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Final

Corrective Measures Study
Task I Report

Tow Way Fuel Farm

Naval Station Roosevelt Roads
RCRA/HSWA Permit No. PR2170027203
Ceiba, Puerto Rico
Volume II of II - Appendices

Prepared For

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007
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Prepared by

CH2M HILL

Federal Group, Ltd.

Baker
Environmental, Inc.

CDM
Federal Programs Corp.

FINAL

CORRECTIVE MEASURES STUDY
TASK I REPORT
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
RCRA/HSWA PERMIT NO. PR2170027203
CEIBA, PUERTO RICO

VOLUME II OF II – APPENDICES

CONTRACT TASK ORDER 0034

APRIL 22, 2003

Prepared for:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

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APPENDIX A
CHEMICAL PROFILES

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CHEMICAL PROFILES

INORGANICS

Antimony

Antimony is a silvery-white metal that is found in the earth's crust. Antimony ores are mined and then mixed with other metals to form antimony alloys or combined with oxygen to form antimony oxide. Antimony is released to the environment from natural sources and from industry. Most antimony ends up in soil, where it attaches strongly to particles that contain iron, manganese, or aluminum. Antimony is found at low levels in some rivers, lakes, and streams.

In short-term studies, animals that inhaled high levels of antimony had lung, heart, liver, and kidney damage and some died. In long-term studies, animals that inhaled low levels of antimony suffered eye irritation, hair loss, lung damage, and heart problems. Reproductive problems in rats have been caused by inhalation of high levels of antimony for a three-month period. Long-term animal studies have reported liver damage and blood changes when animals ingested antimony (ATSDR 1992).

A literature search was conducted on the toxicological effects of antimony ingestion to mammals. A one year study conducted on the effects of antimony on the growth, survival, and tissue levels in mice indicated a chronic oral toxicity dose of 5 ppm (Schroeder et al. 1968). This dose was converted to 1.25 mg/kg/day and considered a chronic LOAEL because median life span was reduced among female mice exposed to the 5 ppm dose level (Sample et al. 1996). A chronic NOAEL of 0.125 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A 6-week study with northern bobwhites, conducted during a critical life stage (reproduction), showed chronic oral toxicity at a dose of 47,400 mg/kg/day (Opresko et al. 1993). This dose was considered a chronic LOAEL. A chronic NOAEL of 4740 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for antimony. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Opresko, D.M., B.E. Sample, and G.W. Suter II. 1993. Toxicological benchmarks for wildlife. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Schroeder, H.A., M. Mitchener, J.J. Balassa, M. Kanisawa, and A.P. Nason. 1968. Zirconium, niobium, antimony, and fluorine in mice: effects on growth, survival and tissue levels. J. Nutr. 95:95-101.

Arsenic

Arsenic tends to be widespread in the environment (Woolson 1975) and is constantly being oxidized, reduced, or mobilized (Eisler 1988). Arsenic is readily adsorbed onto sediments with

high organic matter. Adsorption depends on the arsenic concentration, sediment characteristics, pH, and the ionic concentration of other compounds (Eisler 1988). Arsenate (pentavalent, As^{+5}) is the predominant arsenic form in oxygenated water and arsenite (trivalent, As^{+3}) is the predominant arsenic form under anaerobic conditions (EPA 1981).

Arsenic is not significantly concentrated in aquatic invertebrates. Arsenic may be bioaccumulated by lower trophic level organisms; however, data does not indicate that significant biomagnification occurs (EPA 1985).

A literature search was conducted on the toxicological effects of arsenic ingestion to mammals. A 3-generation study on the reproductive effects of arsenite in mice determined a LOAEL of 1.26 mg/kg/day (Schroeder and Mitchner 1971). At this dose, mice displayed declining litter sizes. A chronic NOAEL of 0.126 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A literature search was conducted on the toxicological effects of arsenic ingestion to birds. In a 7-month study conducted by USFWS (1969) on male brown-headed cowbirds, four dietary dose levels were used. Doses of 675 and 225 ppm caused 100 percent mortality and doses of 75 (33.26 mg/kg) and 25 (11.09 mg/kg) ppm caused 20 percent and 0 percent mortality, respectively. The 75 and 25 ppm doses were considered the chronic LOAEL and NOAEL, respectively. A chronic NOAEL of 2.46 mg/kg/day and a LOAEL of 7.38 mg/kg/day were calculated from these data (Sample et al. 1996). Mallards exposed to arsenic in the diet for 128 days showed effects to survival at doses of 12.84 mg/kg/day (the estimated chronic LOAEL) with the NOAEL estimated at 5.14 mg/kg/day (Sample et al. 1996).

Eisler, R. 1988. Arsenic hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85(1.12), Contaminant Hazard Reviews Report No. 12. 92 pp.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Schroeder, H.A. and M. Mitchener. 1971. Toxic effects of trace elements on the reproduction of mice and rats. Arch. Environ. Health. 23:102-106.

Environmental Protection Agency (EPA). 1981. The carcinogen assessment group's final risk assessment on arsenic. Office of Health and Environmental Assessment, Washington, D.C. PB 81-206013.

EPA. 1985. Health advisory for arsenic - Draft. Office of Drinking Water, Washington, D.C.

United States Fish and Wildlife Service (USFWS). 1969. Bureau of sport fisheries and wildlife. Publication. 74:56-57.

Woolson, E.A. 1975. Arsenical pesticides. ACS Ser. 7:1-176.

Barium

Barium occurs in nature combined with other chemicals such as sulfur, or carbon and oxygen. Some barium compounds dissolve easily in water and are found in lakes, rivers, and streams. Barium is found in most soils and foods at low levels. Fish and aquatic organisms accumulate

barium in their tissues (ATSDR 1992). Studies on animals have shown that ingesting low levels of barium over the long term causes increased blood pressure and heart changes (ATSDR 1992).

A 16-month study conducted with barium administered orally in water to rats was used to derive a chronic NOAEL (endpoints were growth and hypertension) of 5.1 mg/kg/day, while a second study with rats (endpoint was mortality) was used to derive a chronic LOAEL of 19.8 mg/kg/day (Sample et al. 1996).

A 10-day study conducted with barium chloride administered orally in water to rats was conducted at four dose levels: 100, 145, 209, and 300 mg/kg/day. Exposure to 300 mg/kg/day barium chloride resulted in 30 percent mortality to female rats. No adverse effects were observed at any other dose level. The 300 mg/kg/day dose (as barium chloride) was converted to an elemental barium dosage of 198 mg/kg/day and considered a subchronic LOAEL by Sample et al. (1996). A chronic LOAEL was estimated by multiplying the subchronic LOAEL by a subchronic to chronic uncertainty factor of 0.1 (Sample et al. 1996). A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

In a study conducted by Johnson (1960) over a 4-week period, chicks were exposed to eight barium dose levels in their diet. Exposures of up to 2,000 ppm produced no mortality. Chicks in the 4,000 to 32,000 ppm groups experienced 5 to 100 percent mortality, respectively. The 2,000 and 4,000 ppm doses were considered the subchronic NOAEL and LOAEL, respectively. These dietary concentrations were converted to a subchronic NOAEL of 208 mg/kg/day and a subchronic LOAEL of 417 mg/kg/day (Sample et al. 1996). A chronic NOAEL (20.8 mg/kg/day) and LOAEL (41.7 mg/kg/day) was estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic to chronic uncertainty facto of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for barium. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Johnson, D., Jr., A.L. Mehring, Jr., and H.W. Titus. 1960. Tolerance of chickens for barium. Proc. Soc. Exp. Biol. Med. 104:436-438.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Beryllium

In nature, beryllium can be found, in compounds with other elements, in mineral rocks, coal, soil, and volcanic dust. It can enter water from rocks, soil, and industrial waste. Most beryllium compounds do not dissolve in water and settle to the bottom as particles. Fish are not known to accumulate beryllium in their bodies from the surrounding water to any great extent (ATSDR 1993). Based on animal studies, beryllium compounds may be considered carcinogens (ATSDR 1993).

A literature search was conducted on the toxicological effects of beryllium ingestion to mammals. A study conducted on the effect to longevity and weight loss from beryllium given orally in water to rats (lifetime exposures) indicated a chronic no effect level of 5 ppm, the only dose tested (Schroeder and Mitchner 1975). Exposure to 5 ppm beryllium in water did not reduce longevity, but weight loss by male rats was observed in the second and sixth month. Because weight loss was not considered an adverse effect, the 5 ppm dose level was considered to be a chronic NOAEL. The 5 ppm dietary concentration was converted to a daily dose of 0.66 mg/kg/day

(Sample et al. 1996), which was considered the chronic NOAEL. A chronic LOAEL of 6.6 mg/kg/day was estimated by multiplying the NOAEL by an uncertainty factor of 10. No dietary information was found on the toxicological effects of beryllium to birds.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. Toxicological profile for beryllium. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Schroeder, H.A. and M. Mitchener. 1975. Life-term studies in rats: effects of aluminum, barium, beryllium, and tungsten. J. Nutr. 105:421-427.

Cadmium

Freshwater aquatic species are most sensitive to the toxic effects of cadmium, followed by marine organisms, birds, and mammals. Cadmium is a reproductive toxin in fish and other aquatic life. Adverse effects include carcinogenicity and teratogenicity. Other adverse effects in aquatic organisms include decreased oxygen utilization, bone marrow, heart, kidney, and vascular pressure. Diatoms and aquatic plants also show impaired growth and development at low concentrations of cadmium. Cadmium can concentrate in tissues and thus can accumulate in food chains. Vertebrates tend to accumulate cadmium in the kidney and liver (Eisler 1985).

A literature search was conducted on the toxicological effects of cadmium ingestion to mammals. A 6-week study conducted with rats indicated that oral doses of 1 mg/kg/day caused no reproductive impairment (Sample et al. 1996). This dose was considered a chronic NOAEL. Adverse reproductive (fetal) effects occurred at a dose of 10 mg/kg/day. This dose was considered a chronic LOAEL.

A similar study, conducted with dogs over a period of 3 months, indicated a NOAEL of 0.75 mg/kg/day because no adverse reproductive effects were observed (Loser and Lorke 1977). A chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A 90-day study on the effects of cadmium administered orally in the diet on the reproduction of mallards indicated a chronic LOAEL of 20.03 mg/kg/day (White and Finley 1978). Ducks fed cadmium at this level were observed to produce significantly fewer eggs than those in lower dose groups. No adverse reproductive effects were observed at a dose of 1.45 mg/kg/day. This dose was considered to be a chronic NOAEL.

Eisler, R. 1985. Cadmium hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85(1.2), Contaminant Hazard Reviews. Report No. 2. 46 pp.

Loser, E. and D. Lorke. 1977. Semichronic oral toxicity of cadmium. II. Studies on dogs. Toxicology. 7:225-232.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

White, D.H. and M.T. Finley. 1978. Uptake and retention of dietary cadmium in mallard ducks. Environ. Res. 17:53-59.

Chromium

Chromium is a naturally occurring element. Chromium compounds are used in the chemical industry for metal finishing, manufacture of pigments, leather tanning, and water treatment. Chromium has been widely studied and its effects are well known.

A 3-month study on the effects of chromium on survival in rats indicated adverse effects at a dose of 131.4 mg/kg/day. This dose was considered to be a chronic LOAEL (Sample et al. 1996). A chronic NOAEL of 13.14 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 0.1.

A 90-day and 2-year study on the effects of chromium (administered orally in the diet as chromium oxide) was conducted at three dose levels: 1, 2, and 5 percent of diet. Reproductive effects were evaluated among rats fed 2 percent and 5 percent chromium oxide for 90 days, while carnicogenicity and longevity were evaluated among rats fed 1, 2, and 5 percent chromium oxide for 2 years. Because no significant effects were observed at any dose level in either study and both studies considered exposure through two years or a critical lifestage (reproduction), the maximum dose (5 percent of 4,000 mg/kg/day) was considered to be a chronic NOAEL by Sample et. al (1996). This daily dosage of chromium oxide was converted to an elemental chromium dosage of 2,737 mg/kg/day (Sample et al. 1996). A chronic LOAEL of 27,370 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A 1-year study on the effects of hexavalent chromium (administered orally in water as $K_2Cr_2O_3$) on body weight and food consumption in rats indicated no adverse effects at any dose level (0.45, 2.2, 4.5, 7.7, 11.2, and 25 ppm Cr^{+6}). Because no significant differences were observed at any dose level studied and the study considered exposure over 1 year, the maximum dose level of 25 ppm Cr^{+6} (equivalent to a daily dose of 3.28 mg/kg/day) was considered to be a chronic NOAEL (Sample et al. 1996). A chronic LOAEL of 32.8 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A literature search was conducted on the toxicological effects of chromium ingestion to birds. A study conducted with American black ducks indicated that dietary levels of 5.0 mg/kg/day of chromium caused reduced duckling survival. This dose was considered a chronic LOAEL (Sample et al. 1996). A dose of 1.0 mg/kg/day was considered a chronic NOAEL because no adverse reproductive effects were observed at this level.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Cobalt

Rats exposed to cobalt in the diet for 69 days showed impaired reproduction at 50 mg/kg/day; this dose is considered a chronic LOAEL. A chronic NOAEL of 5 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1 (ATSDR 1992). Chickens exposed to cobalt in the diet for 14 days showed impaired growth at 14.7 mg/kg/day; this dose is considered a chronic LOAEL (Diaz et al. 1994). A chronic NOAEL of 1.47 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for cobalt. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. July.

Diaz, G.J., R.J. Julian, and E.J. Squires. 1994. Lesions in broiler chickens following experimental intoxication with cobalt. Avian Diseases. 38:308-316.

Copper

Excess ingestion of copper leads to accumulation in tissues, mainly in the liver. When concentrations in the liver exceed a certain level, the metal is released into the blood causing hemolysis and jaundice. High levels of copper also inhibit essential metabolic enzymes (Demayo et al. 1982). Toxic symptoms appear when the liver accumulates 3 to 15 times the normal level of copper (Demayo et al. 1982).

Ruminants are the most sensitive mammalian species to the toxic effects of copper. Young animals retain more dietary copper than older animals and are more sensitive to copper toxicity (Venugopal and Luckey 1978). Copper is known to have adverse effects on aquatic organisms, but is dependent upon pH and hardness. Copper tends not to accumulate in most organisms or to biomagnify in food chains.

A 357-day study on the effects of copper on the reproduction of mink indicated increased mortality of mink kits at oral doses of 50, 100, and 200 ppm (Aulerich et al. 1982). The 50 ppm dose was converted to a chronic LOAEL of 15.14 mg/kg/day. A chronic NOAEL of 11.7 mg/kg/day was determined from the 25 ppm dietary concentration at which no adverse reproductive effects were observed.

A 10-week study on the effects of copper on the growth and mortality of day old chicks indicated reduced growth and increased mortality at a dietary concentration of 749 ppm (Mehring et al. 1960). This concentration, considered to be a chronic LOAEL, was converted to a daily dose of 61.7 mg/kg/day (Sample et al. 1996). No adverse effects were observed at a dietary concentration of 570 ppm. This concentration, considered to be a chronic NOAEL, was converted to a daily dose of 47 mg/kg/day.

Aulerich, R.J., R.K. Ringer, M.R. Bleavins et al. 1982. Effects of supplemental dietary copper on growth, reproduction performance and kit survival of standard dark mink and the acute toxicity of copper to mink. J. Animal Sci. 55:337-343.

DeMayo, A., M.C. Tyalor and K.W. Taylor. 1982. Effects of copper on humans, laboratory and farm animals, terrestrial plants and aquatic life. CRC Critical Reviews in Environmental Control. 12(3):183-255.

Mehring, A.L. Jr., J.H. Brumbaugh, A.J. Sutherland, and H.W. Titus. 1960. The tolerance of growing chickens for dietary copper. Poult. Sci. 39:713-719.

Sample, B.E., D.M. Opresko and W. Suter. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Venugopal, B. and T.D. Luckey. 1978. Metal toxicity in mammals, Volume 2. Plenum Press, New York, N.Y.

Lead

Organic forms of lead are more bioavailable than inorganic forms, but microorganisms in streams are capable of transforming inorganic lead into organic forms. Soluble lead is toxic to all aquatic plant phyla. In plants, lead inhibits growth by reducing photosynthetic activity, mitosis, and water absorption. In the terrestrial environment, lead has been demonstrated to be toxic to birds, mammals, reptiles, and amphibians. Lead poisoning in birds is particularly well documented, but most lead poisoning in wild birds results from ingestion of lead pellets. In contrast, lead poisoning of birds, such as raptors, from biologically incorporated lead is considered unlikely. Lead is known to be toxic to mammalian species, but information on the effects on wild species is very limited. Toxic effects include mortality, reduced growth and reproduction, alterations of blood chemistry, lesions, and behavioral changes.

Terrestrial vegetation also may be affected by elevated lead concentrations. Demonstrated effects include reduced photosynthesis, mitosis, and water absorption. Lead, however, appears to bind tightly to moist soil, and substantial amounts of lead typically need to accumulate before effects on plants are observed. Lead does not biomagnify to a great extent in food chains, although bioaccumulation in plants and animals has been extensively documented (Wixson and Davis 1993, Eisler 1988).

A study on three generations of rats fed lead acetate indicated a chronic NOAEL of 8 mg/kg/day (Azar et al. 1973). Rats fed this dose level were not observed to exhibit any adverse reproductive effects. Rats fed 80 mg/kg/day were observed to have reduced offspring weights and kidney damage in the young. This dose was considered to be a chronic LOAEL.

A 7-month study on the toxicological effects of lead ingestion in American kestrels found that an oral dose of 3.85 mg/kg/day did not cause any adverse reproductive effects (Sample et al. 1996); this dose was considered a chronic NOAEL. A chronic LOAEL of 38.5 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. A 12-week study with Japanese quail found that oral exposures to lead acetate in the diet did not have any adverse reproductive effects at doses of 1.13 mg/kg/day (chronic NOAEL) although adverse effects were observed at a dose of 11.3 mg/kg/day (chronic LOAEL; Sample et al. 1996).

Azar, A., H.J. Trochimowicz, and M.E. Maxwell. 1973. Review of lead studies in animals carried out at Haskell Laboratory: two-year feeding study and response to hemorrhage study. Pages 199-210 IN Barth, D et al. (eds). Environmental health aspects of lead: proceedings, international symposium. Commission of European Communities.

