## 6.0 NATURE AND EXTENT OF CONTAMINATION

6.1 CONTAMINATION SOURCES Historical reviews of the industrial use at the IHNC sites showed contaminated soils resulting from both point and non-point pollution (Goodwin & Associates, 1992; NOD, 1992). About 20 to 24 localities of concern were identified during the site visits conducted by USACE-NOD (1992). Fourteen (14) potentially contaminated localities were added during the actual sampling program while two (2) areas along the floodwall were initially selected for background samples. Point sources of contamination are fuel storage tanks, paint storage or work facility, metal work facility, oil-saturated soils and other waste piles such as blasting sand piles, stacks of containerized waste (e.g. drums, paint cans and cylinders) and mixed waste mounds. These sources are more or less stationary. Non-point pollution are essentially exemplified by the use of blasting sands as re-surfacing materials, by probable indiscriminate dumping of used oil, fuel or paint solvents on the ground, and by flooding from potentially contaminated canal water.

Contents of tanks, drums, cans and cylinders were not sampled during the field investigation. Rather, sampling of soils around these containerized products or wastes as well as an inventory of these containers were undertaken. The inventory list as of 15 July 1993 yield the following: about 38 tanks containing deisel and gasoline fuel, blast sands and propane gas; about 122 55-gallon drums containing motor oil (virgin, old and used), rust preventive coatings or corrosion inhibitors, lubricants, thinner or cleaning compounds, resin solution and other organic-compound bearing product; about 350 1- and 5- gallon cans containing assorted paint material, epoxies, resins, thinners and a variety of solvents; and about 3 cylinders containing gases such as acytelene and oxygen. This list includes containers that may be full, half full or empty. The structural integrity of the containers range from good for relatively newer drums to very poor for rusted old drums. About 60 percent of these containers are found at the Saucer Marine drum area, about 30 percent are located at the Indian Towing warehouse, trailer and grounds while the rest are distributed between MacDonough Marine, Distributor's Oil, Mayer Yacht and Boland Marine. Not included in this list are drums of motor oil stocked by Distributor's Oil which currently operates as a marine fuel service station.

The above waste sources potentially have released a garden variety of organic and metallic pollutants. The waste mounds in the Saucer Marine area are examples of a collection of wastes where blast sands, oil-saturated soils and probable creosote-treated wood poles are intermixed. The oil in the soils may have been adulterated by chlorinated hydrocarbons from cleaning solutions, by metals from engine wear and by deisel fuel or gasoline.

### 6.2 SAMPLING PROGRAM AND ANALYTICAL RESULTS

As mentioned earlier, the sampling program at IHNC has been guided by a CDAP following engineering guidance ER-1110-1-263. Soil gas, soil and groundwater sampling were conducted in 12 April to 19 May 1993 (Phase 1 survey) and in 12 July - 13 August 1993 (Phase 2 survey).

The passive soil gas survey was collaboratively undertaken by USACE-NOD and NRI during Phase 1 field investigation. The investigation procedure and results are outlined in the NRI soil gas report. Briefly, about 50 per cent of the locations sampled for soil gas show elevated levels of hydrocarbon contamination. The survey identified about 15 "organic hot spots" that were accounted largely to heavyweight hydrocarbons including diesel, waste oil, tar and creosote. The relative response map in Fig. 6.0 shows the distribution of the heavier hydrocarbons, $C_8$ - $C_{13}$

cycloalkanes and alkenes, at the site. Lightweight volatile organics, which includes the BTEX group, are regarded by NRI as less widespread than the heavier hydrocarbons (see Fig. 6.1). Their occurrence are accounted largely to weathering and degradation of the heavy hydrocarbons, to isolated gasoline spills or leaks and some redistribution by the shallow groundwater. Chlorinated hydrocarbons are reported to be the least widespread of the organic contaminants and are found in isolated areas. They are detected in 16 soil gas sampling points with relative responses ranging from mostly very low to few moderate. The chlorinated compounds identified by NRI in the soil gas are methylene chloride, trichloroethene, tetrachloroethane, chlorobenzene and dichlorobenzene. The above results were documented in chemical distribution maps and in specific organic compound listings of soil gas laboratory analyses. Caution must be used in interpreting these results as the soil gas data can be largely influenced by the sampler location, subsurface geology and behaviour of the soil gas in the subsurface.

Soil and groundwater sampling were conducted soon after the soil gas samplers were installed, retreived and shipped for analysis. Before the results of the soil gas survey are made available, sampling of surface soils were confined at or near potential waste sources or waste piles. Deeper soil sampling up to project depths were conducted during Phase 2 survey. Placement of borings for sampling deeper subsurface soils were selected with the aid of soil gas results, preliminary soil and groundwater analytical results and ground water flow investigations at the site.

For ease of analysis and interpretation, EIRA analytical results such as shown in Annex 2 are summarized in Table 6.1a thru Table 6.1e. The analytical results of the soil samples are grouped as follows : (1) bulk or total, (2) fuel tanks, (3) oil-saturated soils, and (4) TCLP. The total concentration data are further subdivided into: (1) surface soils or shallow borings and (2) subsurface soils or 35-foot deep borings. Summary results of the groundwater samples are listed in Table 6.2. The RPD results of field quality control samples are also presented in these tables.

