present Post Spill**					
		0.5 yr	**1 yr**	**2 yr**	**3 yr**	**4yr**	**DSAYs**
Very light	16.23	0.75	0.85	0.95	1		5.53
Light	66.08	0.5	0.75	0.9	1		42.65
Moderate	36.91	0	0.5	0.75	0.9	1	52.76
Heavy	18.01	0	0.5	0.75	0.9	1	25.74
Total	**137.23**						**126.68**

4.5 Marsh

The spill affected approximately 116 acres of marsh along the Delaware river and bay, with 80 % described as very light or light oiling. The previous report indicates 48.4 acres. This report has more than doubled that estimate. What was the rational for this increased estimate? The SAT reviewed the oiling and identified several tributaries on the east and west sides of Delaware River in the state of Delaware that were oiled but were not included in the spatial database provided by the Environmental Unit. These areas were mostly marsh and their inclusion resulted in an increase in injured acres. Oil that stranded in the marshes mostly coated the intertidal vegetation and debris; oil did strand on and persist on the sediments along the moderately and heavily oiled segments. Figure 15 shows examples of oiled marshes during the spill and in September 2005. In areas delineated as moderately and heavily oiled, oil droplets were observed adhered onto marsh vegetation and released from marsh soils when disturbed in September 2005, indicating on-going oil exposures to both epifauna and infauna in these habitats.

Marsh vegetation represents a broad range of ecological services and functions related to primary production, habitat structure, food chain support, sediment/shoreline stabilization, and fish and shellfish production. Marshes are important nursery grounds for shellfish, fish, and birds (Burns et al., 2000). The diamondback terrapin can also be found using the marsh as a protective habitat in which to forage. Marsh vegetation is important for populations of fish and crustaceans that inhabit marshes, many species of which are key prey items for larger fish and birds. Wading birds, such as clapper rails, willets, and egrets, depend on the prey within the marsh and the plant cover for protection.

The spill occurred when the marshes were in senescence and it was not possible to discern any significant impacts to intertidal marsh vegetation in 2005. There were little cleanup efforts in marshes, other than oily debris removal. Therefore, impacts to this habitat type are estimated based primarily on the direct smothering impacts of the oil on associated fauna during the spill, the persistence of oil in sediments in the more heavily oiled areas, the chronic exposure to oil being released from adjacent habitats, and the life histories of associated fauna.

Tables 10a-d present the number of injured acres of marsh habitat, the recovery rate in years following the spill, and the number of DSAYs lost for each oiling category. Marsh that was very lightly oiled was estimated to have lost 25% of services as compared to baseline (75% services present) six months after the spill occurred, as a result of the oil coating of the vegetation. After one year, services would have recovered to 95% of pre-spill conditions, reflecting the return of most associated fauna. Full recovery was expected within two years post-spill. Lightly oiled marshes followed a similar pattern but had an estimated 50% of services lost as compared to baseline and 25% lost one year after the spill.

For moderately and heavily oiled marshes, services losses were estimated to be 100% for the first six months, until new vegetation emerged to replace the oiled vegetation. Oil would have smothered most organisms within the oil band and birds would not have been able to use the area for feeding. Moderately oiled marshes were estimated to have a 25% loss of services (75% services present) one year after the spill, 5% loss of services (95% services present) after two years, and completely recovered after three years. Heavily oiled marshes were estimated to have a 50% loss of services one year after the spill, 25% loss of services after two years (75% services present), 10% loss of services (90% services present) after three years, and completely recovered after four years.

Injury to the 116 acres of marshes that were oiled as a result of the spill was calculated as 60 DSAYs across all states. Figure 16 shows the recovery curves for each of the oiling categories for this habitat type.

TABLE 10a. Recovery rate and total number of DSAYs created from oiled marsh (all states combined).

Oiling Degree	**Acres**	**Previous acres**				**Services Present Post Spill**		
		reported	**0.5 yr**	**1 yr**	**2 yr**	**3 yr**	**4yr**	**DSAYS**
Very light	51.83	24.24	0.75	0.95	1			11.47
Light	40.89	17.65	0.5	0.75	1			22.54
Moderate	17.22	4.07	0	0.75	0.95	1		16.68
Heavy	6.53	2.44	0	0.5	0.75	0.9	1	9.33
Total	**116.47**	**48.4**						**60.02**

4.6 Tributaries

Approximately 1,899 acres of shorelines, extensive wetlands, intertidal flats, and shallow benthic habitats that were included in the tributary injury in New Jersey were oiled as a result of the spill. The majority of tributaries were lightly oiled (1,216 acres), which was described as extensive dull to rainbow sheens on the water within the tributaries.

