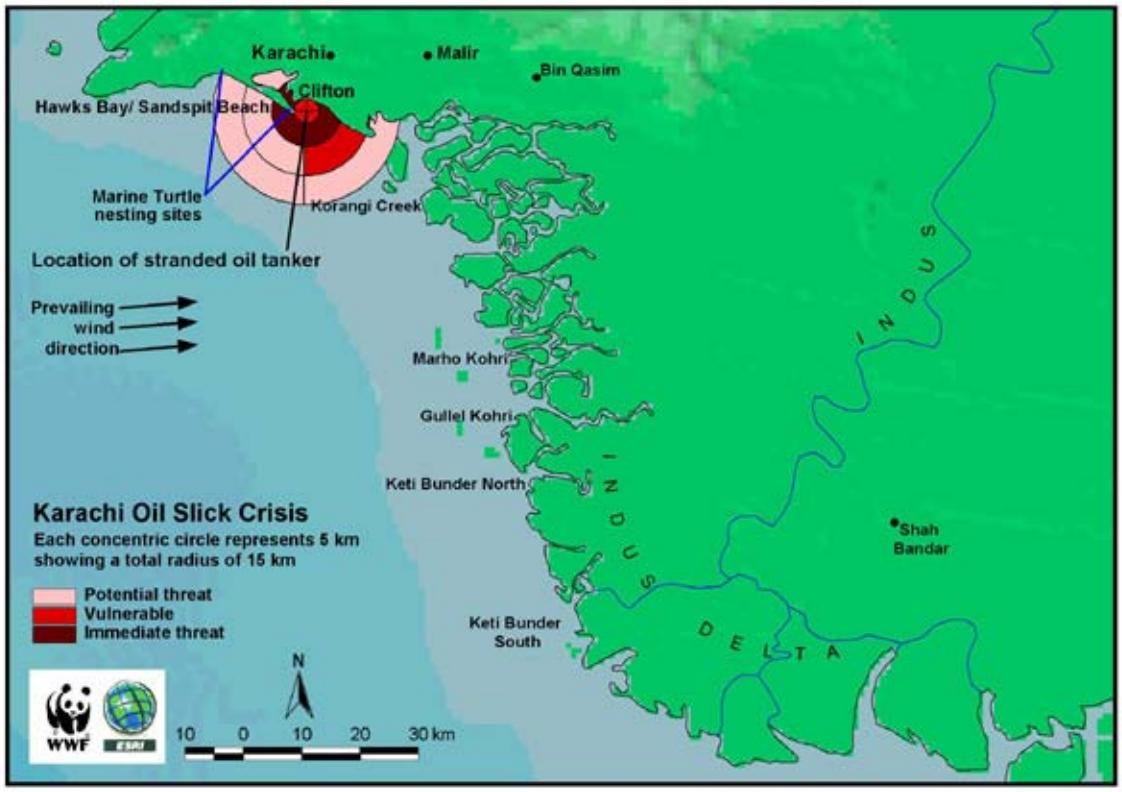
# TASMAN SPIRIT OIL SPILL – ASSESSMENT REPORT

## 1. BACKGROUND

### 1.1 The oil spill

The oil tanker Tasman Spirit grounded in the channel of the port of Karachi, on 27, July 2003 at 1.35 pm The vessel was carrying a cargo of 67,535 tonnes of Iranian Light crude oil (properties of the crude oil are found at Annex 1). for delivery to the Pakistan Refinery Limited (PRL) in Karachi when the grounding occurred. Significant quantities of oil were spilled when the Tasman Spirit broke during the evening of 13 the August. By 18 August approximately 27,000 tonnes of cargo had been lost. On 22 August a further structural collapse occurred leading to a loss of about 100 to 200 tonnes. On 29 August and as well as on the 4 September further releases of oil were reported.




### 1.2 Response to spilled oil

Efforts focussed on the use of dispersant, booming to deviate and keep the oil from reaching the oil piers, skimming and manual clean up of the floating oil debris in the port. The last also a method applied in beach clean-up operations. To date, DHA, City District Government and KPT workers are cleaning the Clifton Beach area: manual methods followed by periodically ploughing the affected beach at low tide are the methods currently being used. Bioremediation is an option that will used once the major part of

the oil willl be removed. Response efforts have taken place under the general guidance of OSRL with advice from ITOPF. Clean-up operations are still underway.

### 1.3 Resources at risk

The coastal environment in which the Tasman Spirit spill occurred is a rich and diverse tropical marine/estuarine ecosystem. It includes extensive mangrove forests (dominated by Avicenia marina), habitat for green and Olive Ridley sea turtles, dolphins, porpoises, and beaked whales, and several species of lizards and sea snakes. About 200 species of fish are known to exist in the region, many of which are important for artisanal and commercial fisheries, as well as important components of the marine food web. Also, there are many species of crustaceans, including shrimp, crab, lobster. The mangrove ecosystem is an important nursery for many of these fish and shellfish species. Over 50 species of birds utilize the area, some resident and some migratory. The region consists of poorly flushes tidal estuaries, river and creek systems, mudflats, sand beaches, and relatively shallow offshore marine waters with moderate current speeds and turbulent mixing.