A summary of the positive or detectable results are likewise shown and are compared with clean-up action levels recommended by EPA (Table 6.3a thru Table 6.3c). The summary results are also compared with analytical results of sediments and water samples from the IHNC Canal, MR-GO Disposal Water and the Mississippi River (Table 6.4). The information provided by Table 6.1e, 6.3a thru 6c and 6.4 is helpful in exploring disposal and *treatment options selected for the ByPass Channel excavation soils.*

Since the water level of the shallow groundwater table ranges from the surface to 3.25 feet below the ground surface, the soil samples sent for analysis are a mixture of soils, some trapped gas and some moisture or trapped water. Lyman et al. (1992) list thirteen (13) physicochemical loci (settings or locations) where organic contaminants occur in the subsurface, from the the ground surface through the vadose zone and into the water table. The pollutants analyzed in the IHNC soils are those present in either one or more of these loci. A detailed characterization of pollutants in the different soil loci would be very helpful in treatment or remediation design. This exercise would be a very difficult task since pollutants are also known to be transient between these locations and their concentration constantly changes in the various phases of each loci. The concentration of pollutants in each loci depends upon their partitioning between the phases occupying each loci, their stability in each location and the rate of transfer of pollutants from one loci to another. In lieu of detailed characterization of the occurrence of pollutants in soil samples, pilot tests are conducted to improve treatment or remediation design of contaminated soils.

6.2.1 SOIL ANALYTICAL RESULTS As mentioned earlier, the analytical results listed in Table 6.1a thru 6.1e are summarized from raw data submitted by the contract laboratory to USACE-NOD. The complete laboratory data sets are compiled in seven 2 to 3-inch thick binders and are available for inspection in their entirety at USACE-NOD. The location of the soil samples listed in the summary tables are shown in Fig. 4.1 and Fig. 4.2.

Table 6.3a and Table 6.3b list only target pollutants with detectable concentration levels. The different range in detection limits is a function of the concentrations of the compounds present in the sample, the sample matrix, and the analytical methods employed. The frequency of detection such as 5/25 indicate 5 positive hits in 25 samples analyzed. Overall, the elements and compounds detected in the soils include about 7 metals, 21 volatile organics, 21 base / neutral semivolatile organics and 2 pesticides. A total of 14 chlorinated hydrocarbon compounds were also detected, 11 of which are listed in the volatile organic group. Soil samples tested for PCBs and herbicides show concentrations below the detection limits of the methods employed. The data also show positive results for TPH, oil and grease, BTEX and asbestos (see Table 6.1c, Table 6.1d and also Annex-2 for asbestos). Dioxin screen for three samples from the Saucer Marine drum area yield negative results (Annex-2).

Soil samples tested for toxicity with the EPA TCLP method yield positive results only for the metals and are below detection limits for the rests of the TCLP compound list (Table 6.1e). The samples tested are all from shallow borings and do not include samples from the 35-foot deep borings. Among the metal group, lead shows results that are close to failing the regulatory limits; most of these samples are found in Indian Towing soils. One sample from Boland Marine (IC-BS-10) with 7.0 mg/l lead in the TCLP extract failed the toxicity test for lead which has a toxicity limit of 5 mg/l. Re-analysis of this same sample at two separate analytical events however yield 2.8 mg/l lead and 4.3 mg/l lead.

Because most of the industrial activities at the site are concentrated at the Canal side, soils collected near the floodwall were initially assumed as background samples. Two (2) shallow soil samples (IC-BS-9 and IC-IS-6) and twelve (12) samples from two (2) 35-foot deep borings (IC-5 and IC-6) were collected and analyzed for background. One (1) water sample from the floodwall was also collected for background. The analytical results show contamination in some of these samples. Sample IC-BS-9 is contaminated with semivolatile compounds (e.g. PAHs) characteristic of deisel fuel and used oil while deep surface samples from IC-6 show slight volatile organic contamination. Re-analysis and results of duplicate samples show repetitiveness in detectable concentrations of the same compounds in IC-BS-9. These positive PAH results indicate isolated spills in soil along the floodwall probably from lawn mower equipment that maintain the floodwall levee. In this investigation, samples with the lowest metal and organic compound concentrations are assumed to be background.

6.2.1.1 SURFACE SOILS, SHALLOW BORINGS About 51 samples were collected from shallow borings to obtain an inventory and concentration levels of metal and organic pollutants in the surface and shallow soils. Another 46 samples were collected to characterize product-rich areas (oil-saturated soil and fuel tanks) and to define the limits of soils contaminated with used oil and petroleum fuel. The above list does not include about 6 samples collected from the top 5 feet of the 35-foot deep soil borings which will be discuss in the next section.

The following discussion focuses on samples listed in Table 6.1a, samples collected around fuel tanks and oil-saturated soils are discussed in more detail in Section 6.2.2. Detectable compounds in shallow soil samples yield a list of about 7 metals, 20 volatile organics (of which 11 are chlorinated), 21 semivolatile organics, and 3 other chlorinated

hydrocarbon compounds (Table 6.3a). Except for benzidine and bis(2-Ethylhexyl)phthalate, the detectable contaminants show concentrations ranging from 3 to 100,000 times lower than 1990 clean-up action levels proposed by the EPA.