Eisler, R. 1988. Lead hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85(1.14), Contaminant Hazard Reviews Report No. 14. 134 pp.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Wixson, B.G. and B.E. Davis. 1993. Lead in soil. Lead in Soil Task Force, Science Reviews. Northwood. 132 pp.

Mercury

Mercury is persistent in the environment and may cause significant effects on ecological receptors. A variety of adverse biological effects have been attributed to mercury. Mercury is a known teratogen, mutagen, and carcinogen. Mercury has been documented to adversely effect reproduction, growth and development, behavior, blood and serum chemistry, motor coordination, vision, hearing, histology, and metabolism at relatively low concentrations in birds and mammals. The reproduction, growth, metabolism, blood chemistry, and oxygen exchange of marine and freshwater organisms also is adversely affected by relatively low concentrations of mercury. The form of mercury most readily assimilated by biota is methylmercury. Once incorporated in tissues, methylmercury is very slow to depurate. The rate of bioaccumulation of methylmercury is species- and site-specific.

A three-generation study on the effects of mercury (administered orally as methyl mercury chloride) on the reproduction of rats indicated a LOAEL of 0.16 mg/kg/day because reduced pup viability was observed (Verschuuren et al. 1976). A chronic NOAEL of 0.032 mg/kg/day was determined because no adverse reproductive effects were observed at this level.

A 93-day study conducted on mink indicated that a dose of 1.8 ppm (administered orally as methyl mercury chloride) caused mortality, weight loss, and behavioral abnormalities (Wobeser et al. 1976). No adverse effects were observed at 1.1 ppm so this dose was considered a chronic NOAEL. These values were converted to a daily dose of 0.25 mg/kg/day (chronic LOAEL) and 0.15 mg/kg/day (chronic NOAEL).

A 6-month study conducted on the effects of mercury (administered orally in the diet as mercuric chloride) on the reproduction of mink indicated that a concentration of 10 ppm mercuric chloride (7.39 ppm as elemental mercury) resulted in reduced kit weight (9 percent relative to controls). However, fertitlity and kit survival was not reduced. Because the study considered exposure through reproduction, the 7.39 ppm Hg dose was considered to be a chronic NOAEL by Sample et al. 1996. This dietary concentration was converted to a daily dose of 1.01 mg/kg/day (NOAEL) by Sample et al. (1996). A chronic LOAEL (10.1 mg/kg) was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

In a 20-month study conducted on the effects of mercury (administered orally in the diet as mercuric sulfide) on mortality and liver and kidney function in mice, adverse effects were not observed at any dose level (30 doses ranging up to 13.2 mg/kg/day). Because the study was over one year in duration, the maximum dose (13.2 mg/kg/day) was considered to be a chronic NOAEL (Sample et al. 1996). A chronic LOAEL of 132 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A literature search was conducted on the toxicological effects of mercury ingestion to birds. A one-year study conducted on Japanese quail indicated that an oral dose of 0.9 mg/kg/day (as mercuric chloride) caused reduced fertility and egg hatchability (Sample et al. 1996). This dose was considered a chronic LOAEL. No adverse reproductive effects were observed at a dose of 0.45 mg/kg/day. This dose was considered a chronic NOAEL.

Mallards fed methyl mercury during a 3-generation study showed significant reproductive effects (reduced egg and duckling production) at a daily dose 0.064 mg/kg/day (Sample et al. 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 0.0064 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Verschuuren, R.G., R. Kroes, E.M. Den Tonkelaar, J.M. Berkvens, P.W. Helleman, A.G. Rauws, P.L. Schuller, and G.J. Van Esch. 1976. Toxicity of methyl mercury chloride in rats. II. Reproduction study. Toxicol. 6:97-106.

Wobeser, G., N.O. Nielson, and B. Schiefer. 1976. Mercury and mink. II. Experimental methyl mercury intoxication. Can. J. Comp. Med. 34-45.

Nickel

Nickel is a metal that is usually used in the formation of alloys such as stainless steel. It is found in the environment as oxides or sulfides. Nickel may be released to the environment through mining, oil- and coal- burning power plants, and incinerators. Nickel will attach to soil or sediment particles, especially those containing iron or manganese. Under acidic conditions, nickel can become more mobile and infiltrate groundwater. Nickel is present in water mostly as insoluble hydroxides at pH levels higher than 6.7. At pH levels below 6.5, most nickel compounds are soluble. Water-insoluble inorganic nickel is usually unavailable in water and soils. However, low pH can enable nickel to be mobilized and therefore more bioavailable for uptake by plants and animals. Therefore, the speciation and physiochemical state of nickel is important in evaluating its behavior in the environment and its availability to biota. Low nickel concentrations can cause acute toxicity to freshwater and marine organisms.

A 3-generation study on the effects of nickel on the reproduction of rats indicated a chronic LOAEL of 80 mg/kg/day due to reduced body weights in offspring (Ambrose et al. 1976). A dose of 40 mg/kg/day was considered a chronic NOAEL because it caused no adverse effects.

A literature search was conducted on the effects of nickel ingestion to birds. A study conducted on mallard ducklings indicated that a dose of 107 mg/kg/day of nickel over a 90-day period caused reduced growth and resulted in 70 percent mortality (Cain and Pafford 1981). This dose was considered to be the chronic LOAEL. A dose of 77.4 mg/kg/day did not increase mortality or reduce growth and was therefore considered a chronic NOAEL.

Ambrose, A.M., P.S. Larson, and J.F. Borzelleca. 1976. Long-term toxicological assessment of nickel in rats and dogs. J. Food. Sci. Technol. 13:181-187.

Cain, B.W. and E.A. Pafford. 1981. Effects of dietary nickel on survival and growth of mallard ducklings. Arch. Environm. Contam. Toxicol. 10:737-745.

Selenium

Selenium is a metal commonly found in rocks and soil. In the environment, selenium is not often found in the pure form. Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals. Selenium and oxygen combine to form several compounds. Small selenium particles in the air settle to the ground or are taken out of the air in rain. Soluble selenium compounds in agricultural fields can be transported from the field in irrigation drainage water. Selenium can accumulate in animals that live in water containing high levels of selenium. Very high amounts of selenium can result in reproductive effects in rats and monkeys. Exposure to high levels of selenium compounds caused malformations in birds, but selenium has not been shown to cause birth defects in other mammals (ATSDR 1996). Chronic

exposure of mice and rats to selenium adversely affected fertility and reduced the viability of the offspring of the pairs of mice that were able to breed (Schroeder and Mitchener 1971).

A one-year study on the effects of potassium selenate on the reproduction of rats indicated a chronic oral toxic dose of 1.5 mg/L (Rosenfeld and Beath 1954). This dose was considered to be a chronic NOAEL because no adverse effects were observed. This dose was converted to a daily dose of 0.20 mg/kg/day. A chronic LOAEL of 2.5 mg/L was indicated due to a reduction in the number of second-generation young. This dose was converted to a daily dose of 0.33 mg/kg/day.

A 100-day study conducted on the effects of selanomethionine on reproduction in mallard ducks indicated a chronic NOAEL of 4 ppm in food because it produced no adverse effects on reproduction. This dose was converted to a daily dose of 0.4 mg/kg/day (Sample et al. 1996). A dose of 8 ppm was determined to be the chronic LOAEL because it resulted in reduced duckling survival and was converted to a daily dose of 0.8 mg/kg/day.

A 78-day study conducted on the effects of sodium selenite on reproduction in mallard ducks indicated a chronic NOAEL and LOAEL of 5 mg/kg and 10 mg/kg in food. The 5 mg/kg concentration represents the highest concentration tested that produced no adverse effects on adult weight and survival and the frequency of lethally deformed embryos. The NOAEL and LOAEL food concentrations (5 mg/kg and 10 mg/kg) were converted to a daily dose of 0.5 mg/kg/day and 1.0 mg/kg/day, respectively (Sample et al. 1996). They are considered chronic doses because the study considered exposure through reproduction (Sample et al. 1996).

Reproduction in screech owls fed selanomethionine for 13.7 weeks was not adversely affected at a daily dose of 0.44 mg/kg/day (chronic NOAEL), although a daily dose of 1.5 mg/kg/day (chronic LOAEL) resulted in decreased egg production, egg hatchability, and nestling survival (Sample et al. 1996).

Reproduction in black-crowned night herons fed selenomethionine for 94 days through reproduction was not adversely affected at a daily dose of 1.8 mg/kg/day. Because exposure was greater than 10 weeks and occurred during reproduction, the study was considered to be chronic in duration (Sample et al. 1996). A chronic LOAEL of 11.8 mg/kg/day was estimated by multiplying the chronic NOAEL by a safety factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. Toxicological profile for selenium. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Rosenfeld, I. and O.A. Beath. 1954. Effect of selenium on reproduction in rats. Proc. Soc. Exp. Biol. Med. 87:295-297.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Schroeder, H.A. and M. Mitchener. 1971. Toxic effects of trace elements on the reproduction of mice and rats. Arch. Environ. Health. 23:102-106.

Silver

Silver adheres strongly to clay particles found suspended in water and in sediments. The impact of silver is most likely to occur in the soil/water interface. It is acutely toxic to scuds at <6 μg/L and midges at <5 μg/L. Aquatic plants are less sensitive to silver exposure.

A literature search was conducted on the toxicological effects of silver ingestion to mammals and birds. A study conducted on rats indicated that a dose of 18.1 mg/kg/day did not result in increased mortality. This dose was considered a chronic NOAEL (ASTDR 1990). A chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. The USEPA reports a chronic NOAEL for mallards of 178 mg/kg/day.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for silver. TO-90/24.

Environmental Protection Agency (EPA). 1999. Screening-level ecological risk assessment protocol for hazardous waste combustion facilities. EPA/630/R-95/001A.

Thallium

Thallium enters the environment primarily from coal-burning and smelting, in which it is a trace contaminant of the raw materials. Thallium is absorbed by plants and enters the food chain. It builds up in fish and shellfish. Studies in rats exposed to high levels of thallium, showed adverse developmental effects (ATSDR 1992). Rats ingesting thallium for several weeks had some adverse reproductive effects (ATSDR 1992). Data also suggest that the male animal reproductive system may be susceptible to damage by low levels of thallium.

A literature search was conducted on the toxicological effects of thallium ingestion to mammals and birds. A study conducted on the reproductive (male testicular function) effects of thallium in rats indicated that a dose of 0.74 mg/kg/day caused reduced sperm motility (Formigli et al. 1986). This dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1 to obtain a daily dose 0.074 mg/kg/day. EPA (1999) reports a chronic NOAEL of 0.35 mg/kg/day for the European starling. This value is based on LD_{50} of 35 mg/kg/day and an uncetainty factor of 0.01.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for thallium. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Environmental Protection Agency (EPA). 1999. Screening-level ecological risk assessment protocol for hazardous waste combustion facilities. EPA/630/R-95/001A.

Formigli, L.,R. Scelsi, P. Poggi, C. Gregotti, A. DiNucci, E. Sabbioni, L. Gottardi, and L. Manzo. 1986. Thallium-induced testicular toxicity in the rat. Environ. Res. 40:531-539.

Tin

Tin enters the environment by both natural and human activities such as mining, coal and oil combustion, and the production and use of tin products (ATSDR 1995). Inorganic and organic forms of tin as well as tin metal are found in air, water and soil near places where they are naturally present in the rocks, or where they are mined, manufactured, or used. The organic form of tin, tributyltin, is known to accumulate in the tissues of plants, fish, and other organisms.

A study conducted on the reproductive effects of bis(tributyltin) oxide (TBTO) on mice during days 6 through 15 of gestation indicated that a dosage of 23.4 mg/kg/day had no effect on fetal weight, survival, and fetal resorption, while mice dosed with 35 mg/kg/day TBTO displayed reduced fetal weight and fetal survival and increased frequency of litter resorption (Sample et al. 1996). Because the study considered exposure during a critical life stage (i.e., during gestation),

the 23.4 and 35 mg/kg/day dose levels were considered a chronic NOAEL and LOAEL, respectively (Sample et al. 1996).

A six-week study was conducted on the reproductive effects of TBTO to Japanese quail. The Japanese quail were fed three concentrations of TBTO in their diet: 24, 60, 150, and 375 mg/kg. Egg weight and hatchability were reduced among quail consuming diets containing 150 mg TBTO/kg, while no consistent adverse effects were observed among those consuming diets containing 60 mg/kg groups. Because the study considered exposure during reproduction, the 150 mg/kg and 375 mg/kg dietary concentrations were considered a chronic NOAEL and LOAEL, respectively. These dietary concentrations were converted to daily doses of 6.8 mg/kg/day (NOAEL) and 16.9 mg/kg/day (LOAEL), respectively.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. ToxFAQs - Tin. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. www.atsdr.cdc.gov.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Vanadium

Vanadium enters the environment primarily from natural sources and from the burning of fuel oils. It is an essential element in certain animals, but may induce toxic effects in sufficient quantities. Young rats fed 92 and 194 ppm vanadium lost body weight and exhibited gross pathological symptoms, and 56 percent of those fed 368 ppm vanadium died (Daniel and Lillie 1938). In a study with mallard ducks, vanadium accumulated in the bone, kidney, and liver. Hens fed 100 ppm accumulated vanadium in the bone to about five times the levels in drakes (White and Dieter 1978). Several studies have shown contradictory effects of vanadium on lipid metabolism in birds and mammals. Responses were dependent on species, age, and diet composition. The alterations in lipid metabolism caused by vanadium were considered biologically significant because they were demonstrable in ducks that had absorbed and accumulated only minute tissue concentrations of the metal (White and Dieter 1978).

A literature search was conducted on the toxicological effects of vanadium ingestion to mammals. A 60-day study was conducted on the reproductive effects of vanadium to rats. The rats were fed three dose levels of sodium metavanadate: 5, 10, and 20 mg/kg/day. Significant differences in reproductive parameters (e.g., number of dead young, litter size) were observed at all dose levels. Therefore, the lowest dose was considered to be a chronic LOAEL. The LOAEL of 5 mg/kg/day was converted to an elemental vanadium dosage of 2.1 mg/kg/day (Sample et al. 1996). A chronic NOAEL (0.21 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A literature search was conducted on the toxicological effects of vanadium ingestion to birds. A study conducted on mortality, body weight, and blood chemistry effects of vanadium to mallards indicated a chronic NOAEL of 11.4 mg/kg/day (White and Dieter 1978). The mallards were fed three dose levels of vanadium in food over a 12-week period and no effects were observed at any dose level. The maximum dose was considered the chronic NOAEL. A chronic LOAEL (114 mg/kg/day) was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Daniel, E.P. and R.D. Lillie. 1938. Experimental vanadium poisoning in the white rat. U.S. Public Health Rep. 53:765-777.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

White, D.H. and M.P. Dieter. 1978. Effects of dietary vanadium in mallard ducks. J. Toxicol. Environ. Health. 4:43-50.

Zinc

Zinc, like many other metals, is essential in cell growth and enzymatic formation. *Ceriodaphnia*, a genus of aquatic invertebrates, are the most sensitive of 35 genera tested, but some aquatic plants are three times as sensitive to zinc. Zinc toxicity can result in destruction of gill epithelium and tissue hypoxia in fish. In terrestrial species, chronic exposure to zinc can result in softening of bone, anemia, enteropathy, and kidney damage. Zinc is not known to magnify in food chains because the body regulates it and excess zinc is eliminated.

A study conducted with rats indicated that a dose of 320 mg/kg/day of zinc caused adverse reproductive effects in pregnant rats (Sample et al. 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 160 mg/kg/day was determined since no adverse effects were observed at this dose. Mink exposed to zinc in the diet for 25 weeks did not exhibit any adverse reproductive effects at a daily dose of 20.8 mg/kg/day (ATSDR 1992).

Reproduction in chickens (white leghorn hens) exposed to zinc in the diet for 44 weeks was not adversely affected at a daily dose of 14.5 mg/kg/day but was adversely affected at 131 mg/kg/day. These doses are considered chronic NOAEL and LOAEL values, respectively (Sample et al. 1996).

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for zinc. Draft. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

SEMI-VOLATILE ORGANICS

1,2,4,5-Tetrachlorobenzene

No information regarding 1,2,4,5-tetrachlorobenzene was available in the literature.

1,2,4-Trichlorobenzene

Three-generation rat studies with 1,2,4-trichlorobenzene indicate adverse effects on reproduction at oral doses of 106 mg/kg/day (Coulston and Kolbye 1994). This dose is considered a chronic LOAEL. No adverse reproductive effects were found at a dose of 53 mg/kg/day. This dose is considered the chronic NOAEL. No avian toxicological data were found for this chemical.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

1,2-Dichlorobenzene and 1,3-Dichlorobenzene

Chronic rat studies with 1,2-dichlorobenzene indicate adverse effects on the liver and kidney at oral doses of 857 mg/kg/day (Coulston and Kolbye 1994). This dose is considered a chronic LOAEL. A chronic NOAEL of 85.7 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Mammalian data for 1,2-dichlorobenzene was applied to 1,3-dichlorobenzene. Avian data for 1,4-dichlorobenzene is applied to these two chemicals.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

1,4-Dichlorobenzene

1,4-dichlorobenzene is used mainly as a fumigant for the control of moths, molds, and mildews and as a space deodorant for toilets and refuse containers (ATSDR 1993). Tests involving acute exposure of animals, such as the LD_{50} test in rats and mice, have shown that 1,4-dichlorobenzene has moderate toxicity from oral exposure (RTECS 1993). Studies have reported effects on the blood, liver, and kidneys from acute, oral exposure. Chronic inhalation exposures can cause adverse effects on the respiratory system, liver, and kidneys. A study on pregnant rats reported adverse developmental effects in fetuses when administering the chemical by gavage (HSDB 1987).

An oral study on the effects of 1,4-dichlorobenzene on pregnant rats determined a chronic NOAEL of 250 mg/kg/day (Coulston and Kolbye 1994). At this level, no adverse effects were seen for maternal and developmental toxicity. Effects were observed at 500 mg/kg/day (the chronic LOAEL).

Fourteen-day studies with northern bobwhites showed adverse effect on growth and survival from oral exposures of 2,500 mg/kg/day (Grimes and Jaber 1989). A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. Toxicological profile for 1,4-dichlorobenzene. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

Grimes, J. and M. Jaber. 1989. Para-dichlorobenzene: An acute oral toxicity study with the bobwhite, Final Report. Prepared by Wildlife International Ltd. - Easton, MD under project No. 264-101 and submitted to Chemical Manufacturers Association, Washington, DC, report dated July 19, 1989.