The popular recreational amenity, Clifton Beach, extending from KPT area to DHA including an extensive reclaimed area to the west covering a total stretch of about 16 kms . To the west of the grounding site are known turtle nesting sites along Hawkes Bay and Sands Pit. Within the port of Karachi are salt ponds, mangrove forests and an artisanal harbor mainly for shrimp fishing as well as shipyard facilities, oil terminals, Pakistan Navy installations and sea water intake all potentially sensitive to oil contamination. To the east of the grounding site are mangrove forests. This area is also a rich source of fishing, the latter also applies to the offshore area from the point of grounding.

## 2. INITIAL RESULTS AND OBSERVATIONS OF THE ENVIRONMENTAL IMPACT COMMITTEE

Below is a summary of the Environmental Impact Committee's findings to date. The preliminary sub-committees reports are attached at Annex 2.

### 2.1 Air pollution

The air was polluted immediately after the major spill on the August 13 and 18 due the evaporated component of the crude oil. According to the chemical properties of the crude oil, approximately 11000 tonnes of volatile organic compounds would have entered the air after the spillsage.

On August 20, the polluted air contained VOCs ranging from 44 ppm at Shireen Jinnah Colony to 179 ppm at Village Restaurant. This had reduced to 8ppm at Shireen Jinnah Colony and to 10 ppm at Village Restaurant. The pungent odour was reported to be perceptible at a distance of one km from the beach area.

The residents of Shireen Jinnah Colony, Seaview and Clifton as well as workers and picnickers were exposed to 40 to 170 ppm of volatile organic compounds for at least 15 to 20 days. The level of pollutants gradually tapered off from 8 to 10 ppm of volatile organic compounds on August 30. Residents in the area complained of the pungent odour of crude oil which was still perceptible on Clifton Beach on September 5. There were concerns expressed by the residents regarding the effects of dispersant spraying. Doctors at the medical camps purposely set up to response to spill related health complaints report a higher incidence of respiratory problems among residents suffering from asthma, irritation of eyes and skin irritation. One of the medical camps established at the site is reported to have provided treatment to 250 persons who reported ailments attributed to petroleum carbon exposure. Further epidemiological studies will need to be carried out to determine the extent of impact on the health of the local population.

### 2.2 Pollution of the marine environment

It is estimated that the initial impacted area covered about 40 $km^2$. Seawater analysis revealed extensive hydrocarbon contamination.

Extensive contamination of the beach was obvious.The oil content of seawater at the open sea was 1.35 mg/litre and varied from 3.95 mg/litre in the Fish Harbour Channel, to 5.15 mg/litre at the point opposite Lighthouse and 10.11 mg/litre at a point near *Tasman Spirit*. The bottom sediment at the open sea was found on August 19 to contain 51.6 mg/kg and varied from 195 mg/kg in the Fish Harbour Channel, to 382 mg/litre at the point opposite Lighthouse and 968 mg/litre at the point near *Tasman Spirit*.

The oil content of the sediment at the bottom and at different depth has not been determined at a sufficiently large number of stations. The same will have to be analysed in order to arrive at better estimates. The present data, however, do suggest that the bottom of the sea over the 40 $km^2$ of the impacted area is covered with the oil residue that was largely dispersed by the high swell of the sea during the 48 hours after the major spill and the subsequent two days when dispersant was used. Assuming that the average oil content at the bottom is 300 ppm in the sediment, the 40 $km^2$ area is expected to contain about 12,000 tons. This estimate should be confirmed through more thorough sediment studies. The contaminated sediment could re-suspend in the water column as a result of turbulent mixing, as well as biodegrade in time. Furthermore with the cessation of the monsoon season contaminated sediments offshore may deposit on shore

### 2.3 Impact on productivity of the affected area

Analysis of phytoplankton samples from Manora Channel, including the location at ship wreck has shown that due to the oil film on the surface water, light penetration was negligible as a result photosynthetic activity was reduced substantially. Observations showed that the phytoplankton groups usually inhabiting this area during the July-September or monsoon period were either absent or were rarely present. The phytoplankton species observed alive but not considered healthy were: *Ceratium, Gonyaulax, Prorocentrum* and *Rhizosolenia*. In a subsequent collection and analysis it was also observed that some of the phytoplankton had developed slight deformations in their cells. This is an important observation and needs further investigation to correlate this with the oil spill event.

The reported chlorophyll values for the euphotic zone in the coastal waters of Karachi range between 0.5 and 40 ug/litre at this time of the year. These are the values that support the fisheries in the area and are likely to be impacted by the toxic components of the spilled oil.

The mean zooplankton biomass for the July-September monsoon period has been estimated at 105 ml/$m^3$. The samples collected from the impacted area as well as the ship-wreck site showed very small percentage of zooplankton such as calanoid, copepods, chaetognaths, salpa, and megalopa larvae, which were alive but showed weak movement. This analysis also shows that the spilled oil has affected the zooplankton population, the estimate of which needs further examination.

It is not possible to estimate the loss of phytoplankton and zooplankton since the baseline data are not available for the impacted area In order to derive better estimates, it is necessary to collect samples from unoiled control sites and to analyse samples from the affected area to see if some regeneration or further degeneration has taken place. This needs done in the next few days in view of the short life cycle of plankton.