Among the RCRA metal group, the metal of concern is lead. The 1990 EPA criteria do not list a numerical criteria for lead. Lead detectable concentration ranges from 9.6 to about 4690 mg/kg. Lead in soils usually range from 2 mg/kg to 200 mg/kg (Dragun, 1985). Assumed background soils at the site, such as IC-IS-6 and deep soils in borings IC-5 and IC-6, average about 8 mg/kg. High lead values (say, >100 mg/kg) are detected in soils associated usually with blast sand materials which are found scattered on the ground surface in almost all of the industrial sites from Boland Marine thru International Tank Terminal (Fig. 6.2). Sand and other abrasive materials were used for commercial blast cleaning of metal surfaces of marine vessels. These high lead blasting sand materials are usually dark colored and are either collected as waste piles or used as resurfacing materials on roadways or work areas. At some areas such as Boland and Indian Towing, the sandblast waste material also display high organic values associated with waste oil and petroleum fuel. Some high lead values (>100 mg/kg) are also found in soils associated with other sources of pollutants such as fuel storage tanks in the Saucer Marine (IC-SS-9) and Boland Marine (IC-BS-1) areas.

Detectable heavy, semivolatile hydrocarbons (i.e. polynuclear aromatic hydrocarbons or PAHs) such as fluoranthene, benzo(a)pyrene, pyrene, chrysene, benzo(a)anthracene and others are associated with oil and deisel fuel which are found to saturate soils in the Saucer Marine (5 areas), Mayer Yacht (1 area), Distributors Oil (2 areas) and Boland Marine (2 areas). Detectable values range from about 200 to 9900 ug/kg in shallow subsurface soils.

Because of the presence of other potential pollutants such as metals and chlorinated hydrocarbons, the oil-saturated soils are more likely adulterated with chlorinated solvents, metals from engine wear, light weight hydrocarbons and, perhaps, other heavy oils (e.g. lubricating, cutting oils) during or after use of the oil. Heavy hydrocarbon contaminated soils are found near work facilities, shed or areas associated with compressor engines, generators, repair shops, etc. Soils contaminated with lightweight hydrocarbons such as BTEX are associated with fuel storage tanks. Outline of soils contaminated with used oils and lighter weight petroleum hydrocarbons are shown in Fig. 6.3.

Concentrations of chlorinated hydrocarbons in the surface soils range from 5 to about 1000 ug/kg. Detectable chlorinated hydrocarbons in soils can be classified into two groups and may be reflective of the type of industrial activity at the sites : (a) chlorinated organic solvents such as trichloroethene, and (b) the aromatic group such as chlorobenzene. Soil samples from the Boland Marine Site show prevalence of compounds belonging to the chlorinated organic solvents while those in the Saucer Marine area include the aromatic chlorinated hydrocarbons.

Other volatile organic compounds detected at a relatively high frequency and concentration include methylene chloride, acetone, 2-butanone, toluene, ethylbenzene and xylene. The first three (3) compounds are also listed as laboratory contaminants by EIRA and are detected in laboratory blanks while toluene is recognized as a common laboratory contaminant. Since the above compounds are also present in laboratory blanks, their concentration in the soil samples analyzed may be overestimated.

Benzidene, dibenzofuran, and bis(2-Ethylhexyl)phthalate are detected at relatively low to high levels. In surface soils, the first two compounds show low concentration and frequency of detection (i.e. 1/37). Benzidine concentration was estimated below the limit of quantification. The

dibenzofuran was detected in one of the splits of a composite sample from the Saucer Marine drum area. Since furans are known to occur with dioxins, three discrete soil samples from the drum area were collected and sent for a dioxin-screen test, the test yielded negative results. The phthalate compound, bis(2-Ethylhexyl)phthalate, is known to occur in laboratory blanks. It is detected in soils from Boland Marine, Indian Towing and Saucer Marine (deep soil sample). Its high concentration and higher frequency of detection in the Indian Towing area relative to other industrial areas suggest the presence of this compound in the soils at the Indian Towing site.

6.2.1.2 SUBSURFACE SOILS Compared with samples from shallow borings, overall concentration levels of metal and organic compounds in samples from the 35-deep borings are lower. Samples from the 35-foot soil borings likewise yield fewer detectable metals (5 elements), volatile organics (12 compounds) and semivolatile organics (9 compounds). In addition, the frequency of detection of the organic compounds dropped in soil samples collected from deep borings. Unlike the samples collected from shallow borings, two pesticide compounds were detected in a soil sample from the deep borings. Of the volatile organics detected, 6 compounds are chlorinated. As in soil samples from shallow borings, except for lead and mercury (in sample IC-2-1), the highest detectable concentrations in this group of soils are 5 to 95,000 times lower than the 1990 soil action levels proposed by EPA.

A detailed examination of the 35-foot deep soil borings show that samples collected from about the top 5-foot section of the borings show higher levels of concentration in both metals and organics than deeper soils (see Table 6.1b). With few exceptions such as probably toluene, analytical results in the deeper soils more likely represent background values at the site.