Hazardous Substances Databank (HSDB). 1987. Record for 1,4-Dichlorobenzene. Computer Printout. National Library of Medicine.

Registry of Toxic Effects of Chemical Substances (RTECS). 1993. Online database. U.S. Department of Health and Human Services. National Toxicology Information Program, National Library of Medicine. Bethesda, MD.

2,3,4,6-Tetrachlorophenol

Information regarding 2,3,4,6-tetrachlorophenol was not available in the literature.

2,4,5-Trichlorophenol and 2,4,6-Trichlorophenol

Rats exposed to 2,4,5-trichlorophenol for 98 days in the diet demonstrated adverse effects to the hepatic and renal systems at doses of 800 mg/kg/day (McCollister et al. 1961). This dose is considered a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Mammalian data for 2,4,5-trichlorophenol was applied to 2,4,6-trichlorophenol. Information regarding toxicological effects on avian species from exposure to 2,4,5-trichlorophenol and 2,4,6-trichlorophenol was not available in the literature.

McCollister, D.D., P.T. Lockwood, and V.K. Rowe. 1961. Toxicologic information on 2,4,5-trichlorophenol. Toxicology and Applied Pharmacology. 3:63-70.

2,4-Dichlorophenol

Information regarding 2,4,-dichlorophenol was not available in the literature.

2-Acetylaminofluorene

Information regarding 2-acetylaminofluorene was not available in the literature.

2-Chloronaphthalene

Information regarding 2-chloronaphthalene was not available in the literature.

2-Methylnaphthalene

Mice exposed to 2-methylnaphthalene in the diet for 81 weeks showed systemic effects at a dose of 1,437 mg/kg/day (the chronic LOAEL; ATSDR 1995). A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Information on the toxicity of 2-methylnaphthalene on birds was not available in the literature.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

2-sec-butyl-4,6-Dinitrophenol

Information regarding 2-sec-butyl-4,6-dinitrophenol was not available in the literature.

3,3'-Dichlorobenzidine

3,3'-dichlorobenzidine breaks down rapidly in water exposed to natural sunlight and in air, but is retained in soil for months. In air, it is estimated that half of the 3,3'-dichlorobenzidine can breakdown within 2 hours. In water exposed to natural sunlight, 3,3'-dichlorobenzidine is expected to break down rapidly with half being removed in approximately 90 seconds.

Death has occurred in experimental animals that have ingested high concentrations of 3,3'-dichlorobenzidine. In studies conducted on pregnant mice, exposure to 3,3'-dichlorobenzidine caused the kidneys of their offspring to develop improperly. Chronic dietary exposure of

experimental animals to moderate levels of 3,3'-dichlorobenzidine caused mild injury to the liver (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological profile for 3,3'-dichlorobenzidine. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

3,3'-Dimethylbenzidine

Information regarding 3,3'-dimethylbenzidine was not available in the literature.

3-Methylcholanthrene

Information regarding 3-methylcholanthrene was not available in the literature.

4-Bromophenyl-phenylether

Information regarding 4-bromophenyl-phenylether was not available in the literature.

4-Chloro-3-methylphenol

Information regarding 4-chloro-3-methylphenol was not available in the literature.

4-Chlorophenyl-phenylether

Information regarding 4-chlorophenyl-phenylether was not available in the literature.

7,12-Dimethylbenz(a)anthracene

Information regarding 7,12-dimethylbenz(a)anthracene was not available in the literature.

Aramite

Information regarding aramite was not available in the literature.

Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate (DEHP) is used in the production of polyvinyl chloride, where it is added to plastics to make them flexible. Acute animal tests, such as the LD_{50} test in rats, have shown DEHP to have low acute toxicity from oral exposure (RTECS 1993). Oral exposure animal studies indicate that DEHP has adverse effects on the liver, kidney, weight gain and food consumption, and can cause liver tumors in rats and mice. Tests on rats and mice demonstrated that DEHP can cause developmental and reproductive toxicity, such as birth defects, decrease in testicular weights, and tubular atrophy (ATSDR 1993). Animal chronic, inhalation exposure studies have reported increased lung weights and liver weights (ATSDR 1993).

A literature search was conducted on the effects of bis(2-ethylhexyl)phthalate ingestion to mammals and birds. A 105-day study conducted on mice indicated that 1,000 mg/kg of bis(2-ethylhexyl)phthalate in the diet caused significant reproductive effects (Lamb et al. 1987). The 1,000 mg/kg dose was considered the chronic LOAEL. No adverse effects were observed among the 100 mg/kg dose group; this value was considered the chronic NOAEL. These dietary concentrations were converted to a daily doses of 183.3 mg/kg/day (LOAEL) and 18.3 mg/kg/day (NOAEL; Sample et al. 1996).

A 4-week study conducted on the reproductive effects of bis(2-ethylhexyl)phthalate to ringed doves indicated a chronic NOAEL of 10 ppm (Peakall 1974). No significant reproductive effects were observed among doves on diets containing 10 ppm of bis(2-ethylhexyl)phthalate. This dietary concentration was converted to daily dose (NOAEL) of 1.1 mg/kg/day (Sample et al. 1996). A chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. Toxicological profile for bis(2-ethylhexyl)phthalate. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Lamb, J.C., IV, R.E. Chapin, J. Teaque, A.D. Lawton, and J.R. Real. 1987. Reproductive effects of four phthalic acid esters in a mouse. Toxicol. Appl. Pharmacol. 88:255-269.

Peakall, D.B. 1974. Effects of di-n-butylphthalate and di-2-ethylhexylphthalate on the eggs of ring doves. Bull. Environ. Contam. Toxicol. 12:698-702.

Registry of Toxic Effects of Chemical Substances (RTECS). 1993. Online database. U.S. Department of Health and Human Services. National Toxicology Information Program, National Library of Medicine. Bethesda, MD.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Butylbenzylphthalate

Butylbenzylphthalate is used as a plasticizer. When it is released into the environment, butylbenzylphthalate tends to bind to soil and sediment. It does not persist in the environment when oxygen is present, with half-lives in air, water, and soil of only a few days. It is more persistent at low temperatures, and in an anaerobic environment.

A two-year study with rats indicated hepatic effects when this chemical was administered orally at a dose of 2,400 mg/kg/day (NTP 1997). This value is considered the chronic LOAEL. A chronic NOAEL (240 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No toxicological data were found for birds.

NTP (National Toxicology Program). 1997. Effect of dietary restriction on toxicology and carcinogenesis studies of butyl benzyl phthalate (CAS No. 85-68-7) in F344/N rats and B6C3F1 mice (feed studies). Technical Report Series No. 458, NTP TR458. Prepared by U.S. Department of Health and Human Services.

Carbozole

Information regarding carbozole was not available in the literature.

Chlorobenzilate

Information regarding chlorobenzilate was not available in the literature.

Diallate

Information regarding diallate was not available in the literature

Dibenzofuran

Dibenzofuran is a polynuclear aromatic compound that may be found in coke dust, grate ash, fly ash, and flame soot. It has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to the environment.

A literature search was conducted on the toxicological effects of dibenzofuran ingestion to mammals and birds. Studies measuring the toxicological effects of dietary dibenzofuran were not available.

Diethylphthalate

Diethylphthalate is a synthetic substance that is commonly used to make plastics more flexible. Products in which it is found include toothbrushes, automobile parts, tools, toys, and food packaging. Diethylphthalate can be released fairly easily from these products because it is not part of the chain of chemicals (polymers) that makes up the plastic. Diethylphthalate is also used in cosmetics, insecticides, and aspirin. Diethylphthalate has a moderate acute and chronic toxicity to aquatic organisms and can be mildly irritating when applied to the skin or eyes of animals.

A literature search was conducted on the toxicological effects of diethylphthalate ingestion to mammals and birds. Information was not available for birds. A 105-day study was conducted on the effects of diethylphthalate on reproduction of mice. Mice fed diets containing 2,500, 12,500, and 25,000 mg/kg diethylphthalate did not exhibit any negative reproductive effects (Lamb et al. 1987). The dose of 25,000 mg/kg (chronic NOAEL) was converted to a daily dose of 4,583 mg/kg/day. A chronic LOAEL of 45,830 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Lamb, J.C., IV, R.E. Chapin, J. Teaque, A.D. Lawton, and J.R. Real. 1987. Reproductive effects of four phthalic acid esters in a mouse. Toxicol. Appl. Pharmacol. 88:255-269.

Di-n-butylphthalate

Di-n-butylphthalate is a man-made chemical that is used to make soft plastics, carpet backing, paints, glue, insect repellents, hairspray, nail polish, and rocket fuel. Di-n-butylphthalate does not evaporate easily, but small amounts do enter into the air as a gas and by attaching to dust particles. In the air, di-n-butylphthalate usually breaks down within a few days. Di-n-butylphthalate does not dissolve easily in water, but can be transported to water by adhering to soil/sediment particles. Bacteria break down di-n-butylphthalate in water and soil within a day or up to a month. The length of time it takes to break down di-n-butylphthalate in soil or water depends on the kind of bacteria present and the soil/water temperature (ATSDR 1990). Di-n-butylphthalate appears to have relatively low toxicity. The levels of di-n-butylphthalate which cause toxic effects in animals are about 10,000 times higher than the typical levels of di-n-butylphthalate found in air, food, or water (ATSDR 1990).

In animals, ingestion of high levels of di-n-butylphthalate can affect their ability to reproduce, cause death of unborn animals, and decrease sperm production. Sperm production seems to return to near normal levels when exposure to di-n-butylphthalate ceases.

A literature search was conducted on the toxicological effects of di-n-butylphthalate ingestion to mammals and birds. In a 105-day study on the effects of di-n-butylphthalate on reproduction of mice, reduced litters per pair and reduced live pups per pair were observed among mice who were

fed a diet containing 1 percent di-n-butyl-phthalate (Lamb et al. 1987). This equates to a daily dose of 1,833 mg/kg/day (chronic LOAEL). No adverse effects were observed among mice fed diets containing 0.03 or 0.3 percent d-n-butylphthalate. The 0.3 percent dose (550 mg/kg/day) was considered the chronic NOAEL.

A study on the effects of di-n-butylphthalate on the reproduction of ringed doves was conducted over a four-week period (Peakall 1974). Doves fed diets containing 10 ppm di-n-butylphthalate (1.1 mg/kg/day) were observed to have reduced eggshell thickness and water permeability of the shell. This dose was considered a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for di-n-butylphthalate. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Lamb, J.C., IV, R.E. Chapin, J. Teaque, A.D. Lawton, and J.R. Real. 1987. Reproductive effects of four phthalic acid esters in a mouse. Toxicol. Appl. Pharmacol. 88:255-269.

Peakall, D.B. 1974. Effects of di-n-butylphthalate and di-2-ethylhexylphthalate on the eggs of ring doves. Bull. Environ. Contam. Toxicol. 12:698-702.

Di-n-octylphthalate

Small amounts of di-n-octylphthalate can accumulate in animals that live in water, such as fish and oysters. Some rats and mice that were given very high doses of di-n-octylphthalate orally died. Mildly harmful effects have been seen in the livers of some rats and mice given very high doses of di-n-octylphthalate orally for short (14 days or less) or intermediate periods (15 to 365 days) of time, but lower doses given for short periods of time generally caused no harmful effects.

Acute toxic effects may include the death of animals, birds, or fish, and death or low growth rate in plants. Acute effects are seen two to four days after animals or plants come in contact with the chemical. Di-n-octylphthalate has moderate acute toxicity to aquatic life. Insufficient data are available to evaluate or predict the short- term effects of di-n-octylphthalate to plants, birds, or land animals. Chronic toxic effects may include shortened life span, reproductive problems, lower fertility, and changes in appearance or behavior. Chronic effects can be seen long after first exposure(s). Di-n-octylhthalate has moderate chronic toxicity to aquatic life. Insufficient data are available to evaluate or predict the long- term effects of di-n-octylphthalate to plants, birds, or land animals.

Estimated chronic LOAELs and NOAELs for mice exposed to di-n-hexylphthalate orally for 105 days were 550 and 55 mg/kg/day, respectively (Sample et al. 1996). These values are directly extrapolated to di-n-octylphthalate. Estimated chronic LOAELs and NOAELs for ring-necked pheasant are 500 and 50 mg/kg/day, respectively (TERRETOX 1998).

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Terrestrial Toxicity Database (TERRETOX). 1998. Environmental Research Laboratory, U.S. Environmental Protection Agency, Duluth, MN.

Hexachlorobenzene

Rats exposed orally to hexachlorobenzene for two years demonstrated adverse effects to their reproduction at a dose of 16 mg/kg/day (ATSDR 1989). This dose was considered a chronic LOAEL. A chronic NOAEL (1.6 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Reproductive effects in birds from oral exposures occurred at a dose of 0.8 mg/kg/day (Coulston and Kolbye 1994). This dose was considered a chronic LOAEL. A chronic NOAEL (0.08 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological profile for hexachlorobenzene. Draft. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

Hexachlorobutadiene

Hexachlorobutadiene is a colorless, manmade liquid that is used in the production of rubber compounds, and lubricants. Hexachlorobutadiene in the water can be released to soil and air. It is expected to remain there for a long time because it attaches to organic matter in the soil. Hexachlorobutadiene can accumulate in fish and shellfish that live in contaminated waters, but it is not known if hexachlorobutadiene accumulates in plants. Under aerobic conditions in water, hexachlorobutadiene undergoes degradation. Degradation does not occur under anaerobic conditions.

Rats exposed orally to hexachlorobutadiene for 90 days demonstrated adverse effects to their reproduction at a dose of 20 mg/kg/day (IPCS 1994). This dose was considered a chronic LOAEL. A chronic NOAEL (2 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Reproductive effects in Japanese quail from oral exposures occurred at a dose of 8 mg/kg/day (Coulston and Kolbye 1994). This dose was considered a chronic LOAEL. The chronic NOAEL from this study was 2.5 mg/kg/day.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

International Programme on Chemical Safety (IPCS). 1994. Environmental health criteria 156 - hexachlorobutadiene. World Health Organization, Geneva.

Hexachlorocyclopentadiene

Rats exposed to hexachlorocyclopentadiene during pregnancy demonstrated adverse effects at a dose of 30 mg/kg/day but no adverse effects at 10 mg/kg/day (EPA 1984). These doses were considered the chronic LOAEL and NOAEL, respectively. Information regarding the toxicological effects on avian species from exposure to hexachlorocyclopentadiene was not available in the literature.

Environmental Protection Agency (EPA). 1984. Health assessment document for hexachlorocyclopentadiene. EPA/600/8-84/001F.

Hexachloroethane

Information regarding hexachloroethane was not available in the literature.

Hexachlorophene

Information regarding hexachlorophene was not available in the literature.

Hexachloropropene

Information regarding hexachloropropene was not available in the literature.

Isosafrole

Information regarding isosafrole was not available in the literature.

N-Nitrosodiphenylamine

N-nitrosodiphenylamine is an industrial compound that has been produced since 1945 in the manufacture of rubber products and other chemicals. Manufacturers have since replaced it with more efficient chemicals. It is not known whether it exists naturally in the environment; there is some evidence that microorganisms may produce it. Aquatic organisms can accumulate low levels of n-nitrosodiphenylamine in their bodies (ATSDR 1993). It is not known whether terrestrial animals and plants accumulate n-nitrosodiphenylamine. Animals exposed to n-nitrosodiphenylamine through long-term dietary intake developed swelling, cancer of the bladder, and changes in body weight (ATSDR 1993). Higher levels have caused death.

Systemic effects in rats fed n-nitrosodiphenylamine for 8 to 11 weeks were observed at a dose of 1,500 mg/kg/day (ATSDR 1993). This dose was considered a chronic LOAEL. A chronic NOAEL of 150 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No avian toxicological data were found.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. Toxicological profile for n-nitrosodiphenylamine. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

p-Dimethylaminoazobenzene

Information regarding p-dimethylaminoazobenzene was not available in the literature.

Pentachlorobenzene

Information regarding pentachlorobenzene was not available in the literature.

Pentachloronitrobenzene

Information regarding pentachloronitrobenzene was not available in the literature.

Pentachlorophenol

Pentachlorophenol is a manufactured chemical not found naturally in the environment. Pentachlorophenol has been used as a biocide and wood preservative. It was one of the most

heavily used pesticides in the United States. Now, only certified applicators can purchase and use pentachlorophenol (ATSDR 1992).

Pentachlorophenol adsorbs to soil particles, but is more likely to occur under acidic conditions than neutral or basic conditions. Microorganisms break it down into other compounds in soil and surface waters (ATSDR 1992).

Reproductive effects of pentachlorophenol on rats exposed to pentachlorphenol in the diet for up to 24 months occurred at a dose of 30 mg/kg/day while a dose of 3 mg/kg/day caused no adverse reproductive effects (Coulston and Kolbye 1994). These doses were considered chronic LOAELs and NOAELs, respectively. Chickens fed pentachlorophenol for 8 weeks showed adverse effects on growth at a dose of 200 mg/kg/day but not at 100 mg/kg/day (Eisler 1989). These doses are considered chronic LOAELs and NOAELs, respectively.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for pentachlorophenol. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

Eisler, R. 1989. Pentachlorophenol hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85(1.17), Contaminant Hazard Reviews Report No. 17. 72 pp.

Phenol

Phenol is mainly a man-made chemical, although it is found in animal wastes and organic material. Phenol is a colorless or white solid when it is pure but it is usually sold and used as a liquid. The largest single use of phenol is production of plastics. It evaporates more slowly than water and dissolves fairly well in water. Phenol is also ignitable (ASTDR 1989).

Pregnant animals that drank water containing high levels of phenol gave birth to offspring that had low birth weights and birth defects. Dermal exposure to small amounts of phenol for short durations can cause blisters and burns on the exposed area. Spilling weak phenol solutions on large parts of the body (more than 25 percent of the body surface) can result in death (ATSDR 1989). The toxicity of dermal exposure to phenol is influenced by the size of the skin area exposed.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological profile for phenol. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Pronamide

Information regarding pronamide was not available in the literature.

POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

PAHs are virtually ubiquitous in nature, primarily as a result of natural processes such as forest fires, microbial synthesis, and volcanic activity. They have been detected in animal and plant tissues, sediments, soils, air, surface water, drinking water, and groundwater. Anthropogenic sources of PAHs in the environment include high temperature combustion of organic materials typical of processes used in the steel industry, heating and power generation, and petroleum refining.