### 2.4 Impact on benthic fauna

The fauna observed on August 27, 2003 on the surface at Clifton Beach near Boat Basin Police Station did not have the same abundance of polychaete worms as has been observed in other occasions before the oil spill. The upper 80 mm layer in the core sample drawn from the same Station revealed the presence of only 3 alive juvenile polychaete worms (*Diopatra* sp), while the lower 80 mm of the same core sample showed the presence of 14 alive juvenile polychaete worms(13 *Diopatra sp* and 1 sabellid).

Clams were not found at the above station on the same date, although large quantities have been documneted to be present (one could see the clam diggers collecting clams) before the incident. Star fish (*Astropecten sp*) were found alive on the beach but they were sluggish in movement. A sample of ten (10) star fish in this condition recovered quickly when put in clean sea water. In an earlier survey i.e. on August 26, dead shells of bivalves (*Arca spp*), gastropod (*Tona sp*), live hermit crabs, spider crabs, and fishes (mullets) were observed to be coated with oil.

### 2.5 Impact on fisheries resources

On August 14, 500 to 600 kg of dead fish were found on Clifton Beach. Identification showed that these fish fell in the following categories: mullets, catfishes, shellfish and crab. The gills of the fishes and other hard parts of the body such as fin spines were coated with a thick layer of oil.

On August 19, out the dead fish collected, 1,000 were found at the Village Restaurant sampling station which was the highly impacted area. The major groups within the fish kill comprised of: grey mullet 50%, and sardinella 20%. The remaining 30% consisted of: sea catfish, croakers, scats, eels, tripod, and scorpion fish. At the Kinara Restaurant sampling station fewer deaths were recorded: 20 dead fish mostly mullet and spotted scats. It must be mentioned that 6 herring gulls were collected on the same date.

On August 30, a similar survey was carried out. A much lower number of dead fish were collected from the shoreline: 50 mullets, 1 partially alive, 18 sardines, 6 catfish and 2 scats from the Village Restaurant; 1 scat and 1 seabream collected from the Kinara Restaurant sampling station.

### 2.6 Impact on mangroves

It has been found that the oil slick moved from Manora channel in the NEE direction towards Clifton Beach and the spilled oil was concentrated in the 7.5 km stretch from Shireen Jinnah colony to Village restaurant. The mangroves of PNS Himalaya in Manora Channel and a small mangrove area in China Creek were also exposed to the crude oil spill. The daily survey conducted by the foresters showed that this distribution pattern remained essentially the same until September 2, 2003.

The impact of oil spill, followed by aerial and surface dispersion has been observed in the form of tissue death of seedlings/propagules of *Avicennia marina* the dominant species of the mangroves in the Manora Channel and it seems to be slowly spreading to the off shore Bundal Island. The mix of dispersant chemicals and Iranian Light crude oil has had a fatal effect on the growth of the young mangrove stock. A major loss to mangroves regeneration has therefore occurred as a result of the oil spill, the extent of which must be determined.

The acute toxicity of oil to mangroves was clearly visible during the field surveys after the spill from *Tasman Spirit*. Propagules and seedlings of mangroves are highly vulnerable to oil exposure and when exposed to large quantities of oil they cannot survive in oiled sediments beyond the point of exhaustion of food reserve stored therein. Damage done to the mangrove seedlings and propagules therefore started being visible in the form of coating on the seeds from August 16 at Clifton Beach and in the form of dead seedlings and propagules on August 23 when 90% dead seedlings estimated to be in millions were found deposited all along the beach from the Shireen Jinnah colony to the mouth of Korangi Creek. The impact was not visible on Bundal Island on August 23 but a small number of dead seedlings estimated to be one in thousand were found washed ashore this island. No visible impact on the biodiversity of the eastern part of Karachi coast viz. the mangrove forests in Bundal Island, Korangi-Phitti Creek and beyond was noticed until September 2, 2003. *Avicennia marina*, with other species was found growing there very well.

It may be worth noting that in the PSO/Bin Qasim Power Station spill of fuel oil in 1999, an initial damage assessment survey conducted in the first month after the spill showed that 46% of mangrove trees, saplings and seedlings had been stressed (defined as a showing yellowed leaf colour) along a transect in the most impacted Korangi Creek area. After three months, the majority of seedlings and saplings and few mature trees in the most impacted area were dead.

## 3. SITE VISITS

Several visits to the contaminated areas were carried out immediately fate the spill by the SEPA officials who visited the turtle nesting sites, mangrove forest as well as surveyed of the wreck and the marine environment.

On the morning of 2nd September an overflight took place for visual observations of the extent of impact of the area. Participating in the overflight were Stefan Micallef (UNEP) Richard Steiner, (consultant IUCN) and Camille Lecat (ITOPF). The overflight took off from the Pakistan Air Force base and followed the following path:

1. mouth of Korangi Creek – no oil or sheen;
2. Bundal Island and its associated mangrove forests no oil or sheen;
3. mouth of Phitti Creek (waterway entrance to Port Qasim) - no oil or sheen;
4. Khand island and its associated mangrove forests no oil or sheen;
   shoreline on Defense Housing Authority (DHA) reclaimed area – no oil on sandy beach but oiling on boulders;
5. Clifton Beach to the Defense Housing Authority (DHA) breakwater which delimits the reclaimed area – some iridescent sheen in the surf zone where oil appeared to be associated with the sediment to sheen on water surface beyond the surf zone towards the open sea;
6. shoreline on Clifton Beach to the Defense Housing Authority (DHA) breakwater: moderate to light oiled sand;
7. casualty and Oyster Island: little black to emulsified oil around the casualty to iridescent sheen to sheen visible around Oyster Island;
8. harbour: some pockets of black oil at the OP1 and in the fishing harbour, mostly sheen in China Creek and some very light sheening in water channels leading to mangrove forests;
9. sandy stretch along Manora point: no oil observed;
10. south of the casualty about ½ nautical mile – separation of oil (sheen) from sediment during dredging operations observed in the wake of the dredger;
11. waters between the beach and wreck has substantial oil.