The vertical lead concentration profiles in IC-1, IC-2, IC-3 and IC-4 (see Fig. 2.3 and Table 6.1b) illustrates clearly the drop in metal concentration in soils deeper than about 5 feet indicating the probable absence of extensive vertical transport of metals in the deep subsurface soils. Concentration levels of semivolatile organic compounds, to some extent, also show similar behaviour as the metals. This is well-illustrated by IC-1, IC-2 and IC-3 where high organic contamination are observed to be generally confined at the nearsurface soils. The contaminants in IC-1 are characteristics of heavy hydrocarbons in waste oil and deisel fuel. Contaminants in IC-2 (Indian Towing) and IC-3 (Saucer Marine) are related to plasticizers which are also found in deeper soils. In addition, dibenzofuran was detected in one deep soil sample from boring IC-2. The phthalic and furan compounds are known to be relatively stable compounds and not very mobile. If these compounds are not due to contamination from the boring operation with the drill rig, their presence in deeper soils suggest their potential for migration. The occurrence of bis(2-Ethyl hexyl)phthalate at Indian Towing and Saucer Marine is not surprising as historical land use study and inventory of containerized wastes indicate the use of resins and epoxies which are known in the plastic industry to be associated with plasticizers.

Vertical concentration profiles of the borings show the volatile organic compounds to be the most mobile among the target pollutants. Like metals and the semi-volatile compounds, the concentration levels of the volatile organics are typically higher in soils collected from the near surface than from those of the deeper subsurface. This is very well illustrated in boring IC-2 (Indian Towing) where the top soil show high concentrations of ethylbenzene, xylene and toluene.

Volatile compounds detected at depths include chlorinated compounds (TCM, EDC, 1,1,2 Trichloroethane, TCE and TeCE), toluene, ethylbenzene, and xylene. The chlorinated compounds are found in the deep subsurface soils

of IC-1 (Boland Marine) and IC-6 (Jourdan Avenue, outside the floodwall). The results in soils from IC-6 suggest potential migration from the site although these contaminants can come from leakage of the storm drainage facility that runs parallel to Jourdan Avenue. Other compounds detected at depths are methylene chloride, acetone, 2-butanone and carbon disulfide. These compounds are also detected in the blanks and are commonly recognized as laboratory contaminants. Their concentrations in these soils can thus be overestimated.

6.2.2 GROUNDWATER ANALYTICAL RESULTS About 25 groundwater field samples and 6 quality control samples were analyzed for parameters including metals, volatile organics, semivolatile organics, chlorinated hydrocarbon, PCBs, pesticides, and herbicides. Analytical results of the groundwater field samples are listed in detail in Table 6.2 and summarized in Table 6.3c. The groundwater field samples show elevated values for metals including arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. Except for silver, the metal concentration levels ranges from 1.5 to about 38 times higher than the 1990 EPA action levels for drinking water (Table 6.3c).

The water samples also show positive hits in 11 volatile organic compounds, 6 semivolatile organics and 8 chlorinated hydrocarbons (5 of which belong to the volatile compound group). Groundwater show negative hits (i.e. concentrations below quantitation limits) for compounds including PCBs, herbicides and pesticides. Except for benzene, methylene chloride and bis(2-Ethylhexyl)phthalate, the detectable concentrations of the organic compounds are about 4 to 2000 times below the 1990 EPA action levels for drinking water. As indicated earlier, methylene chloride and bis(2-Ethylhexyl)phthalate are also detected in blanks and because of their low frequency of detection (i.e. 1/15), their occurrence in the groundwater at high concentrations may be suspect.

6.2.3 SEDIMENT ANALYTICAL RESULTS. Based upon the results of the TCLP testing presented in Table 4.4a thru Table 4.4n, the sediments of the IHNC channel and the proposed disposal area were not considered hazardous under RCRA. All constituents tested for were either below detection limits or were significantly below the TCLP criteria limit. All detection limits were below TCLP criteria limits. Therefore, the sediments in the channel and disposal area are not hazardous and require no special hazardous waste handling.

6.2.4 FUEL TANKS, OIL-SATURATED SOILS AND OTHER AREAS OF CONCERN Analytical results of samples from areas investigated specifically for leaks from fuel tanks and for used-oil contamination are listed, respectively, in Table 6.1c and Table 6.1d. Most of these areas were initially investigated during the Phase 1 survey. Of about sixteen (16) areas examined for contamination from used-oil and petroleum fuel, ten (10) areas may have significant contamination. These include oil-saturated areas in Boland Marine (2 areas), and Saucer Marine (5 areas), and above-ground storage tanks at Saucer Marine (1 area), McDonough Marine (1 area) and Distributor's Oil (1 area). One area with visible oil contamination at Mayer Yacht was not sampled during the investigation. A feasibility study on six (6) areas, all in Saucer Marine, were initiated during the Phase 2 survey.

The analytical data in Table 6.1c show that among the tank areas investigated, soils at the Saucer Marine and Distributor's Oil are relatively highly contaminated with petroleum fuel. Feasibility studies at the Saucer Marine tank show contaminated soils up to 15 feet away from the tank and transfer station (see Fig. 6.3, Fig.4.2 and Table 6.1c). BTEX concentrations in Saucer Marine yield a high level of about 350 mg/kg which is 3.5x a potential clean-up level of 100 mg/kg. TPH from the same area are likewise above 100 mg/kg, ranging from 123 mg/kg TPH (gasoline) to 3040 mg/kg TPH (deisel). Contamination at Distributor's Oil is

observed to be confined towards the Canal side of a tank field, around the office / storage building and the transfer station. Although BTEX concentrations in soils are below 100 mg/kg, TPH (diesel oil) yield a high of 1440 mg/kg. Lead in soils show 113 mg/kg in Saucer Marine and 209 mg/kg in Boland Marine. Groundwater samples collected around tanks show detectable TPH concentration levels of 31.9 mg/l (Distributors Oil) and 49.1 mg/l (McDonough Marine).