TABLE 11. Recovery rate and total number of DSAYs created from the oiled tributaries in NJ.

Oiling Degree	Acres	Services Present Post Spill			
		0.25 yr	1 yr	2 yr	DSAYS
Very light	583.25	0.5	1		179.99
Light	1216.08	0.5	0.9	1	478.23
Moderate	99.9	0.35	0.8	1	56.99
Heavy	0				0.00
Total	**1899.23**				**715.21**

As discussed previously, we believe the exposed area is overstated. Based on sediment samples including sheen from oiled tributaries, we believe the service loss and recovery of the tributary habitats are also overstated. Tributary subtidal sediments were also collected in the Fall of 2005 with no evidence of toxicity in the samples in less than 1 year from the spill. We do not believe injury could occur longer than 1 year, and that initial service loss in the most heavily oiled categories is likely substantially less than 25% over most of the area. We understand that data ere not collected from every location, but they were collected from oiled locations. We feel it is better to base the assessment of service loss on the data available rather than assumption in the absence of data.

As stated in the text of the report, the chemical toxicity of the oil was assumed to be low (see previous response). However, the physical effects of coating, fouling, etc. were considered in the injury assessment. The services losses were primarily based on the persistence of sheens in the tributaries that are important wintering habitat for waterfowl. Also, there was concern that some ATHOS 1 oil had reached the sediments in those tributaries with the most shoreline oiling. With new data on the lack of ATHOS 1 oil in sediments in the tributaries, it is appropriate to revise the injury curve to show complete recovery within 1 year. The proposed curves are as follows (compare to Table 11 above).

Oiling Degree	Acres	Services Present Post Spill		
		0.25 yr	1 yr	DSAYS
Very light	583.25	0.75	1	108.16
Light	1216.08	0.5	1	375.29
Moderate	99.9	0.35	1	40.08
Heavy	0			0.00
Total	**1899.23**			**523.53**

End Specific Comments

Overall, the report involved substantial work and careful thought and we feel the review and manipulation of the SCAT dataset is reasonable and well-supported. We do feel that incorporation of the aquatic data and our understanding of toxicity, when finalized, should play a role in injury magnitude and duration determination for the shoreline group. We also have concerns that exposed areas for some categories may be overstated. We appreciate the opportunity to comment.

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ATTACHMENT B

Chalk Point *Phragmites* Study:

The scientific literature presents conflicting accounts on the impact of *Phragmites* on wetlands. For estuarine fish, Weinstein and Balletto (1999) and Chambers et al. (1999) argued that potential negative impacts of *Phragmites* on nekton could result from the build up of sediment levels and choking of channels, with a reduction of tidal exchange and foraging pathways. In a later study, organic and inorganic material was found to buildup at a three-times greater rate in *Phragmites* monocultures compared to *Spartina* monocultures due to a greater rate of production and slower rate of decay (Windham, 2001). *Phragmites* also appears to have a negative effect on the use of marshes by birds. A lower number of bird species has been reported in stands where *Phragmites* was growing as a monoculture, when compared to other saltmarsh habitats in Connecticut (Benoit and Askins, 1999).

While *Phragmites* appears to affect the use of wetlands by fish and birds, macroinvertebrate abundance does not appear to be reduced in *Phragmites*. Fell et al. (1998) found that the four most common macroinvertebrate species in Connecticut brackish marshes were as abundant, and often more abundant, in *Phragmites* monocultures than in adjacent stands of mixed salt marsh plants (either *Juncus/Spartina* mix or *Typha/Scirpus* mix). Further, they found that the numerically dominant fish species, *Fundulus heteroclitus*, was feeding as effectively on the macroinvertebrate prey within *Phragmites* as on the other marsh types. Thus, *Phragmites* is an effective foraging source and there appears to be a direct trophic link between *Phragmites* and the adjacent estuary that is at least of the same magnitude as for the other, mixed marsh types.

Finally, while there are documented cases where *Phragmites* has reduced plant diversity (Odum et al., 1984), there is little quantitative evidence for a consistent loss of productivity and ecosystem function with a change in marsh-plant species composition. Productivity, energy transfer and use of habitats by faunal components do not appear to be related to species composition of marshes per se, but to structural conditions of the marshes such as tidal exchange and access pathways for fauna. For example, Meyer et al. (2001) found no significant or consistent difference in abundance or biomass of any fish species or of all fish species combined when they compared structurally and hydrologically similar stands of *Phragmites* and *Spartina*. Marshes in each case were relatively open with small sinuous channels between hummocks. In comparison, distinct increases in species diversity and abundance were found when the channel fringe area and tidal exchange were increased by restoration work within a monoculture of *S. alterniflora* (Able and Hagen, 2000).