Most of the observations above were confirmed during boat and land surveys conducted on the 4 and 5 September. Discussions with the authority in Port Qasim indicated that no oil had been observed in the main channel leading to the port whilst interviews with fisherman who fish in the main and secondary channels of Korangi and Phitti Creeks confirmed this. Examination of a selection of fish specimens from a fish catch in these channels did not give off any phenolic odour.

The surface current movement carries mangrove seedlings from the west to east direction. Some damaged seedlings were observed to be present on the shore line of Bundal Island. More importantly were the large quantities of oiled seedlings observed on Clifton beach and those trapped in the surface black oil in the fishing harbour in the main port. The oil on the seedlings would have two impacts: 1) direct damage and 2) restricted dispersal due to a heavier seedling due to oil coating.

It must be underscored that these observations were extremely limited and as such not much can be concluded from them regarding the extent of environmental impact.

## 4. NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA) FOR THE TASMAN SPIRIT OIL SPILL (TSOS)

The Tasman Spirit Oil Spill (TSOS) off Karachi is a major pollution event. The precise extent of this damage should be determined by a methodical scientific investigation

covering all components of the ecosystem – this is called a Natural Resource Damage Assessment (NRDA).

There are 4 primary purposes for a comprehensive NRDA program:

1. to determine the precise extent and severity of ecological injury from the spill;
2. to provide detailed information upon which to base claims;
3. to develop and implement a Restoration program; and
4. to inform, in a transparent and scientifically credible manner, the citizens of Pakistan, particularly those in the effected area, of the extent of the environmental damage from the TSOS.

The assessment of damages to natural resources requires consideration of immediate (acute) injury, long-term injury, sub-lethal injury, ecosystem-wide effects. In general, all components of the potentially affected ecosystem should be assessed for their injury, including coastal habitat, air and water, fish, shellfish, plankton, sediments, marine mammals, terrestrial mammals, and birds.

The initial TSOS impact studies conducted to date by various groups in Karachi have provided valuable but for the most part limited information which gives a very preliminary idea of the environmental impact. Studies to date do not provide the sort of systematic assessment from which a detailed understanding of damages can be understood. In order to make any conclusion regarding the extent and severity of the environmental damage caused by the spill, it is imperative to conduct a three-phase NRDA program as described below.

### 4.1 Phase I - Short-term assessment *(September and as soon as possible)*

Five high priority projects should be fielded immediately:

1. Spill trajectory analysis: It is important to delineate the entire geographic area that could be potentially impacted by the TSOS. Thus, using the most authoritative, pre-existing oceanographic information on water current patterns, together with observed wind / current patterns subsequent to the spill beginning on August 13, a modeled spill map should be produced to delineate the *potentially impacted spill zone*. This spill map will provide the NRDA study area for the subsequent assessments. The oil dispersion has likely not acted in a strictly linear manner, as it would respond to coastal gyres, eddies, convergences, and tidal forces to produce a more complex pattern of dispersion. All this needs to be modeled (estimated) with the best information on current dispersion patterns in the region and observed current and wind patterns post-spill.. This modeled impacted zone should be further refined based on water, sediment, biota, and carcass studies referenced below.

2. Water sampling – a comprehensive assessment of surface oiling and water-column hydrocarbons must be initiated immediately to ascertain the distribution and nature of hydrocarbons and their conversion products across the potentially impacted spill zone. Water quality sampling should be organized along normal scientific sampling procedures, where transects are established and sampled across all potentially affected areas of coastal waters. Objectives are to determine the geographic and temporal distribution of surface, dissolved and particulate TSOS hydrocarbons in the spill impact zone, including their concentrations, persistence, and chemical

composition. A toxicity analysis of these initial TSOS levels in and on the water should be conducted in Phase II of the NRDA in order to estimate potential injury.

3. Sediment sampling: A comprehensive study of hydrocarbons in intertidal, nearshore subtidal, and offshore bottom sediments must also be conducted immediately. This study should follow objectives for the water quality study above, and determine concentrations, persistence, and chemical composition of TSOS hydrocarbons in shoreline and seabed sediments. Sampling should be conducted at a wide range of depths – beach, surf-zone, 1 m, 3 m, 10 m, 20 m, etc., and should be distributed spatially across the potentially impacted spill zone – in the mangroves, in the rivers and creek beds, offshore. With a representative sampling grid, a map of sediment contamination from the TSOS can be produced. Sediment samples should be sufficient to determine the depth distribution and concentrations of hydrocarbons broadly across the spill region. Care should be taken in sediment and water sampling programs to finger print TSOS hydrocarbons to distinguish them from other sources of petroleum in the system. A toxicity analysis of these initial TSOS hydrocarbon levels in seabed sediments should be conducted in Phase II of the NRDA ..