The oil-saturated soils in Saucer Marine show detectable TPH ranging from 186 to 14300 mg/kg (deisel), and, oil and grease concentrations ranging from 149 to 98000 mg/kg. Soil samples from two (2) areas (Locality 16P and Locality 2P) contain low levels of chlorinated hydrocarbons such as dichloroethane, trichloroethene, tetrachloroethane and chlorobenzene. Polynuclear aromatic hydrocarbons in the oil-saturated soils were not detected by EIRA using EPA 8100. Accordingly, the presence of high concentrations of other heavy hydrocarbons such as those found in lubricating and cutting oils interfered with the detection of the targeted PAHs (Stehling, W., personnal communication, 1993). However, preliminary analysis using EPA 8270 of composite samples from the same localities yield detectable PAHs indicating the presence of PAHs in the soils. The lead values in soils collected from the most oil-saturated portion of the localities ranges from 75.3 to 646 mg/kg. Soils collected at depths of 3 feet and 5 feet from locality 4P and Locality 5P yield lead values from 34.2 to 108.0 mg/kg indicating possible lead migration at shallow depths.

Other areas of concern investigated are those examined for special types of pollutants including asbestos, dioxin, PCB and rodenticides (or pesticides). Analytical results of soils collected for these special type of wastes were discussed earlier and, except for asbestos, yielded negative results. Samples investigated for asbestos yield positive result with 5 to 10 % chrysotile fibers in a soil sample from Boland Marine (IC-BS-4) and negative result for a sample from Saucer Marine (IC-SS-1).

7.0 <u>CONTAMINANT MIGRATION</u> Figure 7.0 is a conceptual model which illustrates one interpretation of contaminant migration along major physical pollution pathways identified at the site. As shown, the site includes several receptors and / or structures that would restrict surface migration of the contaminant within the site and the Canal. The thick fat clay unit generally underlying coarser soil material at the surface acts as an aquitard that effectively would limit extensive vertical migration of pollutants.

Horizontal migration to the east of the site are retricted by a 2-3' deep drainage ditch that runs parallel to Surekote Road and by an apron of sheet piles along the floodwall. The drainage ditch collects surface run-off and intercepts the upper portions of the shallow groundwater flowing towards the floodwall. The ditch drains its water back to the IHNC Canal near the fenceline between Saucer Marine and International Tank Terminal. The sheet piles surrounding the site extend from the top of the levee to depths of -8.0 feet (NGVD). Originally constructed as a flood protection structure, the sheet pile apron also contributes to preventing extensive horizontal migration of pollutants.

There are likewise several buried drainage systems in the Boland Marine, Indian Towing and Mayer Yacht areas. These drainage pipes (or boxes) are

example PAHs remain adsorb in soils or mixed in heavy hydrocarbon-rich

nonaqueous phase liquids below oil-saturated soils. In the Canal, the heavier pollutants would settle at the bottom and intermix with the Canal sediments while the soluble and ligther pollutants are carried by the Canal water away from the project site. It is probable that Canal water seeps into the subsurface soils underlying the site via strata more permeable than clays (e.g. thin lenses of silt) thus cycling pollutants from the surface and into the underlying subsurface soils.

8.0 TENTATIVE DISPOSAL / TREATMENT OPTIONS Data is sufficient to tentatively examine disposal and treatment options at the site. The following discussions pertains only to soils represented by analytical results of samples collected so far. There may be potential areas missed by the present investigations.

Based on the EPA TCLP criteria, the analytical results indicate that the bottom sediments from the Canal do not require special hazardous handling. The most contaminated soils at the project site occur within the top 5 feet of the soils underlying the east bank investigation area. Much of the soils below 5 feet from the ground surface are generally background soils. Although vertical concentration profiles show some contaminated soils at depths, concentration of the targeted pollutants are way below the 1990 EPA numerical criteria for soils that requires remedial action.

Highly contaminated soils at the site include those mixed with blast sands, used oil and petroleum fuel (Figure 6.2 and Figure 6.3). Contaminants of concern in these soils are lead, polynuclear aromatic hydrocarbons (PAHs), and BTEX. Not included in this list are hazardous substances such as benzidine and bis(2-Ethylhexyl)phthalate which are found above the EPA action levels in bulk soils. Benzidine was detected in only one sample (IC-TS-6) and below the quantitation limit of the analytical method. The soil sample with an anomalous concentration of bis(2-Ethylhexyl)phthalate was collected from Indian Towing, the persistence of high concentrations of this compound in the Indian Towing soils may need further investigation.

Based on the TCLP criteria and, to some extent, on the 1990 EPA proposed rules for action levels in bulk soils, much of these soils are generally acceptable for land disposal at an industrial landfill. Some soils such as those contaminated with lead, used oil and petroleum fuel may potentially need treatment prior to disposal and have to be investigated further particularly for volume estimates at clean-up or action levels agreed upon with regulatory agencies. Although numerical criterias are published, the action levels of total lead in soils, the action levels of BTEX and TPH in petroleum fuels, and hazardous status of soils saturated with used oil needs further clarification from LDEQ as the State may have special concerns and may recommend more conservative clean-up levels.