Environmental concern has focused on PAHs, which range in molecular size from two-ring structures to seven-ring structures. The number of rings on the molecule strongly affects its biochemical interactions in the environment. Consequently, the fate, transport, and toxicity of PAHs correlate strongly with the size of the specific PAH molecule.

Relatively little information is known on the fate and transport of specific PAH compounds. Information on PAHs as a group is largely inferred from information on benzo(a)pyrene and mixtures of PAHs.

PAHs are moderately persistent in the environment and therefore may potentially cause significant effects to vegetation, wildlife and fish. The carcinogenicity of individual PAHs differs. Some lower weight compounds such as naphthalene, fluorene, phenanthrene, and anthracene exhibit acute toxicity and other adverse effects to some organisms, but are non-carcinogenic. In contrast, the higher molecular weight compounds are significantly less acutely toxic, but many are demonstrably carcinogenic, mutagenic, or teratogenic to a wide variety of organisms, including fish and other aquatic life, amphibians, birds, and mammals.

PAHs can be taken into the mammalian body by inhalation, ingestion or dermal contact. Acute and chronic exposure to carcinogenic PAHs have been shown to cause tumors in the stomach, lung, and skin. PAHs also have been associated with the destruction of hematopoietci and lymphoid tissues, ovatoxicity, adrenal necrosis, changes in intestinal and respiratory epithelia and immunosuppression.

The environmental effects of most non-carcinogenic PAHs are poorly understood. Available information suggests that these PAHs are not very potent teratogens or reproductive toxins. Effects include damage to the liver and kidney, and external effects of sebaceous gland ulceration.

Studies on PAH toxicity in birds indicated no mortality or visible signs of toxicity when fed 4,000 mg total PAH per kilogram of body weight for seven months. In another study, toxic and sub-lethal effects were noted at concentrations of between 0.036 and 0.18 μg PAH per egg following application of various PAHs (e.g., chrysene and benzo(a)pyrene) to the surface of mallard eggs. Another study reported acute oral effect levels for the red-winged blackbird and house sparrow and acenaphthene, phenanthrene and anthracene LD_{50}values exceeded 100 mg/kg of body weight for these species.

Few ingestion-based studies have been conducted on mammals using PAHs. Neal and Rigdon (1967) conducted a study on mice for the development of forestomach tumors. Mice were fed between 0.13 mg/kg/day and 32.5 mg/kg/day of PAH for 110 days. The highest dose produced tumors in 90 percent of the mice. The NOAEL was calculated at 1.3 mg/kg/day and the LOAEL was 2.6 mg/kg/day (4 percent occurrence of tumors) (Charters et al. 1996).

A study conducted on nestling European starlings indicated that a dose of 100 mg/kg/day of 7,12-dimethylbenz(a)anthracene caused an 11 percent reduction in mean body weight, a 16 percent reduction in mean hemoglobin concentrations, and a 90 percent reduction in lymphocyte proliferation (Trust et al. 1993). A dose of 10 mg/kg/day caused no adverse effects to nestling birds. Adult starlings dosed as high as 300 mg/kg/day showed no adverse effects.

Charters, D.W., N.J. Finley, and M. Huston. 1996. Draft report, preliminary ecological risk assessment, Avtex Fibers Site, Front Royal, Virginia. U.S. Environmental Protection Agency, Environmental Response Team Center, Office of Emergency and Remedial Response.

Neal, J. and R.H. Rigdon. 1967. Gastric tumors in mice fed benzo(a)pyrene: a quantitative study. Tex. Rep. Biol. Med. 25:553-557.

Trust, K.A., A. Fairbrother, and M.J. Hooper. 1993. Effects of 7,12-dimethylbenz(a)anthracene on immune function and mixed-function oxygenase activity in the European starling. Environ. Toxicol. and Chemistry. 13:821-830.

Acenaphthene

Mice fed acenaphthene orally for 13 weeks showed adverse reproductive effects at a dose of 3,500 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 350 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. For birds, data for benzo(a)pyrene was applied to this chemical.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Anthracene

Mice fed anthracene orally for 13 weeks showed adverse reproductive effects at a dose of 10,000 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 1,000 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Mallards fed anthracene orally for 7 months showed adverse effects to the hepatic system at a dose of 228 mg/kg/day (Patton and Dieter 1980). This dose was considered a chronic LOAEL. A chronic NOAEL of 22.8 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Patton, J.F. and M.P. Dieter. 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. Comp. Biochem. Physiol. 65C:33-36.

Benzo(a)anthracene

Information regarding benzo(a)anthracene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Benzo(a)pyrene

Female mice were fed benzo(a)pyrene during pregnancy. Adverse reproductive effects were found at a dose of 10 mg/kg/day (Sample et al. 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 1 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Mice fed benzo(a)pyrene orally for 19 to 29 days showed adverse reproductive effects at a dose of 1330 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 133 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Chickens were fed benzo(a)pyrene for 34 days. Adverse reproductive effects were found at a dose of 395 mg/kg/day (Rigdon and Neal 1963). This dose was considered a chronic LOAEL. A chronic NOAEL of 39.5 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Rigdon, R.H. and J. Neal. 1963. Fluorescence of chickens and eggs following the feeding of benzpyrene crystals. Texas Reports on Biology and Medicine 21(4):558-566.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Benzo(b)fluoranthene

Information regarding benzo(b)fluoranthene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Benzo(g,h,i)perylene

Information regarding benzo(g,h,i)perylene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Benzo(k)fluoranthene

Information regarding benzo(k)fluoranthene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Chrysene

Information regarding chrysene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Dibenz(a,h)anthracene

Information regarding dibenz(a,h)anthracene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Fluoranthene

Mice fed fluoranthene orally for 13 weeks showed adverse effects to the hepatic system at a dose of 1,250 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 125 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. For birds, data for benzo(a)pyrene was applied to this chemical.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Fluorene

Mice fed fluorene orally for 13 weeks showed adverse hematological effects at a dose of 1,250 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 125 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. For birds, data for benzo(a)pyrene was applied to this chemical.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Indeno(1,2,3-cd)pyrene

Information regarding indeno(1,2,3-cd)pyrene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Naphthalene

Mice fed naphthalene orally for 13 weeks showed adverse reproductive effects at a dose of 1,400 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 140 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Mallards fed naphthalene orally for 7 months showed adverse effects to the hepatic system at a dose of 228 mg/kg/day (Patton and Dieter 1980). This dose was considered a chronic LOAEL. A chronic NOAEL of 22.8 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Patton, J.F. and M.P. Dieter. 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. Comp. Biochem. Physiol. 65C:33-36.

Phenanthrene

Information regarding phenanthrene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Pyrene

Information regarding pyrene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

VOLATILE ORGANICS

1,1,1,2-Tetrachloroethane

No information regarding 1,1,1,2-tetrachloroethane was available in the literature.

Carbon Tetrachloride

Carbon tetrachloride is a clear liquid that was produced in large quantities to make refridgeration fluid and propellant for aerosol cans. Production of this chemical is being phased out due its harmful effects on the ozone layer. Carbon tetrachloride evaporates very easily and can remain in the air for several years. Carbon tetrachloride does not adhere to soil or sediment particles but instead will move to the groundwater where it will be broken down into other chemicals.

A two-year study on the effects of carbon tetrachloride on reproduction in rats indicated a chronic NOAEL of 16 mg/kg/day (Alumot et al. 1976). This was the highest dose administered and no adverse effects were observed. A chronic LOAEL of 160 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. No data were found on the toxicological effects to birds from ingestion exposures.

Alumot, E., E. Nachtomi, E. Mandel et al. 1976. Tolerance and acceptable daily intake of chlorinated fumigants in the rat diet. Food Cosmet. Toxicol. 14:105-110.

Chlorobenzene

Chlorobenzene is a colorless liquid with an almond-like odor. This chemical does not widely occur naturally but is manufactured for use as a solvent and to produce other chemicals. Chlorobenzene can persist in soil for several months but will persist in air and water for only hours or a few days (ATSDR 1990).

A chronic study on the effects of chlorobenzene on dogs showed adverse effects to the liver at a dose of 273 mg/kg/day (IRIS 1998). This dose is considered a chronic LOAEL. A chronic NOAEL of 27.3 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No data were found on the toxicological effects to birds from ingestion exposures.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for chlorobenzene. Draft. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Integrated Risk Information System (IRIS). 1998. Environmental Protection Agency, Washington DC.

Chloroform

Chloroform is a colorless or water-white liquid. Most of what is produced in the United States is used to make fluorocarbon 22, which is a cooling fluid for air conditioners. A lesser amount is

used in the production of pesticides and solvents. Most of the chloroform that is released to the environment is transported to the air (ATSDR 1988).

A literature search was conducted on the toxicological effects of chloroform ingestion to mammals and birds. Ingestion-based studies were not available for birds.

A 13-week study of the effects of chloroform on livers, kidneys, and gonad condition in rats indicated a chronic LOAEL of 410 mg/kg/day (Palmer et al. 1979). At this dosage, both female and male rats developed gonadal atrophy. A dose of 150 mg/kg/day was determined to be the chronic NOAEL because no adverse effects were observed at this dosage.

Agency for Toxic Substances and Disease Registry (ATSDR). 1988. Toxicological profile for chloroform. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Palmer, A.K., A.E. Street, F.J.C. Roe, A.N. Worden, and N.J. Van Abbe. 1979. Safety evaluation of toothpaste containing chloroform. II. Long term studies in rats. J Environ. Pathol. Toxicol. 2:821-833.

Ethylbenzene

Ethylbenzene occurs naturally in coal tar and petroleum and is also found in many man-made products including paints, inks, and insecticides. Gasoline contains about 2 percent (by weight) ethylbenzene. Ethylbenzene is a colorless liquid that smells like gasoline. It evaporates at room temperature and burns easily. Ethylbenzene is most commonly found as a vapor because it evaporates easily into the air from water and soil. Once in the air, other chemicals help break down ethylbenzene into chemicals found in smog. This breakdown happens in about 3 days with the aid of sunlight. In surface water such as rivers and harbors, ethylbenzene breaks down by reacting with other compounds naturally present in water. In soil, bacteria break down ethylbenzene. It can also infiltrate groundwater since it does not readily bind to soil. Several studies indicate that ethylbenzene causes systemic effects in animals following inhalation exposure. The principal target organs appear to be the lungs, liver, and kidney, with transient toxic effects on the hematological system (ATSDR 1990).

A chronic study on the effects of ethylbenzene on rats showed adverse effects to the liver and kidney at a dose of 971 mg/kg/day (Wolf et al. 1956). This dose is considered a chronic LOAEL. A chronic NOAEL of 97.1 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No data were found on the toxicological effects to birds from ingestion exposures.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for ethylbenzene. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Wolf, M.A., V.K. Rowe, D.D. McCollister, R.L. Hollinsworth, and F. Oyen. 1956. Toxicological studies of certain alkylated benzenes and benzene. Arch. Ind. Health. 14:387-398.

Pentachloroethane

Information regarding pentachloroethane was not available in the literature.

Styrene

Styrene is a colorless liquid used to make rubber and plastics. Billions of pounds of styrene are produced each year in the United States. It does not occur naturally in the environment. Styrene is quickly broken down in the air when ozone is present, but remains in the soil and water for several months (ATSDR 1990).

A 90-day study on the effects of ingestion of styrene on reproduction in rats indicated a chronic NOAEL of 35 mg/kg/day (Beliles et al. 1985). A chronic LOAEL of 350 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

In a 560-day study on the effects of styrene on the hepatic system of dogs indicated a chronic LOAEL of 400 mg/kg/day (Quast et al. 1979). Dogs given this dosage by gavage exhibited increased numbers of Heinz bodies, decreased packed cell values, and sporadic decreases in hemoglobin and erythrocyte counts. No adverse effects were observed a dose of 200 mg/kg/day. This was determined to be a chronic NOAEL.

No data on the toxicological effects of styrene on birds were found in the literature.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for styrene. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Beliles, R.P., J.H. Butala, C.R. Stack et al. 1985. Chronic toxicity and three-generation reproduction study of styrene monomer in the drinking water of rats. Fundam. Appl. Toxicol. 5:855-868.

Quast J.F., C.G. Humiston, and R.V. Kalnins. 1979. Results of a toxicity study of monomeric styrene administered to beagle dogs by oral intubation for 19 months. Report to manufacturing Chemists Association, Washington, D.C., by Health and Environmental Sciences, Dow Chemical USA, Midland, MI.

Toluene

Toluene is produced as a by-product in the processing of gasoline and coke, and in the manufacture of styrene. Toluene readily degrades once it is released to the environment. It is readily broken down by microorganisms in the soil and evaporates quickly from the soil and surface water. Toluene can accumulate in aquatic organisms such as fish, shellfish, plants, and aquatic mammals. It is not known to biomagnify in food chains.

Studies on animals have shown that toluene can effect the central nervous system, liver, kidney and lungs. Studies using moderate to high concentrations of toluene indicate that toluene is a developmental toxicant, but not a reproductive toxicant (ATSDR 1994).

A study on the effects of toluene on the reproduction of rats indicated a chronic LOAEL of 0.3 mL/kg/day (Nawrot and Staples 1979). Exposure to this dose via oral gavage during gestation significantly reduced fetal weights and significantly reduced embryo mortality. The chronic LOAEL was converted to a daily dose of 260 mg/kg/day (Sample et al. 1996). A chronic NOAEL of 26 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Ingestion-based studies were not available for birds.

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. Toxicological profile for toluene. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Nawrot, P.S. and R.E. Staples. 1979. Embryofetal toxicity and teragenicity of benzene and toluene in the mouse. Teratology. 19: 41A.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-86/R3.

Trichloroethene

A study on the effects of trichloroethene on rats showed adverse reproductive effects at a dose of 10,000 mg/kg/day (Coulston and Kolbye 1994). This dose is considered a chronic LOAEL. A chronic NOAEL of 1,000 mg/kg/day was calculated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No data were found on the toxicological effects to birds from ingestion exposures.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. Regulatory Toxicology and Pharmacology. 20:S1-S1056.

Xylenes

Xylene is primarily a man-made chemical that is produced from petroleum and coal. Xylene also occurs naturally in petroleum and coal tar, and is formed during forest fires. There are three forms or isomers of xylene including *meta*-xylene, *ortho*-xylene, and *para*-xylene.

Xylene evaporates and burns easily. Xylene does not mix well with water, however, it does mix with alcohol and with many other chemicals. Xylene is a liquid and it can leach into soil, surface water (creeks, streams, and rivers), and groundwater where it can remain for 6 months or longer before it is broken down into other chemicals. Because it evaporates readily, most xylene is transported to the air, where it lasts for several days and is broken down by sunlight into other kinds of chemicals.

Results of studies with animals indicate that large amounts of xylene can cause changes in the liver and adverse effects on the kidney, lung, heart, and nervous system. Short-term exposure to high concentrations of xylene causes death in some animals, as well as muscular spasms, incoordination, hearing loss, changes in behavior, changes in organ weights, and changes in enzyme activity. Long-term exposure to low concentrations of xylene has not been well studied in animals (ATSDR 1990).

A study on the effects of xylene on the reproduction in mice indicated a chronic LOAEL of 2.6 mg/kg/day (Marks et al. 1982). A dose of 2.6 mg/kg/day showed significantly reduced fetal weights and increased the incidence of fetal malformations. While the xylene exposure studies were of a short duration, they occurred during a critical lifestage. The highest dose that produced no adverse effects (2.1 mg/kg/day) was considered to be a chronic NOAEL.

Quail exposed to xylene in the diet showed chronic effects at an estimated dose of 405 mg/kg/day (Hill and Camardese 1986). A chronic NOAEL of 40.5 mg/kg/day was estimated by multiplying this chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for xylene. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Hill, E.F. and M.B. Camardese. 1986. Lethal dietary toxicities of environmental contaminants and pesticides to *Coturnix*. U.S. Fish and Wildlife Service Technical Report 2.

Marks, T.A., T.A. Ledoux, and J. A. Moore. 1982. Teratogenicity of a commercial xylene mixture in the mouse. J. Toxicol. Environ. Health. 9:97-105.

APPENDIX B
EQUILIBRIUM PARTITIONING APPROACH

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EQUILIBRIUM PARTITIONING APPROACH

The U. S. Environmental Protection Agency (USEPA) has chosen the EqP approach for developing sediment quality criteria (or sediment screening values in the case of this ERA) for nonionic organic chemical constituents (USEPA 1993). This approach was used to derive sediment screening values for nonionic organic chemicals lacking literature-based, bulk sediment screening values.

There are three underlying assumptions to the derivation of sediment quality criteria. First, it is assumed that sediment toxicity correlates with the concentration of the chemical in the sediment pore water and not the bulk sediment concentration (i.e., the pore water concentration represents the bioavailable fraction). Second, partitioning between sediment pore water and bulk sediment is assumed to be dependent on the organic content of the sediment with little dependence upon other chemical or physical properties. Third, the EqP approach assumes that equilibrium has been attained between the sediment pore water concentration and the bulk sediment concentration.

The relationship between the concentration of a nonionic organic chemical in sediment pore water and bulk sediment is described by the partitioning coefficient, K_p (USEPA 1993):

$$K_p = (C_s)/(C_{pw}) \quad \text{(Equation B-1)}$$

Where C_s is the concentration in bulk sediment and C_{pw} is the concentration in sediment pore water. For a given organic chemical, the partition coefficient can be derived by multiplying the fraction of organic carbon (f_{oc}) present in the sediment by the chemical's organic carbon partition coefficient (K_{oc}) (USEPA 1993):

$$K_p = (f_{oc})(K_{oc}) \quad \text{(Equation B-2)}$$

Combining Equations B-1 and B-2 yields the following:

$$C_s = (K_{oc})(f_{oc})(C_{PW}) \quad \text{(Equation B-3)}$$

If the organic carbon content of the sediment is known, a site-specific sediment screening value (SSV) can be calculated for a given non-polar organic chemical by setting C_{pw} equivalent to a conservative surface water screening value for that chemical (SWSV):

$$SSV = (K_{oc})(f_{oc})(SWSV) \quad \text{(Equation B-4)}$$

In this equation, SSV represents the concentration of the chemical in bulk sediment that, at equilibrium, will result in a sediment pore water concentration equal to the surface water screening value. Sediment concentrations less than SSV would be protective of sediment-associated biota. The use of surface water threshold screening values (i.e., criteria and toxicological benchmarks) in Equation B-4 assumes that the sensitivities of sediment-associated biota and the species typically tested to derive surface water screening values such as USEPA NAWQC (predominantly water column species) are similar. Furthermore, it assumes that levels of protection afforded by the surface water screening values are appropriate for sediment-associated biota. It is noted that the EqP approach can only be used if the f_{oc} in sediment is

greater than 0.02 (i.e., 2.0 percent. At f_{oc} values less than 0.02, other factors (e.g., particle size, sorption to nonorganic mineral fractions) become relatively more important (USEPA 1993).