4. Biological monitoring: A biological monitoring program to detect TSOS hydrocarbons should be initiated immediately. This should include field sampling across the potentially impacted spill zone of tissues of at least three trophic levels: a bivalve species (as a bottom suspension feeder); plankton (as a water filter feeder), and a fish species. This bio-monitoring regime could also include deployment of filter feeding bivalves in suspended cages to be sampled at regular intervals for TSOS hydrocarbon contamination.

   The seedling of mangroves and salt tolerant grass should also be included as part of the biological monitoring programme. They are seasonal and are planting their seedlings at this time of the year.

5. Carcass survey and collection: An effort should be made to find and collect carcasses of organisms in the spill impact zone, iIn order to estimate the immediate spill mortality. This could probably best be accomplished opportunistically in conjunction with the water and sediment sampling regime above. All carcasses of marine organisms should be collected and delivered to a central receiving point (wildlife agency, etc.) where they should be identified, measured and weighed, necropsied to determine probable cause of death, and tissue samples should be collected and analyzed for presence of petroleum hydrocarbons. And as most organisms killed by the oil will likely not be recovered, a quantitative effort should be made to estimate the ratio of recovered carcasses / total number of organisms killed (other spill experiences have provided estimates at 1:20 or higher for this ratio).

Samples collected in this program should be subjected to quality assurance and rigorous control in the most proficient and credible laboratories available, and they should have consistent analytical methodologies applied. The guidelines for oil spill follow-up studies produced within the framework of the Helsinski Convention can provide a good basis for the organization of phase 1 – website:
*http://www.helcom.fi/recommendation/guidelines_12_9.htm.*

### 4.2 Phase II – Mid-term assessment *(early October – December)*

All Phase I studies should be continued in the Phase II NRDA program as necessary. In addition, 8 more in-depth investigations should be initiated. All such studies should establish study sites selected across the wide range of habitats in the potentially impacted spill zone, and sampled at regular intervals during the study period. All efforts should be made to keep study methodologies consistent and of high quality. A centralized data management capability, including GIS anlayisis, should be established.

Phase II studies should include:

1. Mangroves: a comprehensive study of the impact of the TSOS on the coastal mangrove ecosystem in the area should be initiated. This should include estimates of oil-injury to mangrove seedlings and their viability upon exposure to the oil. Also, ecological modelling of the potential impact of seedling damage on the reproductive and regeneration of mangrove forests in the spill zone should be conducted. The study should establish several sites for regular analysis over the study period. See attached proposal regarding mangrove damage assessment studies and restoration along the Karachi coast (Annex 3).

2. Fish / Shellfish: A study of the potential injury to various fish, crab, and shrimp populations in the region should be initiated. Indicator species should be selected, such as mudskippers, sardines, mullet, prawn, shrimp, and crab. Their distribution and abundance in the potential spill impact zone should be documented, and tissue samples should be collected from a representative number of these selected indicator species for hydrocarbon, histopathology, and physiological analysis (including blood chemistry and liver enzymes, etc.). This could be done be sampling a small percentage of the fish catch in the region. The fish / shellfish studies should analyze egg, larval, and juvenile stages as well. Studies elsewhere have shown that various stage of fish and shellfish species can be affected by exposure to hydrocarbon concentrations as low as a few parts per billion.

3. Birds: A study on potential impact on birds in the region should be conducted, including a general distribution and abundance compared with both pre-spill information, and/or non-oiled study sites. Indicator species should be selected for more intensive monitoring, including resident birds such as herons, plovers, waders, egrets, sandpipers, kites, crows, ospreys curlews and gulls.

4. Marine Mammals: A survey of marine mammals, including aerial and vessel surveys should be conducted. Of particular note should be the two species of dolphins found in the region, the bottlenose and humpback dolphin. This survey should be compared to the expected distribution and abundance in the region, and/or in other non-oiled regions as a control.

5. Sea Turtles: A monitoring program for green sea turtles and Olive Ridley sea turtles should be initiated. In particular, nesting distribution and success should be ascertained. Any obvious evidence of oiling should be noted on incoming females, and all non-viable eggs should be collected (after the hatchlings have left the nest) to be analyzed for hydrocarbons and histopathology. The out-migration of hatchlings should be monitored in relation to what is found to be the spill zone, and sub-lethal effects should be investigated, including skin lesions, tumors, morphological deformities, etc.

6. Bottom (benthic) organisms: A monitoring program for bottom-dwelling invertebrates should be conducted, including those in sediments (in-fauna), and those on top of the sea bed (epi-fauna). This should include assessment of petroleum hydrocarbon concentrations in tissues, histopathologies, physiological effects, effects on growth rates, reproduction, etc. This study should compare benthic organisms in contaminated areas to those in non-contaminated control sites.

7. Plankton: A monitoring study to assess the potential impact of the TSOS on the phytoplankton and zooplankton communities in the water column should be conducted, as initial information has indicated the absence of certain species in the spill zone.

1. Fate and Toxicity of Tasman Spirit oil: based on studies of Phase I and II, amass balance of the spilled oil should be developed in order to estimate the total tons of TSOS that evaporated, deposited in offshore sediments, deposited on beaches, and dissolved in the water column. And the relative toxicity of the oil to various organisms should be ascertained in laboratory analysis.

Additional ecosystem components may be selected for further study as well, depending on what is found in Phase I.