If required, about 26070 cy of contaminated soils may need treatment for lead, used oil and BTEX. Of this, about 14000 cy soils is estimated if soils contaminated with lead at 100 mg/kg or greater will require treatment. This estimate assumes the delimited lead-rich areas in Figure 6.2 and an average depth of 3 feet. A depth of 6" may be more realistic for areas uniformly re-surfaced with sandblast material, however there are isolated areas where sandblast materials were encountered at depths of 5 feet. If a lead treatment level of, say, 10 mg/kg (site background) is recommended by the State or Federal Regulating Agency, the volume of soils requiring treatment would increase greatly.

There are about 8250 cy of soil saturated with used oil at the site. Contaminants in these soils are generally the polynuclear aromatic hydrocarbon compounds such as benzo(a)pyrene. In addition, if regulatory levels of 100 mg/kg BTEX and 100 mg/kg TPH are followed by the State of Louisiana, 3820 cy of soils associated with petroleum fuel tanks are

estimated to require treatment. The volume estimates for soils contaminated with used oil and petroleum fuel assume the delimited areas in Figure 6.3 and depths of 5 feet. An unestimated volume of petroleum-rich liquids at the bottom of oil-saturated soils may likewise be required for collection and proper disposal during and/or before excavation of the oil-saturated soils at the site is undertaken.

Several groundwater samples fail the 1990 EPA water health-based or action level criteria for the following compounds : As, Ba, Cd, Cr, Pb, Hg, methylene chloride, benzene and bis(2-Ethylhexyl)phthalate (Table 6.3c). This criteria is for drinking water. The metal concentration levels of the project site groundwater samples are comparable to slightly elevated than the water in the IHNC, the Mississippi River and the Disposal Site (Table 6.4). However, the groundwater metal concentrations pass both the 1986 EPA freshwater and saltwater numerical criterias suggesting the potential acceptability for aqueous disposal of the groundwater.

Unlike sediments from the Canal, the soils from the east bank were not investigated for aqueous disposal. Analytical data from soils and bottom sediments are however available and can be compared. Table 6.4 lists and compares targeted pollutants in surface and subsurface soils from the ByPass Channel Site and bottom sediments from the Canal, MR-GO disposal site and the Mississippi River disposal site. The lower range of concentration levels in the ByPass Channel soils, particularly those below 5 feet (see also Table 6.1b and Table 6.3b), are clearly comparable to slightly lower and moderately higher than those in the Canal and proposed disposal areas. Since the Canal sediments are acceptable for aqueous disposal at the proposed sites (USACE-NOD Water Quality Report, 1993), much of the soils from the ByPass Channel Site, with exception of the highly contaminated soils mentioned in the preceeding paragraphs, should be acceptable for aqueous disposal.

9.0 PUBLIC HEALTH AND ENVIRONMENTAL RISK ASSESSMENT To date, this investigation has generated a comprehensive analytical data base across the site. Data is available to explore risk associated with excavation, transport and placement (at selected disposal sites) of contaminated soils and sediments excavated or dredged from the IHNC project site. The most significant contaminants in soils identified to date are lead, PAHs and BTEX. In addition, petroleum product-rich liquids have accumulated below oil-saturated soils. The shallow groundwater likewise yield elevated metal concentrations which are above the Federal numerical criteria for drinking water.

## 10.0 SUMMARY AND RECOMMENDATIONS

10.1 SUMMARY Field investigation and analytical testing yield a comprehensive chemical data base for soils, groundwater, bottom sediments and surface water at the IHNC New Lock project site. The data reveal that soils and groundwater in the ByPass Channel site are impacted with metal and organic contaminants as a result of industrial activities at the site. The Canal bottom sediments and Canal water are likewise determined to be contaminated with pollutants from both east and west banks of the Canal. Although analytical testing confirm the presence of contaminants, their bulk abundance levels and TCLP test results indicate that a large volume of the surface soils and bottom sediments can be considered as industrial wastes. Analytical testing of soil samples collected from the six 35-foot deep borings yield fewer detectable target pollutants and lower concentration levels indicating the probable lack of extensive vertical migration of contaminants. The deep soils have not been tested for acceptability at the proposed marsh creation site but the abundance levels of targeted contaminants are comparable to Canal bottom sediments which have been determined to be acceptable for aqueous disposal.

10.1.1 SOIL CHARACTERISTICS Soil borings show that the immediate subsurface at the site is made up of a fill unit generally consisting of poorly sorted gravel, shell, blasting sand, silt and clay. The coarser soils consisting of gravel, shell, blasting sand and silt are commonly found as resurfacing material around and underneath building and work facilities and on road surfaces. The coarser section of the fill material average about 2 to 3 feet thick but in places it extend to as much as 5 feet below the ground surface.

Underlying the coarse grain soils are the fine grained fat clay fill that are more likely derived from excavation of the Canal. The depth to the original ground surface is difficult to determine but it is estimated that the fill unit has thicknesses ranging from 14 to 16 feet.

10.1.2 HYDRAULIC CONDUCTIVITY To date, the hydraulic conductivities of soils underlying the IHNC site were not examined in detail. However, recent investigation of similar soils underlying a nearby site, the CSXT Gentilly Yard site, yield hydraulic conductivities of $7.4 \times 10^{-4}$ ft/min or 1.1 ft/day for poorly sorted gravel, sand and silt unit, $1.8 \times 10^{-5}$ cm/sec for organic-rich clays and $1.2 \times 10^{-8}$ cm/sec for silty clays. These CSXT data indicate that water move rapidly in the poorly sorted coarse grain fill material while very slow in organic-rich clays and silty clays.