Although the EqP approach was developed by the EPA for nonionic organic chemicals, this method was also used to derive sediment screening values for ionic organic chemicals lacking literature-based bulk sediment toxicological benchmarks. Application of the EqP approach to ionic organic chemicals likely overestimates their pore water concentrations since adsorption mechanisms other than hydrophobicity may significantly increase the fraction of the chemical sorbed to sediment particles (Jones et al. 1997). Therefore, the EqP-based threshold screening values developed for ionic chemicals may be overly conservative. Regardless, application of the EqP approach to the development of sediment screening values for ionic chemicals is documented in the literature (USEPA 1996 and Jones et al. 1997).

The EqP-based sediment screening values summarized in Section 3.0, Table 3-11 are conservatively based on a default f_{oc} of 0.01 (one percent) (USEPA 1996). The K_{oc} values applied to Equation B-4 were estimated from the following equation (USEPA 1993 and 1996):

$$Log\ K_{oc} = 0.00028 + (0.983)(Log\ K_{ow}) \quad \text{(Equation B-5)}$$

Where log K_{ow} is the log octanol-water partition coefficient. Log K_{ow} and estimated K_{oc} values for organic chemicals evaluated by the Tier I screening-level ERA are listed in Section 3.0, Table 3-8. Surface water screening values used in the derivation of EqP-based sediment screening values were taken from Section 3.0, Table 3-10. EqP-based sediment screening values could not be calculated for those organic chemicals lacking a surface water screening value.

References

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APPENDIX C
IDENTIFICATION OF BIOACCUMULATIVE CHEMICALS

APPENDIX C

IDENTIFICATION OF BIOACCUMULATIVE CHEMICALS

Only those organic chemicals with a log octanol-water partition coefficient (K_{ow}) value greater than or equal to 3.0 will be considered a bioaccumulative chemical. Justification for defining bioaccumulative organic chemicals as those with log K_{ow} values greater than or equal to 3.0 is provided below.

- The potential for organic chemicals to accumulate in organisms has been shown to correlate well with the K_{ow}. USEPA (1985), as sited in USEPA/ACOE (1998), recommends that only chemicals for which the log K_{ow} is greater than 3.5 be considered for evaluation of bioaccumulation potential since chemicals with log K_{ow} values less than 3.5 are not likely to bioaccumulate to a significant degree.

- Although organic chemicals with log K_{ow} values in the 2 to 7 range have at least some potential to bioconcentrate (Connell 1990), significant bioconcentration does not generally occur for chemicals with log K_{ow} values less than 3.0 (Maki and Duthie 1978) to 5.0 (Gobas and Mackay 1990). Most work with bioconcentration (uptake from the surrounding medium, such as water) and bioaccumulation (uptake from all exposure routes, including via food) of organic chemicals has concerned chemicals with log K_{ow} values of 3.0 or more (USEPA 1995a), since organic chemicals with lower log K_{ow} values generally have little potential for significant bioaccumulation.

- The USEPA has developed a number of scoring algorithms to evaluate the relative hazard of chemicals to human or ecological receptors. All of these algorithms have a component that addresses bioaccumulation potential. The evaluation of bioaccumulation potential is generally based on measured or estimated (using log K_{ow} values) BCFs or BAFs, or less commonly using log K_{ow} itself. For example, USEPA (1980) developed a bioaccumulation potential scoring system that considered organics with BCF values of less than 100 (equivalent to a log K_{ow} of approximately 3.0) to have negligible potential to bioaccumulate in aquatic food webs, while organic chemicals with BCFs in the 100 to 1,000 range (equivalent to log K_{ow} values of about 3.0 to 4.3) are considered to have low bioaccumulation potential. The more recent Scoring and Ranking Assessment Model (SCRAM), developed by EPA Region 5 for the Great Lakes, has similar bioaccumulation scoring cut-offs (USEPA 2000).

- The proposed categorization of persistent, bioaccumulative, and toxic (PBT) chemicals under the Toxic Substances Control Act (TSCA) defines chemicals with a tendency to accumulate in organisms as those with a BCF or BAF of greater than 1,000 (Federal Register 63(192):53417; 10/5/98). Using the equation listed below (USEPA 1995b), a BCF/BAF of 1,000 equates to a log K_{ow} value of approximately 4.3.

$$Log\ BCF = [(0.79)(\log K_{ow}) - 0.40] \qquad \text{(Equation C-1)}$$

- The Beta Test Version 1.0 of the EPA Waste Minimization Prioritization Tool (WMPT), used to develop a list of PBTs for the Resource Conservation and Recovery Act (RCRA) program, defined organic chemicals with a low potential to bioaccumulate as those with log K_{ow} values of less than 3.5 and those with a high potential to bioaccumulate as those with log K_{ow} values greater than 5.0 (USEPA 1998). The 1998 version of the EPA WMPT defines bioaccumulation potential based on BCF or BAF values (rather than on log K_{ow} values directly), with a scoring "fenceline" for organic chemicals with a low

bioaccumulation potential defined as a BCF or BAF of less than 250. Although the tool no longer uses log K_{ow} directly, log K_{ow} values can be used to estimate a BCF or BAF value. Using Equation C-1, a BCF/BAF of 250 equates to a log K_{ow} value of approximately 3.5.

- Garten and Trabalka (1983) have reviewed terrestrial food web data and concluded that only organic chemicals with log K_{ow} values greater than 3.5 have the potential to significantly bioaccumulate from food to birds to mammals.

The information listed above indicates that a log K_{ow} of 3.0 to 3.5 is a reasonable, non-arbitrary parameter value to use in defining an organic chemical with the potential to bioaccumulate. For conservatism, the low end (3.0) of this log K_{ow} range will be used to define a bioaccumulative organic chemical. Section 4.0, Table 4-2 lists log K_{ow} values (range and recommended value) for volatile and semi-volatile organic chemicals that have been or will be analyzed surface water, sediment, and surface soil collected from the TWFF. Log K_{ow} values were primarily obtained from the USEPA (1995c and 1996). The recommended value from these sources generally represents a "high-end" or best estimate from empirical data. The organic chemicals that will be evaluated in the dietary intake models are those with a log K_{ow} value of greater than or equal to 3.0. For conservatism, the maximum value in the log K_{ow} range is used for this determination not the recommended value.

Inorganic chemicals were not quantitatively screened for bioaccumulation potential since log K_{ow} values are not available for these chemicals. However, cyanide was eliminated from the list since it is readily metabolized and is not known to bioaccumulate (Eisler 1991). Although all Appendix IX metals are retained for evaluation in the upper trophic level food chain models, only mercury and selenium are known to biomagnify in food chains (in organic forms; Suter 1993) and only cadmium, copper, and zinc generally have the potential to bioaccumulate significantly. The other metals are retained by default.

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APPENDIX D
ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002
Volatiles (mg/kg)								
Ethylbenzene	0.005 U	0.006 U	0.005 UJ	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Styrene	0.005 U	0.006 U	0.005 UJ	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
cis-1,3-Dichloropropene	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
trans-1,3-Dichloropropene	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
1,2-Dibromoethane	0.022 U	0.022 U	0.021 U	0.021 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Acrolein	0.54 UJ	0.56 UJ	0.52 UJ	0.54 UJ	0.13 R	0.14 R	0.12 R	0.11 R
3-Chloro-1-propene	0.022 U	0.022 U	0.021 U	0.021 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
1,2-Dichloroethane	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Propionitrile	0.054 R	0.055 R	0.052 R	0.054 R	0.13 U	0.14 U	0.12 U	0.11 U
Acrylonitrile	0.11 U	0.11 U	0.1 U	0.11 U	0.13 U	0.14 U	0.12 U	0.11 U
Vinyl acetate	0.011 U	0.011 U	0.01 U	0.011 U	0.013 U	0.014 U	0.012 U	0.011 U
4-Methyl-2-pentanone	0.011 U	0.011 U	0.01 U	0.011 U	0.032 U	0.036 U	0.029 UJ	0.028 UJ
Toluene	0.005 U	0.006 U	0.005 U	0.005 U	0.0037 J	0.0035 J	0.014	0.042
Chlorobenzene	0.005 U	0.006 U	0.005 UJ	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
trans-1,4-Dichloro-2-buten	0.022 U	0.022 U	0.021 UJ	0.021 U	0.013 U	0.014 U	0.012 U	0.011 U
Dibromochloromethane	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Methacrylonitrile	0.022 U	0.022 U	0.021 U	0.021 U	0.13 U	0.14 U	0.12 U	0.11 U
Chloroprene	0.11 U	0.11 U	0.1 U	0.11 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Tetrachloroethene	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Xylene	0.005 U	0.002 J	0.005 UJ	0.005 U	0.0064 U	0.0071 U	0.012 U	0.0046 J
trans-1,2-Dichloroethene	NA	NA	NA	NA	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Carbon tetrachloride	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
2-Hexanone	0.011 U	0.011 U	0.01 UJ	0.011 U	0.032 U	0.036 U	0.029 UJ	0.028 UJ
1,1,1,2-Tetrachloroethane	0.011 U	0.011 U	0.01 UJ	0.011 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Acetone	0.011 U	0.011 U	0.054 J	0.011 U	0.064 U	0.02 J	0.058 R	0.055 R

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CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002
Chloroform	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Benzene	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
1,1,1-Trichloroethane	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Bromomethane	0.011 U	0.011 U	0.01 U	0.011 U	0.013 U	0.014 U	0.012 U	0.011 U
Chloromethane	0.011 UJ	0.011 UJ	0.01 UJ	0.011 UJ	0.013 U	0.014 U	0.012 U	0.011 U
Iodomethane	0.011 U	0.011 U	0.01 U	0.011 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Dibromomethane	0.011 U	0.011 U	0.01 U	0.011 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Chloroethane	0.011 U	0.011 U	0.01 U	0.011 U	0.013 U	0.014 U	0.012 U	0.011 U
Vinyl chloride	0.011 U	0.011 U	0.01 U	0.011 U	0.013 U	0.014 U	0.012 U	0.011 U
Acetonitrile	0.11 U	0.11 U	0.1 U	0.11 U	0.26 UJ	0.28 U	0.23 U	0.22 U
Methylene chloride	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Carbon disulfide	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Bromoform	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Bromodichloromethane	0.005 UJ	0.006 UJ	0.005 UJ	0.005 UJ	0.0064 U	0.0071 U	0.0058 U	0.0055 U
1,1-Dichloroethane	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
1,1-Dichloroethene	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Trichlorofluoromethane	0.011 U	0.011 U	0.01 U	0.011 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Dichlorodifluoromethane	0.022 U	0.022 U	0.021 U	0.021 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Pentachloroethane	0.022 UJ	0.022 UJ	0.021 UJ	0.021 UJ	0.032 U	0.036 U	0.029 U	0.028 U
Isobutanol	2.2 R	2.2 R	2.1 R	2.1 R	0.26 R	0.28 R	0.23 R	0.22 R
1,2-Dichloropropane	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
2-Butanone	0.011 U	0.011 U	0.01 U	0.011 U	0.032 U	0.036 U	0.029 U	0.028 U
1,1,2-Trichloroethane	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Trichloroethene	0.005 U	0.006 U	0.005 U	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0043 J
1,1,2,2-Tetrachloroethane	0.005 U	0.006 U	0.005 UJ	0.005 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Methyl methacrylate	0.022 U	0.022 U	0.021 U	0.021 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U

APPENDIX D.1

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CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002
1,2-Dibromo-3-chloropropa	0.022 U	0.022 U	0.021 UJ	0.021 U	0.013 U	0.014 U	0.012 U	0.011 U
1,2,3-Trichloropropane	0.011 U	0.011 U	0.01 UJ	0.011 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U
Ethyl methacrylate	0.022 U	0.022 U	0.021 U	0.021 U	0.0064 U	0.0071 U	0.0058 U	0.0055 U

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB01-00	7SB02-00	7SB03-00	7SB23-00	7SB24-00	7SB25-00	7SB26-00	7SB27-00
Site ID	7SB01	7SB02	7SB03	7SB23	7SB24	7SB25	7SB26	7SB27
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/21/1996	3/21/1996	3/21/1996	1/23/2002	1/23/2002	1/24/2002	1/24/2002	1/12/2002
Volatiles (mg/kg)								
Ethylbenzene	0.005 UJ	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Styrene	0.005 UJ	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
cis-1,3-Dichloropropene	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
trans-1,3-Dichloropropene	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
1,2-Dibromoethane	0.021 U	0.023 U	0.02 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Acrolein	0.53 U	0.57 UJ	0.51 UJ	0.12 R	0.11 UJ	0.15 UJ	0.13 UJ	0.11 R
3-Chloro-1-propene	0.021 U	0.023 U	0.02 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
1,2-Dichloroethane	0.005 UJ	0.006 UJ	0.005 UJ	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Propionitrile	0.053 R	0.057 R	0.051 R	0.12 U	0.11 U	0.15 U	0.13 U	0.11 U
Acrylonitrile	0.11 UJ	0.11 U	0.1 U	0.12 U	0.11 U	0.15 U	0.13 U	0.11 U
Vinyl acetate	0.011 U	0.011 U	0.01 U	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
4-Methyl-2-pentanone	0.011 U	0.011 U	0.01 U	0.03 U	0.027 U	0.038 U	0.032 U	0.027 U
Toluene	0.005 U	0.006 U	0.005 U	0.0059 U	0.056	0.0076 U	0.0032 J	0.014
Chlorobenzene	0.005 UJ	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
trans-1,4-Dichloro-2-buten	0.021 UJ	0.023 U	0.02 U	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
Dibromochloromethane	0.005 UJ	0.006 UJ	0.005 UJ	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Methacrylonitrile	0.021 U	0.023 U	0.02 U	0.12 U	0.11 U	0.15 U	0.13 U	0.11 U
Chloroprene	0.11 U	0.11 U	0.1 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Tetrachloroethene	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Xylene	0.005 UJ	0.006 U	0.005 U	0.012 U	0.0054 J	0.015 U	0.013 U	0.0053 U
trans-1,2-Dichloroethene	NA	NA	NA	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Carbon tetrachloride	0.005 U	0.006 UJ	0.005 UJ	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
2-Hexanone	0.011 UJ	0.011 U	0.01 U	0.03 U	0.027 U	0.038 U	0.032 U	0.027 U
1,1,1,2-Tetrachloroethane	0.011 UJ	0.011 U	0.01 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Acetone	0.011 UJ	0.011 U	0.01 U	0.059 U	0.054 U	0.076 U	0.064 U	0.043 J

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB01-00	7SB02-00	7SB03-00	7SB23-00	7SB24-00	7SB25-00	7SB26-00	7SB27-00
Site ID	7SB01	7SB02	7SB03	7SB23	7SB24	7SB25	7SB26	7SB27
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/21/1996	3/21/1996	3/21/1996	1/23/2002	1/23/2002	1/24/2002	1/24/2002	1/12/2002
Chloroform	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Benzene	0.005 UJ	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
1,1,1-Trichloroethane	0.005 U	0.006 UJ	0.005 UJ	0.0059 U	0.0032 J	0.0076 U	0.0064 U	0.0053 U
Bromomethane	0.011 U	0.011 U	0.01 U	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
Chloromethane	0.011 UJ	0.011 UJ	0.01 UJ	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
Iodomethane	0.011 U	0.011 U	0.01 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Dibromomethane	0.011 U	0.011 U	0.01 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Chloroethane	0.011 U	0.011 U	0.01 U	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
Vinyl chloride	0.011 UJ	0.011 U	0.01 U	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
Acetonitrile	0.11 U	0.11 U	0.1 U	0.24 U	0.22 U	0.31 U	0.26 U	0.21 U
Methylene chloride	0.005 U	0.006 UJ	0.005 UJ	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0022 J
Carbon disulfide	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Bromoform	0.005 UJ	0.006 UJ	0.005 UJ	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Bromodichloromethane	0.005 U	0.006 UJ	0.005 UJ	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
1,1-Dichloroethane	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
1,1-Dichloroethene	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Trichlorofluoromethane	0.011 U	0.011 U	0.01 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Dichlorodifluoromethane	0.021 UJ	0.023 U	0.02 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Pentachloroethane	0.021 UJ	0.023 UJ	0.02 UJ	0.03 U	0.027 U	0.038 U	0.032 U	0.027 U
Isobutanol	2.1 R	2.3 R	2 R	0.24 U	0.22 U	0.31 U	0.26 U	0.21 R
1,2-Dichloropropane	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
2-Butanone	0.011 U	0.011 U	0.01 U	0.03 U	0.027 U	0.038 U	0.032 U	0.0054 J
1,1,2-Trichloroethane	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Trichloroethene	0.005 U	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
1,1,2,2-Tetrachloroethane	0.005 UJ	0.006 U	0.005 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Methyl methacrylate	0.021 U	0.023 U	0.02 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB01-00	7SB02-00	7SB03-00	7SB23-00	7SB24-00	7SB25-00	7SB26-00	7SB27-00
Site ID	7SB01	7SB02	7SB03	7SB23	7SB24	7SB25	7SB26	7SB27
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/21/1996	3/21/1996	3/21/1996	1/23/2002	1/23/2002	1/24/2002	1/24/2002	1/12/2002
1,2-Dibromo-3-chloropropa	0.021 UJ	0.023 U	0.02 U	0.012 U	0.011 U	0.015 U	0.013 U	0.011 U
1,2,3-Trichloropropane	0.011 UJ	0.011 U	0.01 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U
Ethyl methacrylate	0.021 U	0.023 U	0.02 U	0.0059 U	0.0054 U	0.0076 U	0.0064 U	0.0053 U