### 4.3 Phase III – Long-term assessment *Year 2004 (and beyond as appropriate)*

The Phase III NRDA program should be developed on the basis of the results of Phases I and II. After the completion of these initial and mid-term studies (early January, 2004), all investigators should assemble in a symposium to report their results, propose what additional long-term studies should be conducted, as well as what restoration programme should be initiated. Long-term studies should continue on ecosystem components where injury is detected or suspected. A broad request for proposals (RFP) should be noticed to all potential scientific organizations in the region – government, academia, NGOs. Project proposals should be developed Principal Investigators, with objectives, methodologies, and budgets. These should be submitted to the Chair of the EIEC, peer-reviewed, and funded (or not) on the advice of a peer-review committee. Phase III studies should include ecological modeling of the ecosystem effects of the TSOS, based on all previous NRDA results. This should include an assessment of the cumulative, synergistic effects of the TSOS in conjunction with other ecological stressors in the region.

## 5. RESTORATION FRAMEWORK *Year 2004 and beyond*

One of the primary purposes of conducting the above Natural Resource Damage Assessment is to develop and implement a Restoration program. Restoration is generally defined as any action that endeavors to restore to their pre-spill condition any population injured, lost or destroyed as a result of the oil spill, or that replaces or substitutes for the injured resources, or that provides another positive environmental offset to the damage suffered. An ecosystem is considered “recovered” when the population of organisms are again present, healthy, and productive; there is a full

complement of age classes; and people have the same opportunities for the use of natural resources as they would have had the spill not occurred.

Based on the results of the NRDA program, potential options should be developed with which to restore, replace, or provide other environmental benefit to offset the damage from the TSOS. Under the general guidelines of restoration, two main categories are appropriate for consideration regarding the TSOS:

1. Direct Restoration / Rehabilitation – e,g, replanting of mangroves in injured areas, restocking injured fish populations, removal of contaminated sediments, etc; and

2. Indirect Restoration – e.g. redirecting fishing effort to aid recovery, reducing human disturbance around sensitive habitat areas, developing sustainable fishery management regimes, increased enforcement of laws and regulations, protected areas designation, reduction of marine pollution, etc.

*Direct Restoration* of impacted marine populations is often difficult, but any opportunity to do such should be explored and implemented. Beyond such direct restoration opportunities as may be available, it is suspected that the greatest Restoration opportunity from the TSOS may be *Indirect Restoration* - the implementation of other environmental offsets as mitigation, such as general abatement of other pollutants in the coastal ecosystem. The general concept here is that "if you cannot fix what was broken by the spill, at least you should fix something else" in order to provide a net environmental benefit to the impacted ecosystem.

In this context, it is recognized that the coastal environment in which the TSOS occurred was already significantly degraded prior to the spill. An effective Restoration program must take this degraded ecosystem context into account. In the long-term, reducing the chronic, point-source input of pollutants to this coastal area would offer broad ecological and economic benefit, and perhaps be the most cost-effective option for restoration. Additional Restoration options include the designation of the Indus River Delta as an International Biosphere Reserve, implementing the UN Coastal Environmental Management Plan for Pakistan (1992 and 1996), and/or the Strategic Plan for Coastal and Marine Resources Management and Poverty Reduction in South Asia (ADB and IUCN, 2002).

In general, Restoration should aim to contribute to a healthy, productive, and biologically diverse ecosystem. The program should assess what limitations may exist to the sustainability of the coastal ecosystem, and develop options to mitigate such limitations. Restoration decisions should take into account what extent natural recovery is occurring, the priority of the resource both ecologically and economically, and the technical feasibility of the option.

The Restoration program should be subjected to independent scientific review, government acceptance, and be responsive to local residents concerns and ideas. Without presupposing what sorts of Restoration options should be selected, some potential options for consideration include the following:

**5.1 Potential Restoration Options -** Direct Restoration possibilities

1. *Protection, rehabilitation, and replanting of mangroves* in affected areas, reseeding mangroves in areas already cleared or disturbed prior to the spill (see Annex 3).

2. *Restocking of fisheries* (through aquaculture techniques) to supply additional food resources for predators, and additional resources for fishermen.

3. *Clean contaminated sites* in the coastal ecosystem, using bioremediation, mechanical removal, etc. This could include TSOS contamination, as well as other contamination.

4. Test feasibility of *enhancing bird nesting success*, via predator deterrence, artificial nest sites, etc.

**5.2 Potential Restoration Options -** Indirect Restoration possibilities

5. *Intensified management* of fish and shellfish populations to prevent overfishing: existing fisheries could be restricted or redirected to other areas to enhance the fish populations and the predators dependent upon them. Various restrictive management tools could be considered, including catch limits, additional gear restrictions, time / area closures to fishing, fish size restrictions, etc.

6. *Intensified management* and protection of sea turtle, bird, and marine mammal populations -- reducing human disturbance of sensitive habitats for priority species by restricting human access to sensitive habitats, implementing measures to reduce the incidental take of such species in fish nets, expanded buffers around sensitive habitats, etc.

7. *Increased enforcement* of fish and wildlife laws and regulations – the provision of funds for additional enforcement officers, vessels, aircraft, etc, to reduce illegal harvests, both nearshore and offshore, and to catch those using non-approved methods.

8. *Reduce or Eliminate introduced species* from the ecosystem, e.g. rats, through rat trapping, etc.