10.1.3 SITE HYDROGEOLOGY Investigation of the site hydrogeology show that the underlying shallow groundwater is essentially a perched aquifer and that groundwater flow is generally influenced by manmade activites at the site. Groundwater at the site is interpreted to flow in two opposite directions, one flows north and into the Canal and another flows south and away from the Canal. Water from this latter flow is likely intercepted by the an open storm ditch along the western border of Surekote Road which would flush water back into the Canal.

10.1.4 CONTAMINANT MIGRATION The conceptual model proposed indicate that most of the contaminants are held at the surface and nearsurface by a thick clay unit. The hydrogeology of the site suggest that soluble contaminants can be quickly carried into the Canal.

10.1.5 ANALYTICAL RESULTS Analytical results show that although the soil samples yield elevated total concentration of targeted metal and organic contaminants, only benzidine, bis(2-EthylHexyl)Phthalate and the BTEX-compound group exceed 1990 EPA proposed and potential LA action levels. There is no numerical criteria for lead. The soil samples tested for toxicity generally pass the TCLP numerical criteria as well as samples submitted for ignitability tests. Out of twenty-two (22) samples submitted for TCLP testing, only one soil sample (IC-BS-10) failed the lead regulatory criteria, re-analyses of the sample pass the lead criteria. Groundwater samples collected generally failed the 1990 recommended (drinking water) action levels for several metals and few organics but pass the 1986 EPA freshwater and marine water aquatic life criteria. The Canal sediments likewise show contamination although all passed the TCLP test.

10.1.6 PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT Data is available to explore risk associated with excavation, transport and placement (at selected disposal sites) of the soils and sediments excavated or dredged from the project site.

10.2 RECOMMENDATIONS Several EPA recommended numerical criteria were utilized to make a preliminary determination of acceptable disposal schemes of contaminated soil, groundwater and sediments at the IHNC project site. Our evaluation indicate that the most contaminated soils at the east bank investigation area are generally restricted to surface and near surface soils. Much of the soils to be excavated (i.e. till -35 ft

NGVD excavation depths) may be acceptable for land disposal and about 26070 cy may need treatment or special handling prior to disposal.

The EPA numerical criteria are federal guidance and it is well-recognized that various States have their own more specific and/or conservative guidelines (e.g. Doyle and Sweet, 1990; Bell et al., 1991). The final determination of what will be treated and up to what levels should be clarified with the Louisiana DEQ (and with EPA) to accommodate their specific concerns. Upon agreement on numerical criterias for clean-up or treatment of specific contaminants found at the site and in addition to LDEQs recommendation on additional investigation at the site, the USACE-NOD will need to undertake feasibility studies on delimiting the volume of *contaminated soils that need special handling for disposal. Target areas* include the lead-rich sand blast areas, oil-saturated areas and BTEX-contaminated areas. It must be re-iterated that there is still no final ruling on the hazardous status of used oil (and oil-saturated soils). To date, used oil are not regulated and are classified as industrial waste, however characterization of oil-saturated soils will be useful for potential manifest requirements on soil and groundwater contaminated by this type of waste.

Based on the available information derived from field investigation and analytical testing of samples, the following are recommended:

1. Using available data, initiate a risk assessment of public health and the environment associated with excavation, transport and placement of contaminated soils, groundwater and sediments.

2. Continue field investigation and analytical testing related to remedial investigation and feasibility study. This includes : analytical testing of the deep groundwater and investigation of the deep groundwater flow up to project excavation depths of - 35 feet NGVD, geophysical survey of the reported pit(s) with buried drums at Saucer Marine, and detail investigation of oil-saturated soils, lead rich soils and BTEX-rich soils. Although the buried pit(s) at Saucer Marine is (are) unsubstantiated, it is prudent to conduct subsurface mapping of potential buried waste pit(s) that can be easily missed by the field investigations conducted to date.

3. Initiate an interim remedial action on waste piles including containerized waste (drums, cans, cylinders and tanks), mixed waste mounds such as at the Saucer Marine area, and oil-saturated soils to prevent further contamination of soils and groundwater at the site.

4. Start consultations with LDEQ and EPA to clarify concerns regarding results of USACE-NOD investigations including the treatment levels of contaminated soils such as lead and petroleum fuels, and, the hazardous / nonhazardous status of soils saturated with used oils.

It must be noted here that LDEQ may require a Preliminary Assessment Report (PA), Contamination Assessment Report (CAR) and Interim Remedial Action (IRA) Plan of the project site. Much of the information generated in this report will be utilized in the PA, CAR and IRA. Further work at the project site should be guided by the Contamination Assessment Plan (CAP) and IRA approved by LDEQ. The contents of the Initial Assessment and this Remedial Investigation reports, both developed by NOD, should meet the requirements of these three reports.

11.0 <u>LIMITATIONS.</u> A Remedial Investigation does not guarantee the existence or the non-existence of HTRW within or affecting the project area aside from those areas tested. The analysis, conclusions and recommendations in this report are based on the HTRW Initial Assessment

and the sampling and analytical results contained herein. This report does not constitute a guarantee or certification of the existance or the non-existance of HTRW contamination. Should additional information become available in the future, this report may be modified to reflect the information.