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
Volatiles (mg/kg)							
Ethylbenzene	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Styrene	0.0063 U	0.0057 U	0.0045 J	0.005 U	0.006 U	0.006 U	0.005 U
cis-1,3-Dichloropropene	0.0063 U	0.0057 U	0.0054 U	0.005 UJ	0.006 UJ	0.006 UJ	0.005 U
trans-1,3-Dichloropropene	0.0063 U	0.0057 U	0.0054 U	0.005 UJ	0.006 UJ	0.006 UJ	0.005 U
1,2-Dibromoethane	0.0063 U	0.0057 U	0.0054 U	0.022 U	0.022 U	0.023 U	0.021 U
Acrolein	0.12 R	0.11 R	0.11 R	0.54 UJ	0.56 UJ	0.57 UJ	0.52 UJ
3-Chloro-1-propene	0.0063 U	0.0057 U	0.0054 U	0.022 U	0.022 U	0.023 U	0.021 U
1,2-Dichloroethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Propionitrile	0.12 U	0.11 U	0.11 U	0.054 R	0.056 R	0.057 R	0.052 R
Acrylonitrile	0.12 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.1 U
Vinyl acetate	0.012 U	0.011 U	0.011 U	0.011 UJ	0.011 UJ	0.011 UJ	0.01 UJ
4-Methyl-2-pentanone	0.031 U	0.028 U	0.027 U	0.011 U	0.011 U	0.011 UJ	0.01 U
Toluene	0.0063 U	0.012	0.057	0.005 U	0.006 U	0.006 U	0.005 U
Chlorobenzene	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
trans-1,4-Dichloro-2-buten	0.012 U	0.011 U	0.011 U	0.022 U	0.022 U	0.023 U	0.021 U
Dibromochloromethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Methacrylonitrile	0.12 U	0.11 U	0.11 U	0.022 U	0.022 U	0.023 U	0.021 U
Chloroprene	0.0063 U	0.0057 U	0.0054 U	0.11 U	0.11 U	0.11 U	0.1 U
Tetrachloroethene	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Xylene	0.012 U	0.0057 U	0.0039 J	0.005 U	0.006 U	0.006 U	0.005 U
trans-1,2-Dichloroethene	0.0063 U	0.0057 U	0.0054 U	NA	NA	NA	NA
Carbon tetrachloride	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
2-Hexanone	0.031 U	0.028 U	0.027 U	0.011 U	0.011 U	0.011 U	0.01 U
1,1,1,2-Tetrachloroethane	0.0063 U	0.0057 U	0.0054 U	0.011 U	0.011 U	0.011 U	0.01 U
Acetone	0.063 U	0.0088 J	0.056 J	0.011 UJ	0.011 UJ	0.022	0.01 U

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
Chloroform	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Benzene	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
1,1,1-Trichloroethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Bromomethane	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U
Chloromethane	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U
Iodomethane	0.0063 U	0.0057 U	0.0054 U	0.011 UJ	0.011 UJ	0.011 UJ	0.01 UJ
Dibromomethane	0.0063 U	0.0057 U	0.0054 U	0.011 UJ	0.011 UJ	0.011 UJ	0.01 UJ
Chloroethane	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U
Vinyl chloride	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U
Acetonitrile	0.25 U	0.23 UJ	0.22 U	0.11 U	0.11 U	0.11 UJ	0.1 UJ
Methylene chloride	0.0063 U	0.0057 U	0.0067	0.005 UJ	0.006 UJ	0.006 UJ	0.005 UJ
Carbon disulfide	0.0063 U	0.0057 U	0.0054 U	0.005 UJ	0.006 UJ	0.006 UJ	0.005 UJ
Bromoform	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Bromodichloromethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
1,1-Dichloroethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
1,1-Dichloroethene	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Trichlorofluoromethane	0.0063 U	0.0057 U	0.0054 U	0.011 U	0.011 U	0.011 U	0.01 U
Dichlorodifluoromethane	0.0063 U	0.0057 U	0.0054 U	0.022 UJ	0.022 UJ	0.023 UJ	0.021 UJ
Pentachloroethane	0.031 U	0.028 U	0.027 U	0.022 U	0.022 U	0.023 U	0.021 U
Isobutanol	0.25 U	0.23 R	0.22 R	2.2 R	2.2 R	2.3 R	2.1 R
1,2-Dichloropropane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
2-Butanone	0.031 U	0.028 U	0.0059 J	0.011 UJ	0.011 UJ	0.011 UJ	0.01 UJ
1,1,2-Trichloroethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Trichloroethene	0.0063 U	0.0057 U	0.01	0.005 U	0.006 U	0.006 U	0.005 U
1,1,2,2-Tetrachloroethane	0.0063 U	0.0057 U	0.0054 U	0.005 U	0.006 U	0.006 U	0.005 U
Methyl methacrylate	0.0063 U	0.0057 U	0.0054 U	0.022 U	0.022 U	0.023 U	0.021 U

APPENDIX D.1

SURFACE SOIL DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
1,2-Dibromo-3-chloropropa	0.012 U	0.011 U	0.011 U	0.022 UJ	0.022 UJ	0.023 UJ	0.021 UJ
1,2,3-Trichloropropane	0.0063 U	0.0057 U	0.0054 U	0.011 U	0.011 U	0.011 U	0.01 U
Ethyl methacrylate	0.0063 U	0.0057 U	0.0054 U	0.022 U	0.022 U	0.023 U	0.021 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00	7SB01-00	7SB02-00	7SB03-00	7SB23-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19	7SB01	7SB02	7SB03	7SB23
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002	3/21/1996	3/21/1996	3/21/1996	1/23/2002
Semivolatiles (mg/kg)												
4-Nitroaniline	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
4-Nitrophenol	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
Benzyl alcohol	0.35 UJ	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
n-Nitrosopiperidine	0.35 UJ	0.36 UJ	0.34 UJ	0.35 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.36 UJ	0.38 UJ	0.34 UJ	0.38 U
4-Bromophenyl phenyl ether	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2,4-Dimethylphenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
n-Nitrosomethylethylamine	0.35 UJ	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
1,4,-Dichlorobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
4-Chloroaniline	0.7 U	0.72 U	0.68 U	0.7 U	0.82 U	0.94 U	0.74 U	0.8 U	0.71 U	0.76 U	0.68 U	0.77 U
1,4-Phenylenediamine	0.7 UJ	0.72 UJ	0.68 UJ	0.7 UJ	2.1 U	2.4 U	1.9 U	2.1 U	0.71 UJ	0.76 UJ	0.68 UJ	2 U
Bis(2-chloroisopropyl)ether	0.35 UJ	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Phenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Picoline	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Pryridine	0.7 UJ	0.72 UJ	0.68 UJ	0.7 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.71 UJ	0.76 UJ	0.68 UJ	0.38 U
Bis(2-chloroethyl)ether	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Bis(2-chloroethoxy)methane	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Bis(2-ethylhexyl)phthalate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.068 J	0.19 J	0.4 U	0.36 U	0.38 U	0.34 U	0.79
Di-n-octylphthalate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Hexachlorobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
3,3'-Dimethylbenzidine	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
Anthracene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Isosafrole	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 R	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
1,2,4-Trichlorobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2,4-Dichlorophenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2,4-Dinitrotoluene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
A, A-Dimethylphenethylamine	1.7 UJ	1.8 U	1.7 U	1.7 U	84 U	96 U	75 U	82 U	1.8 U	1.9 U	1.7 U	78 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00	7SB01-00	7SB02-00	7SB03-00	7SB23-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19	7SB01	7SB02	7SB03	7SB23
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002	3/21/1996	3/21/1996	3/21/1996	1/23/2002
1,4-Dioxane	0.7 UJ	0.72 UJ	0.68 UJ	0.7 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.71 UJ	0.76 UJ	0.68 UJ	0.38 U
o,o,o-Triethylphosphorothioat	NA	NA	NA	NA	0.41 U	0.47 U	0.37 U	0.4 U	NA	NA	NA	0.38 U
Pyrene	0.35 U	0.049 J	0.32 J	0.35 U	0.0043 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
1,4-Naphthoquinone	1.7 UJ	1.8 UJ	1.7 UJ	1.7 UJ	0.41 U	0.47 U	0.37 U	0.4 U	1.8 UJ	1.9 UJ	1.7 UJ	0.38 U
Dimethylphthalate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
3&4-Methylphenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Dibenzofuran	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
1-Naphthylamine	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
Aramite	0.7 U	0.72 UJ	0.68 UJ	0.7 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.71 UJ	0.76 UJ	0.68 UJ	0.38 U
Hexachloropropene	1.7 U	1.8 U	1.7 U	1.7 U	0.41 U	0.47 U	0.37 U	0.4 U	1.8 U	1.9 U	1.7 U	0.38 U
Benzo(g,h,i)perylene	0.35 U	0.36 U	0.06 J	0.35 U	0.0032 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Indeno(1,2,3-cd)pyrene	0.35 U	0.36 U	0.067 J	0.35 U	0.0022 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Benzo(b)fluoranthene	0.054 J	0.36 U	0.19 J	0.35 U	0.0025 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Fluoranthene	0.35 U	0.066 J	0.36	0.35 U	0.0062 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Benzo(k)fluoranthene	0.35 U	0.36 U	0.1 J	0.35 U	0.0036 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Acenaphthylene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Chrysene	0.048 J	0.36 U	0.21 J	0.35 U	0.0033 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Diallate	0.35 UJ	0.36 UJ	0.34 UJ	0.35 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.36 UJ	0.38 UJ	0.34 UJ	0.38 U
Pronamide	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Benzo(a)pyrene	0.039 J	0.36 U	0.13 J	0.35 U	0.0027 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2,4-Dinitrophenol	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
Dibenzo(a,h)anthracene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Acetylaminofluorene	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
4,6-Dinitro-2-methylphenol	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
1,3-Dichlorobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
n-Nitrosodiethylamine	0.35 UJ	0.36 UJ	0.34 UJ	0.35 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.36 UJ	0.38 UJ	0.34 UJ	0.38 U
3-Methylcholanthrene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00	7SB01-00	7SB02-00	7SB03-00	7SB23-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19	7SB01	7SB02	7SB03	7SB23
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002	3/21/1996	3/21/1996	3/21/1996	1/23/2002
Benzo(a)anthracene	0.35 U	0.36 U	0.16 J	0.35 U	0.0032 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
4-Nitroquinoline-1-oxide	1.7 R	1.8 R	1.7 R	1.7 R	4.1 R	4.7 R	3.7 R	4 R	1.8 R	1.9 R	1.7 R	3.8 R
7,12-Dimethyl benz(a)anthrac	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
2,3,4,6-Tetrachlorophenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
4-Chloro-3-methylphenol	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
n-Nitrosomorpholine	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
p-Dimethylaminoazobenzene	0.7 UJ	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
2,6-Dinitrotoluene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Pentachlorobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Phenacetin	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Ethyl methanesulfonate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Aniline	1.7 U	1.8 U	1.7 U	1.7 U	0.41 U	0.47 U	0.37 U	0.4 U	1.8 U	1.9 U	1.7 U	0.38 U
n-Nitrosodimethylamine	0.35 UJ	0.36 UJ	0.34 UJ	0.35 UJ	0.41 U	0.47 U	0.37 U	0.4 U	0.36 UJ	0.38 UJ	0.34 UJ	0.38 U
n-Nitroso-di-n-propylamine	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Benzoic acid	1.7 U	1.8 U	1.7 U	1.7 U	NA	NA	NA	NA	1.8 U	1.9 U	1.7 U	NA
Methyl methanesulfonate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Hexachloroethane	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Hexachlorophene	3.5 U	3.6 U	3.4 U	3.5 U	210 U	240 U	190 U	210 U	3.6 U	3.8 U	3.4 U	200 U
4-Chlorophenyl-Phenylether	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Hexachlorocyclopentadiene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Isophorone	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Pentachloronitrobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Acenaphthene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Diethylphthalate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Di-n-butylphthalate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.065 J	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Phenanthrene	0.35 U	0.36 U	0.34 U	0.35 U	0.0034 J	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Butylbenzylphthalate	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00	7SB01-00	7SB02-00	7SB03-00	7SB23-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19	7SB01	7SB02	7SB03	7SB23
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002	3/21/1996	3/21/1996	3/21/1996	1/23/2002
n-Nitrosodiphenylamine	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Fluorene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2,6-Dichlorophenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Hexachlorobutadiene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Pentachlorophenol	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
2,4,6-Trichlorophenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Nitroaniline	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
2-Nitrophenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Dinoseb	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
Naphthalene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Methylnaphthalene	0.35 U	0.36 U	0.34 U	0.35 U	0.0084 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Chloronaphthalene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Naphthalamine	0.87 U	0.91 U	0.86 U	0.87 U	0.41 U	0.47 U	0.37 U	0.4 U	0.89 U	0.94 U	0.85 U	0.38 U
Methapyrilene	0.87 UJ	0.91 UJ	0.86 UJ	0.87 UJ	84 U	96 U	75 U	82 U	0.89 UJ	0.94 UJ	0.85 UJ	78 U
3,3'-Dichlorobenzidine	0.7 U	0.72 U	0.68 U	0.7 U	0.82 U	0.94 U	0.74 U	0.8 U	0.71 U	0.76 U	0.68 U	0.77 U
4-Aminobiphenyl	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
n-Nitroso-di-n-butylamine	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
n-Nitrosopyrrolidine	1.7 U	1.8 U	1.7 U	1.7 U	0.41 U	0.47 U	0.37 U	0.4 U	1.8 U	1.9 U	1.7 U	0.38 U
Safrole	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Methylphenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
1,2-Dichlorobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
o-Toluidine	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
2-Chlorophenol	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
1,2,4,5-Tetrachlorobenzene	0.35 R	0.36 R	0.34 R	0.35 R	0.41 U	0.47 U	0.37 U	0.4 U	0.36 R	0.38 R	0.34 R	0.38 U
2,4,5-Trichlorophenol	1.7 U	1.8 U	1.7 U	1.7 U	0.41 U	0.47 U	0.37 U	0.4 U	1.8 U	1.9 U	1.7 U	0.38 U
Acetophenone	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U
Nitrobenzene	0.35 U	0.36 U	0.34 U	0.35 U	0.41 U	0.47 U	0.37 U	0.4 U	0.36 U	0.38 U	0.34 U	0.38 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00	7SB01-00	7SB02-00	7SB03-00	7SB23-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19	7SB01	7SB02	7SB03	7SB23
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002	3/21/1996	3/21/1996	3/21/1996	1/23/2002
3-Nitroaniline	1.7 U	1.8 U	1.7 U	1.7 U	2.1 U	2.4 U	1.9 U	2.1 U	1.8 U	1.9 U	1.7 U	2 U
1,3,5-Trinitrobenzene	3.5 U	3.6 U	3.4 U	3.5 U	0.41 UJ	0.47 U	0.37 UJ	0.4 UJ	3.6 U	3.8 U	3.4 U	0.38 UJ
5-Nitro-o-toluidine	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
m-Dinitrobenzene	0.7 U	0.72 U	0.68 U	0.7 U	0.41 U	0.47 U	0.37 U	0.4 U	0.71 U	0.76 U	0.68 U	0.38 U
1-Methylnaphthalene	NA	NA	NA	NA	0.0084 U	NA	NA	NA	NA	NA	NA	NA

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB24-00	7SB25-00	7SB26-00	7SB27-00	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB24	7SB25	7SB26	7SB27	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/23/2002	1/24/2002	1/24/2002	1/12/2002	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
Semivolatiles (mg/kg)											
4-Nitroaniline	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 U	1.8 U	1.8 U	1.7 U
4-Nitrophenol	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 UJ	1.8 U	1.9 UJ	1.7 UJ
Benzyl alcohol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 U	0.38 UJ	0.35 UJ
n-Nitrosopiperidine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
4-Bromophenyl phenyl ether	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2,4-Dimethylphenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
n-Nitrosomethylethylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 UJ	0.38 U	0.35 U
1,4,-Dichlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
4-Chloroaniline	0.7 U	0.93 U	0.8 U	0.72 U	0.85 U	0.75 U	0.76 U	0.71 U	0.72 U	0.75 U	0.69 U
1,4-Phenylenediamine	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	0.71 R	0.72 R	0.75 R	0.69 R
Bis(2-chloroisopropyl)ether	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 UJ	0.38 UJ	0.35 UJ
Phenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2-Picoline	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 UJ	0.38 UJ	0.35 UJ
Pryridine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 UJ	0.75 U	0.69 U
Bis(2-chloroethyl)ether	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Bis(2-chloroethoxy)methane	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Bis(2-ethylhexyl)phthalate	0.1 J	0.068 J	0.14 J	0.36 U	0.07 J	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Di-n-octylphthalate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Hexachlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
3,3'-Dimethylbenzidine	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 U	0.72 U	1.9 U	1.7 U
Anthracene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Isosafrole	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
1,2,4-Trichlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2,4-Dichlorophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2,4-Dinitrotoluene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
A, A-Dimethylphenethylamin	71 U	94 U	81 U	73 U	86 U	76 U	77 U	1.8 UJ	1.8 UJ	1.9 UJ	1.7 UJ