9. *Coastal pollution abatement initiative* - Develop an aggressive initiative to reduce or eliminate point-source pollution into the spill impacted region. This should include a comprehensive analysis of the effluent discharge from all tanneries, steel mills, power plants, textile mills, refineries, sewage outfalls, fishing vessels, large ships (deballasting and pumping of bilges), port facilities, etc. in the region. The U.N. Coastal Environmental Management Plan for Pakistan (1996) is a good context for this. On the basis of the comprehensive analysis and mapping of all effluent discharges into the coastal ecosystem, a detailed plan for the reduction of such deleterious point-source inputs should be prepared with a necessary budget, timetables, and measurable outcomes. It is proposed that the target for completing this program be year 2010. This project should be contracted to a credible

environmental engineering firm, with a proven track record on such large pollution abatement projects. Initial emphasis should be on Karachi Harbor, Manora Channel, Karangi Creek, and Chinna Creek.

10. *Marine debris cleanup and control* – the large amount of plastic debris in the coastal ecosystem should be cleaned up – from beaches, mangroves, and nearshore waters to the extent practicable. Such debris is well known to effect many marine organisms, including birds, fish, mammals, and sea turtles. Also, a program to eliminate this source of degradation in coastal waters should be implemented – improved solid waste management on-shore, better on-shore collection facilities, an education program, etc.

11. *Economic alternatives for local fishermen* – as the offshore fishery is dominated at present by foreign vessels, a program to award a portion of the offshore fishery catch / quota progressively to small nearshore fishing coops could gradually phase out foreign fishing and develop an all-Pakistani, domestic fishery. Also, a fishery observer program for offshore foreign fisheries could be implemented (or expanded if it already exists) to provide additional enforcement of fishery regulations as well as to train coastal fishermen in offshore fishing technologies.

12. *Develop tourism / recreational alternatives* to substitute for the loss in tourism and recreational opportunities – development of new parks and other tourist amenities along the beaches, etc.

13. *Provide alternative home energy resources* (bio-gas generators, charcoal, wood from elsewhere, compressed paper logs, etc.) for coastal residents who currently harvest mangroves, etc. for cooking, etc.

14. Designation of the *Indus Delta International Biosphere Reserve*, to be managed accordingly. This will require extensive financial resources, including those necessary to increase water flow down the Indus and to sustainably manage the Delta ecosystem.

15. *Develop an environmental education* program for children and adults to increase awareness of the importance of conservation and sustainable management.

16. *Initiate a feasibility study for the use of solar* power to reduce reliance on imported oi.l

## 6. NRDA PROGRAM MANAGEMENT

*Finances:* in keeping with the concept of strict liability (where the polluter pays regardless of fault), it is suggested that the government of Pakistan negotiate with the Responsible Party to receive funds with which to conduct Phase I and Phase II of the NRDA program. This amount should be credited against the final claim for damages by the government of Pakistan against the Responsible Party.

The implementation of the coastal pollution abatement initiative (Restoration option 9 above) will be expensive. Thus, additional funds necessary to implement this pollution abatement program above those provided by the TSOS Restoration program may need to be sought from donor agencies.

*Management*: it is suggested that the Sindh Environmental Protection Agency (SEPA) be given overall management authority for the NRDA program (serving as Chair of the process), in consultation with technical advice from the IUCN Pakistan; and the United Nations Environment Programme (UNEP). In addition, a reputable Chief Scientist with local knowledge and experience in biological monitoring should be appointed to oversee all projects proposed and conducted in the NRDA program. It should be the responsibility of this Chief Scientist to develop the request for proposals, and consult with various organizations in recommending to SEPA which projects merit funding. Final decisions regarding funding must rest with the Chair of the NRDA program. Each project should have a lead agency and a Principal Investigator, clearly defined objectives, statistically valid methodologies, and a reasonable budget. As part of their academic training, consideration should be given for university students to undertake certain projects under the supervision of the Principal investigator.

It is recommended that SEPA establish a Scientific Advisory Committee to the TSOS NRDA, chaired by the Chief Scientist, and including such organizations as, IUCN, WWF, the National Institute for Oceanography (NIO), Pakistan Council of Scientific and Industrial Research (PCSIR), the University of Karachi's various departments, the Centre of Excellence in Analytical Chemistry at the University of Sindh, and others as appropriate.

## 7. SOCIO-ECONOMIC DAMAGE ASSESSMENT FOR TASMAN SPIRIT OIL SPILL (TSOS)

In addition to a comprehensive NRDA program (for environmental damage), there is need to conduct a detailed assessment of the socio-economic damages caused by the TSOS, including commercial losses, social/cultural losses, and human health damage. These socio-economic damages will form the basis of a claim for compensatory damages to be collected from the Responsible Party, and used to compensate those suffering losses as a result of the spill. The Aga Khan Community Sciences could coordinate this assessment.

## 8. A NATIONAL SYSTEM FOR PREPAREDNESS AND RESPONSE

Accidental marine oil for the most part is generally considered as an environmental emergency which may have a serious impact on the population, on its economic activities as well as a certain degree of damage to the ecosystem. It is generally expected that governments undertake response measures and to exercise direct control over the operations or to co-ordinate the response. Regardless of the scale of the oil pollution, response to a marine pollution emergency can only be successful if the response organization exists, if the strategy of response has been agreed upon in advance and if the trained personnel, tools and equipment are available to operationally execute such a strategy.