## 12.0 REFERENCES


Bell, C.E., Kostecki, P.T. and Calebrese, E.J., 1991, Review of State Cleanup Levels for Hydrocarbon Contaminated Soils, in Hydrocarbon Contaminated Soils and Groundwater, Kostecki, P.T. and Calabrese, E.J. (eds), Lewis Publishers, v.3, p.77-89.

Bourg, A.C.M., Mouvet, C. and Lerner, D.N., 1992, A review of attenuation of trichloroethylene in soils and aquifers, Quarterly Journal of Engineering Geology, v.25, p.359-370.

Bishop, P.K., Burston, M.W., Lerner, D.N. and Eastwood, P.R., 1992, Soil gas surveying of chlorinated solvents in relation to groundwater pollution studies, Quarterly Journal of Engineering Geology, v. 25, p. 359-370.

CDM Federal Programs Corporation, Remedial Investigation/Feasibility Study for the Popile, Inc. Site, El Dorado, Arkansas, June 26, 1992.

Dial, D.C., 1983, Ground-water data for the Mississippi River Parishes in the Greater New Orleans Area, Louisiana, USGS Water Resources Basic Records Report No. 11, 47 p.

Doyle, M.E. and Sweet, C., 1990, Cleanup Goals for Total Petroleum Hydrocarbons, State and Federal Policy and Programs, p.21-24.

Dragun, J., 1985. Soil Chemistry of Hazardous Materials. Unpublished manuscript (?).

EPA, 1988, Laboratory Data Validation, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency.

EIRA, 1993, Analytical Results of Soil and Groundwater Samples Collected from the USACE IHNC New Lock - ByPass Channel Project Site, New Orleans, Louisiana, Laboratory reports submitted to USACE-NOD.

40 CFR 261,20-24 and 40 CFR 261.30-35.

Federal Register, Proposed Rules, v.55, n.145, July 27, 1990.

Goodwin, R. Christopher and Associates, A Land Use History of Areas Adjacent to the Inner Harbor Navigation Canal Lock, New Orleans Final Report, November 1992.

GWL, Inc., Contamination Assessment Report: CSXT Gentilly Yard, New Orleans, Louisiana, March 1991.

Lopez-Avila, V., Milanes, J., Constantine, F. and W.F. Beckert, 1990, Typical Phthalate Ester Contamination Incurred Using EOA Method 8060, J. Assoc. Off. Anal. Chem., v.73, p.709-720.

Lyman, W.J., Reidy, P.J., and Levy, B., 1992, Mobility and Degradation of Organic Contaminants in Subsurface Environments, C.K. Smoley, Inc., Chelsea, Michigan.

McCabe, M.M., 1988, Waste Oil, in Standard Handbook of Hazardous Waste Treatment and Disposal, Freeman, H.M. (ed), McGrawHill Book Company, p.4.3-4.12.

NRI, Inc., Final Report of Findings of the Petrex Soil Gas Survey of the Inner Harbor Navigation Canal Site, New Orleans, Louisiana, Report submitted to the USACE-NOD, 22 July 1993, 16p with Appendices.

Rollo, J.R., 1966, Groundwater Resources of the Grater New Orleans Area, Louisiana, USGS Water Resources Bulletin No. 9, 69 p.

Stehling, W., EIRA, Personal Communication, September 1993.

Stover, S.T., Preliminary Site Assessment: CSXT Transportation, Gentilly Yard, New Orleans, Louisiana, January 1990.

Sullivan, B.P., Carty, D.J., Lupo, M.J. and Felkey, J., 1993, Phthalates: Unreliable Indicators of Hydrocarbon Contamination in Environmental Soil and Water Analysis, in Hydrocarbon Contaminated Soils and Groundwater, Kostecki, P.T. and Calabrese, E.J. (eds), Lewis Publishers, v.3, p.57-74.

USACE, Draft Chemical Data Acquisition Plan for the IHNC New Lock - ByPass Channel Project Site, February 1993.

USACE, Memorandum For Project Engineer: Cost Estimates for IHNC New Ship Lock, HTW Soil Investigation, September 8, 1992.

USACE, Draft Hazardous and Toxic Waste (HTW) Guidance for Civil Works Projects, July 25, 1990.

USACE, ER-1110-1-263, Chemical Data Quality Management for Hazardous Waste Remedial Activities, October 1, 1990.

USACE, Jefferson and Orleans Parishes, Louisiana Urban Flood Control and Water Quality Management - Reconnaisance Study, Volume 1 Main Report, July 1992.

USACE, Engineering Regulation 1165-2-132, Water Resources Policies and Authorities - Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects, June 26 1992.

USACE, Mississippi River - Gulf Outlet, New Lock and Connecting Channels Feasibility Study, HTRW Initial Assessment, July, 1993.

USACE, Mississippi River - Gulf Outlet, New Lock and Connecting Channels Feasibility Study, Water Quality Report, October, 1993.

USACE, Technical Report HL-82-2, Lake Pontchartrain and Vicinity Hurricane Protection Plan, Report I, Prototype Data Acquisition and Analysis, January 1982.

USEPA, Record of Decision, EPA Region VIII for Equivalency Demonstration for Denver-Arapahoe Chemical Waste Processing Facility, Drum Burial Cell, Pad C. and Pond 3 Units, USEPA Region VIII, July 1991.