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB24-00	7SB25-00	7SB26-00	7SB27-00	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB24	7SB25	7SB26	7SB27	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/23/2002	1/24/2002	1/24/2002	1/12/2002	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
1,4-Dioxane	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 UJ	0.72 UJ	0.75 UJ	0.69 UJ
o,o,o-Triethylphosphorothioat	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	NA	NA	NA	NA
Pyrene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.09 J	0.36 U	0.38 U	0.35 U
1,4-Naphthoquinone	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	1.8 UJ	1.8 UJ	1.9 UJ	1.7 UJ
Dimethylphthalate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
3&4-Methylphenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Dibenzofuran	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
1-Naphthylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.36 U	0.75 U	0.69 U
Aramite	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 UJ	0.72 UJ	0.75 UJ	0.69 UJ
Hexachloropropene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	1.8 U	0.72 R	1.9 U	1.7 U
Benzo(g,h,i)perylene	0.046 J	0.038 J	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.11 J	0.07 J	0.38 U	0.35 U
Indeno(1,2,3-cd)pyrene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Benzo(b)fluoranthene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.035 J	0.38 U	0.1 J	0.36 U	0.38 U	0.04 J
Fluoranthene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.052 J	0.38 U	0.09 J	0.36 U	0.38 U	0.35 U
Benzo(k)fluoranthene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Acenaphthylene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Chrysene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.033 J	0.38 U	0.07 J	0.36 U	0.38 U	0.35 U
Diallate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Pronamide	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Benzo(a)pyrene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.06 J	0.36 U	0.38 U	0.35 U
2,4-Dinitrophenol	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 U	1.8 UJ	1.9 U	1.7 U
Dibenzo(a,h)anthracene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2-Acetylaminofluorene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 U	0.75 U	0.69 U
4,6-Dinitro-2-methylphenol	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 U	1.8 U	1.9 U	1.7 U
1,3-Dichlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
n-Nitrosodiethylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
3-Methylcholanthrene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB24-00	7SB25-00	7SB26-00	7SB27-00	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB24	7SB25	7SB26	7SB27	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/23/2002	1/24/2002	1/24/2002	1/12/2002	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
Benzo(a)anthracene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.029 J	0.38 U	0.05 J	0.36 U	0.38 U	0.35 U
4-Nitroquinoline-1-oxide	3.5 R	4.6 R	4 R	3.6 R	4.2 R	3.8 R	3.8 R	1.8 R	1.8 R	1.9 R	1.7 R
7,12-Dimethyl benz(a)anthrac	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 U	0.75 U	0.69 U
2,3,4,6-Tetrachlorophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 UJ	0.38 UJ	0.35 UJ
4-Chloro-3-methylphenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 U	0.75 U	0.69 U
n-Nitrosomorpholine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 UJ	0.72 UJ	0.75 UJ	0.69 UJ
p-Dimethylaminoazobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 UJ	0.72 U	0.75 UJ	0.69 UJ
2,6-Dinitrotoluene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Pentachlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Phenacetin	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 UJ	0.38 U	0.35 U
Ethyl methanesulfonate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Aniline	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	1.8 UJ	1.8 UJ	1.9 UJ	1.7 UJ
n-Nitrosodimethylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 UJ	0.38 U	0.35 U
n-Nitroso-di-n-propylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Benzoic acid	NA	NA	NA	NA	NA	NA	NA	1.8 U	1.8 U	1.9 U	1.7 U
Methyl methanesulfonate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Hexachloroethane	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Hexachlorophene	180 U	240 U	200 U	180 U	220 U	190 U	200 U	3.5 R	3.6 UJ	3.8 R	3.5 R
4-Chlorophenyl-Phenylether	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Hexachlorocyclopentadiene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Isophorone	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Pentachloronitrobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Acenaphthene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Diethylphthalate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Di-n-butylphthalate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Phenanthrene	0.35 U	0.46 U	0.4 U	0.025 J	0.42 U	0.025 J	0.38 U	0.05 J	0.36 U	0.38 U	0.35 U
Butylbenzylphthalate	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB24-00	7SB25-00	7SB26-00	7SB27-00	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB24	7SB25	7SB26	7SB27	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/23/2002	1/24/2002	1/24/2002	1/12/2002	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
n-Nitrosodiphenylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Fluorene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2,6-Dichlorophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 UJ	0.38 UJ	0.35 UJ
Hexachlorobutadiene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Pentachlorophenol	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 U	1.8 U	1.9 U	1.7 U
2,4,6-Trichlorophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2-Nitroaniline	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 UJ	1.8 U	1.9 UJ	1.7 UJ
2-Nitrophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
Dinoseb	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 UJ	0.38 U	0.71 UJ	0.72 UJ	0.75 UJ	0.69 UJ
Naphthalene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2-Methylnaphthalene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 UJ	0.38 UJ	0.35 UJ
2-Chloronaphthalene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2-Naphthalamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.89 UJ	0.36 UJ	0.94 UJ	0.86 UJ
Methapyrilene	71 U	94 U	81 U	73 U	86 U	76 U	77 U	0.89 UJ	0.91 U	0.94 UJ	0.86 UJ
3,3'-Dichlorobenzidine	0.7 U	0.93 U	0.8 U	0.72 U	0.85 U	0.75 U	0.76 U	0.71 U	0.72 U	0.75 U	0.69 U
4-Aminobiphenyl	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 U	0.75 U	0.69 U
n-Nitroso-di-n-butylamine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 UJ	0.38 U	0.35 U
n-Nitrosopyrrolidine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	1.8 UJ	1.8 UJ	1.9 UJ	1.7 UJ
Safrole	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2-Methylphenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
1,2-Dichlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
o-Toluidine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 R	0.36 R	0.38 R	0.35 R
2-Chlorophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
1,2,4,5-Tetrachlorobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U
2,4,5-Trichlorophenol	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	1.8 U	1.8 U	1.9 U	1.7 U
Acetophenone	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 UJ	0.36 UJ	0.38 UJ	0.35 UJ
Nitrobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.35 U	0.36 U	0.38 U	0.35 U

APPENDIX D.2

SURFACE SOIL DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB24-00	7SB25-00	7SB26-00	7SB27-00	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB24	7SB25	7SB26	7SB27	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/23/2002	1/24/2002	1/24/2002	1/12/2002	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
3-Nitroaniline	1.8 U	2.4 U	2 U	1.8 U	2.2 U	1.9 U	2 U	1.8 U	1.8 U	1.9 U	1.7 U
1,3,5-Trinitrobenzene	0.35 UJ	0.46 UJ	0.4 UJ	0.36 UJ	0.42 UJ	0.38 UJ	0.38 UJ	3.5 UJ	3.6 U	3.8 UJ	3.5 UJ
5-Nitro-o-toluidine	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 U	0.75 U	0.69 U
m-Dinitrobenzene	0.35 U	0.46 U	0.4 U	0.36 U	0.42 U	0.38 U	0.38 U	0.71 U	0.72 U	0.75 U	0.69 U
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

APPENDIX D.3

SURFACE SOIL DATA (METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW01-00	7MW02-00	7MW03-00	7MW04-00	7MW16-00	7MW17-00	7MW18-00	7MW19-00	7SB01-00	7SB02-00	7SB03-00
Site ID	7MW01	7MW02	7MW03	7MW04	7MW16	7MW17	7MW18	7MW19	7SB01	7SB02	7SB03
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	3/27/1996	3/21/1996	3/21/1996	3/21/1996	1/15/2002	1/16/2002	1/29/2002	1/30/2002	3/21/1996	3/21/1996	3/21/1996
Metals - Total (mg/kg)											
Lead	15.1	5	13.2	4.6	7.9 J	9.6	3	4.4	13.1	20.3	14.7
Mercury	0.04 U	0.06 U	0.05 U	0.04 U	0.012 J	0.029	0.005 J	0.0037 J	0.05 U	0.04 U	0.04 U
Nickel	24.9	17.6	25.4	10	10	20	9.5	5.3	11.7	7.8	4.3
Silver	0.3 U	0.32 U	0.32 U	0.21 U	1.1 U	1.3 U	1 U	1.1 U	0.27 U	0.34 U	0.25 U
Thallium	0.16 UJ	0.13 U	0.15 U	0.14 UJ	1.1 U	1 J	1 J	1.7 J	0.15 UJ	0.16 U	0.15 UJ
Tin	1 U	1.4	1.1 U	0.72 U	5.7 U	6.5 U	5.1 U	5.5 U	0.92 U	1.6	1.6
Antimony	1.9 UJ	2.1 UJ	2 UJ	1.3 UJ	0.93 J	0.67 J	2 U	2.2 U	1.7 UJ	2.1 UJ	1.6 UJ
Arsenic	1.1	0.89	0.56 U	0.52 U	1.9 J	1.4	1.2	0.85 J	1.1	1.1	0.75
Barium	76 J	93.4 J	342 J	87.6 J	66	130	78	190	73.7 J	64.7 J	60.9 J
Beryllium	0.22	0.44	1.8	0.23	0.19 J	0.34 J	0.23 J	0.18 J	0.3	0.21	0.06 U
Cadmium	0.42	0.25	0.22 U	0.22	0.41 J	0.42 J	0.4 J	0.55 U	0.28	0.55	0.3
Chromium	39.2 J	31.7 J	64.9 J	15.6 J	20 J	36	9.8	11	23.3 J	20.6 J	8.7 J
Cobalt	27.3 J	30.4 J	28.9 J	21.4 J	17	37	17	17	20.1 J	19.5 J	7.3 J
Copper	74.7	92.7	71.9	99.7	81 J	120 J	110	42	74.3	79.1	23.1
Vanadium	132	160	132	122	97	220 J	110	77	110	176	42.4
Zinc	54.2 J	79.8 J	51.3 J	52.5 J	60	290	83 J	56 J	64.4 J	52.6 J	59.8 J
Selenium	0.37	0.31 J	0.16 UJ	0.29 U	1.1 U	1.3 U	1 U	1.1 U	0.44 J	0.83 U	0.16 UJ

APPENDIX D.3

SURFACE SOIL DATA (METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SB23-00	7SB24-00	7SB25-00	7SB26-00	7SB27-00	7SB28-00	7SB29-00	7SB30-00	8SS01	8SS02	8SS03	8SS04
Site ID	7SB23	7SB24	7SB25	7SB26	7SB27	7SB28	7SB29	7SB30	8SS01	8SS02	8SS03	8SS04
Sample Depth (ft.)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Sample Date	1/23/2002	1/23/2002	1/24/2002	1/24/2002	1/12/2002	1/22/2002	1/12/2002	1/12/2002	4/4/1996	4/4/1996	4/4/1996	4/4/1996
Metals - Total (mg/k												
Lead	14	1.9	6.4	9.5	7.9	4.9	11	6.7	13.1	5.1	2.3	1.6
Mercury	0.0096 J	0.0083 J	0.0085 J	0.02 J	0.019	0.011 J	0.018 J	0.016 J	0.05 U	0.05 U	0.05 U	0.04 U
Nickel	16	15	17	12	19	17	14	15	NA	NA	NA	NA
Silver	1.1 U	0.97 U	1.3 U	1.2 U	0.99 U	1.3 U	1 U	1 U	0.33 U	0.35 U	0.37 U	0.35 U
Thallium	0.79 J	2.3 J	1.2 J	1 J	2.1 J	1.5 J	2.5 J	2.5 J	NA	NA	NA	NA
Tin	5.3 U	4.8 U	6.4 U	6 U	4.9 U	6.4 U	5.2 U	5.2 U	NA	NA	NA	NA
Antimony	1.3 J	1.9 U	2.6 U	2.4 U	2 U	0.93 J	0.59 J	0.64 J	NA	NA	NA	NA
Arsenic	2.8	0.97 U	1.5	3.2	2.2 J	1.9	1.7 J	1.8 J	2.2	1	1.2	1.4
Barium	50	47	96	110	31	120	58	27	44.8	100	60.4	54.8
Beryllium	0.32 J	0.12 J	0.34 J	0.23 J	0.6	0.36 J	0.41 J	0.45	NA	NA	NA	NA
Cadmium	0.77	0.14 J	0.21 J	0.53 J	0.8	0.36 J	0.78	0.74	0.24 U	0.28	0.27 U	0.25 U
Chromium	32	19	65	18	23	31	21	20	14.4 J	31 J	29.8 J	7.2 J
Cobalt	27	18	27	20	22	38	23	18	NA	NA	NA	NA
Copper	110	110	100	110	54	110	77	46	NA	NA	NA	NA
Vanadium	140	110	220	110	120	170	130	120	NA	NA	NA	NA
Zinc	78 J	54 J	48 J	74 J	85	96 J	74	73	NA	NA	NA	NA
Selenium	1.1 U	0.97 U	0.86 J	1.2 U	0.58 J	1.3 U	0.97 J	0.59 J	0.12 UJ	0.31 J	0.14 UJ	0.14 UJ

APPENDIX D.4

GROUND WATER DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002	1/10/2002	1/11/2002	1/12/2002
Volatiles (mg/L)													
Ethylbenzene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Styrene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
cis-1,3-Dichloropropene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
trans-1,3-Dichloropropene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dibromoethane	0.005 UJ	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Acrolein	0.1 R	4 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R
3-Chloro-1-propene	0.005 UJ	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dichloroethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Propionitrile	0.1 UJ	4 U	0.1 U	0.1 U	0.1 U	0.1 U	0.012 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.1 U	4 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ
Vinyl acetate	0.01 U	0.4 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Methyl-2-pentanone	0.025 U	2 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Toluene	0.005 U	0.2 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chlorobenzene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
trans-1,4-Dichloro-2-buten	0.01 U	0.4 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dibromochloromethane	0.005 UJ	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Methacrylonitrile	0.1 U	4 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ
Chloroprene	0.005 UJ	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Tetrachloroethene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Xylene	0.01 U	0.4 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
trans-1,2-Dichloroethene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Carbon tetrachloride	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2-Hexanone	0.025 UJ	2 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
1,1,1,2-Tetrachloroethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Acetone	0.05 UJ	5 U	0.05 U	0.05 U	0.05 R	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Chloroform	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.075
Benzene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

APPENDIX D.4

GROUND WATER DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002	1/10/2002	1/11/2002	1/12/2002
1,1,1-Trichloroethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromomethane	0.01 UJ	0.2 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ
Chloromethane	0.01 U	0.2 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Iodomethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dibromomethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chloroethane	0.01 U	0.2 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl chloride	0.01 U	0.2 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acetonitrile	0.2 U	8 UJ	0.2 UJ	0.2 UJ	0.2 U	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Methylene chloride	0.005 U	0.095 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0016 J
Carbon disulfide	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromoform	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromodichloromethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0029 J
1,1-Dichloroethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethene	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichlorofluoromethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dichlorodifluoromethane	0.01 U	0.2 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachloroethane	0.025 R	1 UJ	0.025 R	0.025 R	0.025 R	0.025 R	0.025 R	0.025 UJ	0.025 UJ	0.025 UJ	0.025 UJ	0.025 UJ	0.025 UJ
Isobutanol	0.2 R	2.7 J	0.2 R	0.2 R	0.2 R	0.27 J	0.2 R	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-Dichloropropane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2-Butanone	0.025 UJ	2 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
1,1,2-Trichloroethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichloroethene	0.005 U	28 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1,2,2-Tetrachloroethane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Methyl methacrylate	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dibromo-3-chloropropa	0.005 U	0.2 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ
1,2,3-Trichloropropane	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Ethyl methacrylate	0.005 U	0.2 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

APPENDIX D.4

GROUND WATER DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/11/2002	1/11/2002
Volatiles (mg/L)							
Ethylbenzene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Styrene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
cis-1,3-Dichloropropene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
trans-1,3-Dichloropropene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dibromoethane	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U
Acrolein	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R
3-Chloro-1-propene	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Propionitrile	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.1 UJ	0.1 UJ	0.1 U	0.1 UJ	0.1 UJ	0.1 U	0.1 UJ
Vinyl acetate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U
4-Methyl-2-pentanone	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Toluene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chlorobenzene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
trans-1,4-Dichloro-2-buten	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dibromochloromethane	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U
Methacrylonitrile	0.1 UJ	0.1 UJ	0.1 U	0.1 UJ	0.1 UJ	0.1 U	0.1 UJ
Chloroprene	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U
Tetrachloroethene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Xylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
trans-1,2-Dichloroethene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Carbon tetrachloride	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2-Hexanone	0.025 U	0.025 U	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U
1,1,1,2-Tetrachloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Acetone	0.05 U	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U
Chloroform	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Benzene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