Pakistan has prepared a draft National Contingency Plan (NCP) which is presently awaiting approval. Accordingly the response is based on 3 levels. Level 1 is the oil spill situation in which the Agency (Port Authority/Provincial Organization and Institutions) in whose jurisdiction the oil spill has occurred to be competent to respond to the oil spill without activation of the NCP of Pakistan. Accordingly the Agency which would act as lead Agency may however request assistance from any other Agency under mutual agreement to respond to the oil spill under Level 1. Level 2 is the oil spill status in which the Agency whose jurisdiction the oil spill has occurred requests the National Environmental Coordination Committee (NECC) chaired by the DG by the Federal EPA which is responsible for the execution of the NCP to activate the NCP irrespective of size of the oil spill.. Level 3 is the situation in which the NECC request international assistance. NECC is supported by an Admin & Finance Committee whilst operational matters to combat the spill is given to the DG of the Maritime Security Agency who is designated as the coordinator of the Operations Committee.

In light of the lessons learnt, it would be recommended that the NCP is revisited to reflect in light of this experience before it is taken further. Furthermore this exercise should be part of the contribution to building the capacities for preparedness for and response to oil pollution. Such a project needs to be placed within the context of the International Convention on Oil Pollution Preparedness Response and Cooperation, 1990 (OPRC 90) which Pakistan has ratified, the South Asia Cooperative Environment Program (SACEP) established by UNEP and National Environmental Action Plan supported by UNDP in the field of environmental capacity building. The overall objective of the project shall be to establish an efficient and reliable national system for preparedness for and response to accidental marine oil pollution. The Project could have the following specific objectives;

- to revise and update the **draft national contingency plan** and related regional, local, public and private plans for the Provincial area of Sindh;

- to prepare **legislation** establishing a national system (organization) for accidental marine pollution response preparedness;

- to make detailed **risk assessment** for Karachi Port and Port Qasim;

- to introduce **sensitivity mapping and oil spill modeling**, as tools for developing proper response strategies; such sensitivity mapping should not be developed just for oil spill response but to support response to all human activity influencing the marine environment;

- to establish **a database on national expertise and programmes** on oil related matters;

- to **identify oil spill response equipment, products and other means** required for the effective implementation of the National Contingency Plan, and to facilitate the procurement of necessary material and the setting up of response equipment stockpiles;

- to facilitate the **establishment of an Oil Spill Response Centre** equipped with communication equipment for use in case of emergency covering Karachi Port and Port Qasim;

- to **train** sufficient number of response personnel at different levels, in various aspects of oil spill response, with a view to enabling effective functioning of the national system and the implementation of the National Contingency Plan within areas extending from Karachi port to Port Qasim.

## 9. OIL SPILL COMPENSATION

Pakistan has not ratified the international compensation Conventions for oil pollution damage: the 1992 Civil Liability Convention (for Oil Pollution Damage) and the 1992 Fund Convention (International Convention for Compensation for Oil Pollution Damage). Reliance in the event of the TSOS may have to be placed on the broader laws originally developed for other purposes unless Pakistan has its specific domestic legislation for compensating those affected by oil spills from tankers in its territory. If the former applies there can be considerable uncertainty in the event of the TSOS as to the legal, operational and financial responsibilities of the main parties involved as well as to the amount of compensation that is going to be available for clean up and restoration/reinstatement of an impaired environment.

The 1992 CLC and 1992 Fund Convention provide a straightforward mechanism whereby the costs of clean-up and pollution damage can be recovered on strict liability basis from the individual tanker owner and P&I Club involved in the incident and from the 1992 Fund so long as the clean-up measures taken in response to an incident and the associated costs are reasonable and the claims for compensation are well presented. It this regard it would be recommendable that Pakistan ratify the 1992 CLC and 1992 Fund Convention.

## 10. SUMMARY OF RECOMMENDATIONS

- The extent of damage be determined by a methodical scientific investigation covering all components of the ecosystem through a Natural Resource Damage Assessment (NRDA).

- The NRDA should be composed of:
  Phase 1 – Short term assessment (September and as soon as possible);
  Phase II – Mid-term assessment (early October to December);
  Phase III – Long term assessment (Year 2004 and beyond).

- All NRDA investigators should assemble after Phases I and II to report their results to date, recommend further studies as necessary and agree on a draft restoration plan.

- The Government of Pakistan should approach the Responsible Party to receive funds with which to conduct Phases I and II of the NRDA.

- Overall management authority for the NRDA programme should be vested in SEPA with technical advice from IUCN Pakistan and UNEP.

- A chief scientist with local knowledge and experience in biological monitoring should be appointed to oversee NRDA science projects.

- Develop and implement a Restoration programme which should comprised of:
  Direct Restoration/Rehabilitation;
  Indirect Restoration.

- Implementation of the Restoration programme should be done through project development. UNEP, UNDP and IUCN Pakistan should be approached to assist in the design, management and implementation of the projects.

- A high priority for the Restoration programme should be the coastal abatement initiative.

- An assessment of socio-economic damages should be conducted.

- The draft national contingency plan for oil spill response should be revisited and strengthen within the framework of a process for building capacities for oil response preparedness. UNDP, IMO and UNEP should facilitate the process consistent with their mandate.

- Pakistan should ratify the 1992 CLC and 1992 Fund Convention.