APPENDIX D.4

GROUND WATER DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/11/2002	1/11/2002
1,1,1-Trichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromomethane	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ
Chloromethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U
Iodomethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dibromomethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chloroethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl chloride	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acetonitrile	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U	0.2 UJ
Methylene chloride	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Carbon disulfide	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromoform	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromodichloromethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethene	0.005 U	0.005 U	0.005 U	0.0017 J	0.005 U	0.005 U	0.005 U
Trichlorofluoromethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dichlorodifluoromethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachloroethane	0.025 UJ	0.025 UJ	0.025 R	0.025 UJ	0.025 UJ	0.025 UJ	0.025 UJ
Isobutanol	0.2 U	0.2 U	0.2 R	0.2 U	0.2 U	0.2 R	0.2 U
1,2-Dichloropropane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2-Butanone	0.025 U	0.025 U	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U
1,1,2-Trichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichloroethene	0.005 U	0.0004 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1,2,2-Tetrachloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Methyl methacrylate	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dibromo-3-chloropropa	0.005 UJ	0.005 UJ	0.005 U	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ
1,2,3-Trichloropropane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Ethyl methacrylate	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002	1/10/2002	1/11/2002	1/12/2002
Semivolatiles (mg/L)													
4-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
4-Nitrophenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 R	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzyl alcohol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosopiperidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.01 U	0.01 U
4-Bromophenyl phenyl ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dimethylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosomethylethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.01 U	0.01 U
1,4,-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Chloroaniline	0.02 U	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
1,4-Phenylenediamine	2 U	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
Bis(2-chloroisopropyl)ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Picoline	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Pryridine	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Bis(2-chloroethyl)ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bis(2-chloroethoxy)methane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bis(2-ethylhexyl)phthalate	0.0009 J	0.01 U	0.0011 J	0.0021 J	0.001 J	0.0019 J	0.0011 J	0.015	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Di-n-octylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Hexachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3,3'-Dimethylbenzidine	0.02 U	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Isosafrole	0.01 U	0.01 R	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 R	0.01 R	0.01 U	0.01 R	0.01 R	0.01 R
1,2,4-Trichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dinitrotoluene	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
A, A-Dimethylphenethylamin	2 UJ	2 UJ	2 U	2 U	2 UJ	2 U	2 U	2 U	2 U	2 UJ	2 UJ	2 UJ	2 U
1,4-Dioxane	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
o,o,o-Triethylphosphorothioat	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002	1/10/2002	1/11/2002	1/12/2002
Pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,4-Naphthoquinone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dimethylphthalate	0.01 U	0.01 U	0.0005 J	0.01 U	0.01 UJ	0.01 U	0.0018 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3&4-Methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dibenzofuran	0.01 U	0.01 U	0.01 U	0.01 U	0.0005 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1-Naphthylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Aramite	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachloropropene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Benzo(g,h,i)perylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.0014 J	0.01 U
Indeno(1,2,3-cd)pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.0006 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Benzo(b)fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(k)fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Acenaphthylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Chrysene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Diallate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pronamide	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(a)pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
2,4-Dinitrophenol	0.05 UJ	0.05 UJ	0.05 U	0.05 U	0.05 UJ	0.05 R	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 U
Dibenzo(a,h)anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
2-Acetylaminofluorene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4,6-Dinitro-2-methylphenol	0.05 UJ	0.05 UJ	0.05 U	0.05 U	0.05 UJ	0.05 R	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 U
1,3-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosodiethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.01 U	0.01 U
3-Methylcholanthrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Benzo(a)anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Nitroquinoline-1-oxide	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 UJ	0.02 R	0.02 R	0.02 R
7,12-Dimethyl benz(a)anthrac	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
2,3,4,6-Tetrachlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002	1/10/2002	1/11/2002	1/12/2002
4-Chloro-3-methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosomorpholine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.01 U	0.01 U
p-Dimethylaminoazobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,6-Dinitrotoluene	0.01 UJ	0.01 UJ	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U
Pentachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Phenacetin	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Ethyl methanesulfonate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Aniline	0.02 U	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
n-Nitrosodimethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitroso-di-n-propylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Methyl methanesulfonate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachloroethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorophene	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U
4-Chlorophenyl-Phenylether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorocyclopentadiene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Isophorone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachloronitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
Acenaphthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Diethylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.0007 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Di-n-butylphthalate	0.01 U	0.01 U	0.0012 J	0.0016 J	0.0003 J	0.0013 J	0.0011 J	5E-04 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenanthrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	5E-04 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Butylbenzylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosodiphenylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Fluorene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.001 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,6-Dichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U
Hexachlorobutadiene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachlorophenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 R	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2,4,6-Trichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06	UGW07	UGW08	UGW09
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002	1/10/2002	1/11/2002	1/12/2002
2-Nitrophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dinoseb	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U
Naphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Methylnaphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.0062 J	0.01 U	0.01 U	0.096	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Chloronaphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Naphthalamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Methapyrilene	2 U	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U	2 U	2 UJ	2 UJ	2 U	2 U
3,3'-Dichlorobenzidine	0.02 U	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
4-Aminobiphenyl	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitroso-di-n-butylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosopyrrolidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U
Safrole	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
o-Toluidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Chlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2,4,5-Tetrachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4,5-Trichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 R	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acetophenone	0.01 U	0.01 U	0.01 U	0.01 U	0.0048 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Nitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
1,3,5-Trinitrobenzene	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 R	0.01 R	0.01 U	0.01 UJ	0.01 U	0.01 R
5-Nitro-o-toluidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U
m-Dinitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/11/2002	1/11/2002
Semivolatiles (mg/L)							
4-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
4-Nitrophenol	0.05 U	0.05 U	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U
Benzyl alcohol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosopiperidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Bromophenyl phenyl ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dimethylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosomethylethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,4,-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Chloroaniline	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
1,4-Phenylenediamine	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Bis(2-chloroisopropyl)ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Picoline	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pryridine	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Bis(2-chloroethyl)ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bis(2-chloroethoxy)methane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bis(2-ethylhexyl)phthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Di-n-octylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3,3'-Dimethylbenzidine	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Isosafrole	0.01 R	0.01 R	0.01 U	0.01 R	0.01 R	0.01 R	0.01 R
1,2,4-Trichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dinitrotoluene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
A, A-Dimethylphenethylamin	2 U	2 UJ	2 UJ	2 U	2 UJ	2 UJ	2 UJ
1,4-Dioxane	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U
o,o,o-Triethylphosphorothioat	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/11/2002	1/11/2002
Pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,4-Naphthoquinone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dimethylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3&4-Methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dibenzofuran	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1-Naphthylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Aramite	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachloropropene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(g,h,i)perylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0014 J
Indeno(1,2,3-cd)pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(b)fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(k)fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acenaphthylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Chrysene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Diallate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pronamide	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(a)pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dinitrophenol	0.05 U	0.05 UJ	0.05 UJ	0.05 U	0.05 UJ	0.05 U	0.05 UJ
Dibenzo(a,h)anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Acetylaminofluorene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4,6-Dinitro-2-methylphenol	0.05 U	0.05 UJ	0.05 UJ	0.05 U	0.05 UJ	0.05 UJ	0.05 UJ
1,3-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosodiethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3-Methylcholanthrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Benzo(a)anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Nitroquinoline-1-oxide	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R
7,12-Dimethyl benz(a)anthrac	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,3,4,6-Tetrachlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/11/2002	1/11/2002
4-Chloro-3-methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosomorpholine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
p-Dimethylaminoazobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,6-Dinitrotoluene	0.01 U	0.01 UJ	0.01 UJ	0.01 U	0.01 UJ	0.01 U	0.01 UJ
Pentachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenacetin	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U
Ethyl methanesulfonate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Aniline	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
n-Nitrosodimethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitroso-di-n-propylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Methyl methanesulfonate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachloroethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorophene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Chlorophenyl-Phenylether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorocyclopentadiene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Isophorone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachloronitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acenaphthene	0.001 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Diethylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Di-n-butylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenanthrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Butylbenzylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosodiphenylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Fluorene	0.0027 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,6-Dichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorobutadiene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachlorophenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2,4,6-Trichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U

APPENDIX D.5

GROUNDWATER DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/11/2002	1/11/2002
2-Nitrophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dinoseb	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Naphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Methylnaphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Chloronaphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Naphthalamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Methapyrilene	2 U	2 U	2 U	2 U	2 U	2 U	2 U
3,3'-Dichlorobenzidine	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
4-Aminobiphenyl	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitroso-di-n-butylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosopyrrolidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Safrole	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
o-Toluidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Chlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2,4,5-Tetrachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4,5-Trichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acetophenone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Nitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
1,3,5-Trinitrobenzene	0.01 R	0.01 U	0.01 U	0.01 R	0.01 U	0.01 U	0.01 U
5-Nitro-o-toluidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
m-Dinitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.6

GROUNDWATER DATA (TOTAL METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002
Metals-Total (mg/L)										
Lead	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U	0.0017 J	0.005 U	0.005 UJ	0.005 UJ	0.005 UJ
Mercury	0.0002 U	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0004 UJ	0.0002 UJ	2E-04 UJ	0.0002 UJ
Nickel	0.04 U	0.04 U	0.04 U	0.0057 J	0.04 U	0.04 U	0.0073 J	0.04 U	0.04 U	0.04 U
Silver	0.002 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.01 U	0.0072 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.006 J	0.01 U
Tin	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Antimony	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Arsenic	0.013	0.01 UJ	0.0086 J	0.01 U	0.0039 J	0.01 U	0.0039 J	0.01 UJ	0.01 UJ	0.0034 J
Barium	0.028	0.0088 J	0.062	0.13	0.14	0.15	0.8	0.054	0.063	0.056
Beryllium	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Cadmium	0.0029 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chromium	0.01 U	0.0019 J	0.01 U	0.0025 J	0.01 U	0.01 U	0.004 J	0.01 U	0.01 U	0.01 U
Cobalt	0.01 U	0.01 U	0.01 U	0.0032 J	0.0038 J	0.002 J	0.018	0.01 U	0.016	0.01 U
Copper	0.0073 J	0.0018 J	0.02 U	0.0081 J	0.0025 J	0.0019 J	0.02	0.001 J	0.002 J	0.0029 J
Vanadium	0.014	0.02	0.01 U	0.012	0.0071 J	0.0067 J	0.019	0.0034 J	0.043	0.01 U
Zinc	0.02 U	0.0067 J	0.02 U	0.0074 J	0.02 U	0.02 U	0.023	0.0081 J	0.02 U	0.02 U
Selenium	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.006 J	0.01 UJ	0.01 UJ	0.01 UJ

APPENDIX D.6

GROUNDWATER DATA (TOTAL METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW07	UGW08	UGW09	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW07	UGW08	UGW09	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/10/2002	1/11/2002	1/12/2002	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/12/2002	1/11/2002
Metals-Total (mg/L)										
Lead	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ	0.005 U	0.005 UJ	0.005 UJ	0.0067 J	0.005 UJ
Mercury	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 U	0.0024 J	0.0002 J	0.0002 UJ	0.0002 UJ
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.0077 J	0.04 U
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.01 U	0.0096 J	0.01 U	0.01 U	0.01 U	0.013	0.01 U	0.01 U	0.01 U	0.01 U
Tin	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Antimony	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Arsenic	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.018	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ
Barium	0.046	0.32	0.0024 J	0.028	0.0065 J	0.16	0.01 U	0.0015 J	0.9	0.014
Beryllium	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Cadmium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.00097 J	0.005 U
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0082 J	0.01 U
Cobalt	0.01 U	0.002 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.014	0.01 U
Copper	0.0097 J	0.02 U	0.0054 J	0.02 U	0.02 U	0.0035 J	0.02 U	0.02 U	0.053	0.02 U
Vanadium	0.01 U	0.0026 J	0.14	0.0034 J	0.01 U	0.0035 J	0.018	0.065	0.03	0.092
Zinc	0.02 U	0.02 U	0.0077 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.11	0.02 U
Selenium	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.0083 J	0.01 UJ	0.01 UJ	0.01 UJ	0.0051 J

APPENDIX D.7

GROUNDWATER DATA (DISSOLVED METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06
Site ID	7MW06	7MW07	7MW10	7MW11	7MW12	7MW13	7MW14	GW04	GW06	UGW06
Sample Date	1/9/2002	1/13/2002	1/26/2002	1/27/2002	2/1/2002	1/27/2002	1/29/2002	1/10/2002	1/11/2002	1/10/2002
Metals - Dissolved (mg/L)										
Lead	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 UJ	0.005 UJ	0.005 UJ
Mercury	0.0002 U	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	2E-04 UJ	2E-04 UJ	0.0002 UJ
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.0067 J	0.04 U	0.005 J	0.04 U
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Tin	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Antimony	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Arsenic	0.01 U	0.01 UJ	0.0049 J	0.0082 J	0.0038 J	0.01 U	0.0053 J	0.01 U	0.01 U	0.0042 J
Barium	0.027	0.0072 J	0.06	0.13	0.14	0.14	0.79	0.042	0.063	0.06
Beryllium	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Cadmium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chromium	0.01 U	0.0037 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cobalt	0.002 J	0.01 U	0.01 U	0.0021 J	0.0033 J	0.01 U	0.02	0.01 U	0.016	0.01 U
Copper	0.0039 J	0.02 U	0.02 U	0.02 U	0.0033 J	0.02 U	0.0016 J	0.02 U	0.002 J	0.0054 J
Vanadium	0.02	0.018	0.01 U	0.0032 J	0.0076 J	0.01 U	0.0087 J	0.01 U	0.044	0.011 J
Zinc	0.02 U	0.0064 J	0.02 U	0.02 U	0.02 U	0.02 U	0.016 J	0.02 U	0.02 U	0.02 U
Selenium	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0051 J

APPENDIX D.7

GROUNDWATER DATA (DISSOLVED METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW07	UGW08	UGW09	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Site ID	UGW07	UGW08	UGW09	UGW10	UGW11	UGW15	UGW16	UGW18	UGW20R	UGW26
Sample Date	1/10/2002	1/11/2002	1/12/2002	1/12/2002	1/12/2002	1/9/2002	1/12/2002	1/12/2002	1/12/2002	1/11/2002
Metals - Dissolved (mg/L										
Lead	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ	0.005 U	0.005 UJ	0.005 UJ	0.005 UJ	0.005 UJ
Mercury	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 UJ	0.0002 U	0.0022 J	0.0003 J	0.0002 UJ	0.0002 UJ
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Tin	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Antimony	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Arsenic	0.007 J	0.01 U	0.01 UJ	0.01 UJ	0.01 UJ	0.01 U	0.01 UJ	0.01 UJ	0.01 UJ	0.01 U
Barium	0.044	0.3	0.0018 J	0.026	0.0062 J	0.15	0.01 U	0.0014 J	0.93	0.014
Beryllium	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Cadmium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cobalt	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0091 J	0.01 U
Copper	0.0013 J	0.02 U	0.0036 J	0.02 U	0.02 U	0.002 J	0.02 U	0.02 U	0.0015 J	0.02 U
Vanadium	0.0024 J	0.01 U	0.14	0.0025 J	0.01 U	0.0056 J	0.017	0.068	0.01 U	0.095
Zinc	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.0077 J	0.02 U
Selenium	0.01 U	0.01 U	0.01 UJ	0.01 UJ	0.0049 J	0.01 U	0.01 UJ	0.0053 J	0.01 UJ	0.01 U

APPENDIX D.8

SURFACE WATER DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TAK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
Volatiles (mg/L)									
Ethylbenzene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Styrene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
cis-1,3-Dichloropropene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
trans-1,3-Dichloropropene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dibromoethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Acrolein	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R	0.1 R
3-Chloro-1-propene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Propionitrile	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Vinyl acetate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Methyl-2-pentanone	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Toluene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chlorobenzene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
trans-1,4-Dichloro-2-buten	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dibromochloromethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Methacrylonitrile	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chloroprene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Tetrachloroethene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Xylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
trans-1,2-Dichloroethene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Carbon tetrachloride	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2-Hexanone	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
1,1,1,2-Tetrachloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Acetone	0.05 U	0.01 J	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Chloroform	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Benzene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

APPENDIX D.8

SURFACE WATER DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TAK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
1,1,1-Trichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromomethane	0.01 UJ	0.01 U	0.01 UJ	0.01 U	0.01 UJ	0.01 UJ	0.01 U	0.01 UJ	0.01 U
Chloromethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Iodomethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dibromomethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chloroethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl chloride	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acetonitrile	0.2 U	0.2 UJ	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 UJ
Methylene chloride	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Carbon disulfide	0.005 U	0.0033 J	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U	0.005 U	0.005 U
Bromoform	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Bromodichloromethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1-Dichloroethene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichlorofluoromethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dichlorodifluoromethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachloroethane	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Isobutanol	0.2 R	0.2 R	0.2 R	0.2 R	0.2 R	0.2 R	0.2 R	0.2 R	0.2 R
1,2-Dichloropropane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2-Butanone	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
1,1,2-Trichloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Trichloroethene	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,1,2,2-Tetrachloroethane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Methyl methacrylate	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2-Dibromo-3-chloropropa	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
1,2,3-Trichloropropane	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Ethyl methacrylate	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

APPENDIX D.9

SURFACE WATER DATA (SEMIVOLATILE) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
Semivolatiles (mg/L)									
4-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
4-Nitrophenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzyl alcohol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosopiperidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Bromophenyl phenyl ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dimethylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosomethylethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,4,-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Chloroaniline	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
1,4-Phenylenediamine	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Bis(2-chloroisopropyl)ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Picoline	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pryridine	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Bis(2-chloroethyl)ether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bis(2-chloroethoxy)methane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bis(2-ethylhexyl)phthalate	0.01 U	0.01 U	0.012	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Di-n-octylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3,3'-Dimethylbenzidine	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Isosafrole	0.01 U	0.01 U	0.01 U	0.01 U	0.01 R	0.01 R	0.01 R	0.01 R	0.01 R
1,2,4-Trichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dinitrotoluene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
A, A-Dimethylphenethylamin	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
1,4-Dioxane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

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SURFACE WATER DATA (SEMIVOLATILE) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
o,o,o-Triethylphosphorothioat	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,4-Naphthoquinone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dimethylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3&4-Methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dibenzofuran	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1-Naphthylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Aramite	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachloropropene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Diallate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pronamide	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4-Dinitrophenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2-Acetylaminofluorene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4,6-Dinitro-2-methylphenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
1,3-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosodiethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3-Methylcholanthrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Nitroquinoline-1-oxide	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R	0.02 R
7,12-Dimethyl benz(a)anthrac	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,3,4,6-Tetrachlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-Chloro-3-methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosomorpholine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
p-Dimethylaminoazobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,6-Dinitrotoluene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Phenacetin	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Ethyl methanesulfonate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Aniline	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U

APPENDIX D.9

SURFACE WATER DATA (SEMIVOLATILE) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
n-Nitrosodimethylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitroso-di-n-propylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Methyl methanesulfonate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachloroethane	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorophene	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U
4-Chlorophenyl-Phenylether	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorocyclopentadiene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Isophorone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachloronitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Diethylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Di-n-butylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Butylbenzylphthalate	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosodiphenylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,6-Dichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Hexachlorobutadiene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Pentachlorophenol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2,4,6-Trichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2-Nitrophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Dinoseb	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Chloronaphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Naphthalamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Methapyrilene	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
3,3'-Dichlorobenzidine	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
4-Aminobiphenyl	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitroso-di-n-butylamine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
n-Nitrosopyrrolidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.9

SURFACE WATER DATA (SEMIVOLATILE) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
Safrole	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Methylphenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2-Dichlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
o-Toluidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-Chlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2,4,5-Tetrachlorobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2,4,5-Trichlorophenol	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Acetophenone	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Nitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
3-Nitroaniline	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
1,3,5-Trinitrobenzene	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
5-Nitro-o-toluidine	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
m-Dinitrobenzene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.10

SURFACE WATER DATA (PAHs) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID			7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	3/12/2002	3/12/2002	3/12/2002	3/12/2002	3/12/2002
PAHs (mg/L)									
Anthracene	0.00008 J	0.0002 U	0.00008 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Pyrene	0.0002 U	0.0002 U	0.0002 U	0.00009 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Benzo(g,h,i)perylene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Indeno(1,2,3-cd)pyren	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Benzo(b)fluoranthene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Fluoranthene	0.00005 J	0.0002 U	0.00005 J	0.00017 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Benzo(k)fluoranthene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Acenaphthylene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Chrysene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Benzo(a)pyrene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Dibenzo(a,h)anthracen	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Benzo(a)anthracene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Acenaphthene	0.0002 U	0.0002 U	0.0002 U	0.00012 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Phenanthrene	0.0002 U	0.0002 U	0.0002 U	0.00017 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Fluorene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
1-Methylnaphthalene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Naphthalene	0.0002 U	0.0002 U	0.0002 U	0.00011 J	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
2-Methylnaphthalene	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U

APPENDIX D.11

SURFACE WATER DATA (TOTAL METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
Metals - Total (mg/L)									
Lead	0.005 U	0.005 U	0.005 U	0.005 U	0.0017 J	0.005 U	0.005 U	0.005 U	0.005 U
Mercury	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00008 J	0.0002 U
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Tin	0.05 U	0.05 U	0.05 U	0.011 J	0.0068 J	0.05 U	0.05 U	0.05 U	0.05 U
Antimony	0.02 U	0.02 U	0.02 U	0.0057 J	0.02 U	0.0054 J	0.02 U	0.02 U	0.02 U
Arsenic	0.01 U	0.004 J	0.0061 J	0.0039 J	0.007 J	0.01 U	0.0042 J	0.0046 J	0.01 U
Barium	0.0086 J	0.009 J	0.021	0.012	0.0093 J	0.0088 J	0.0084 J	0.0086 J	0.0086 J
Beryllium	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Cadmium	0.005 U	0.005 U	0.00072 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cobalt	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Copper	0.0032 J	0.0038 J	0.0052 J	0.014 J	0.0022 J	0.0029 J	0.0022 J	0.0026 J	0.0021 J
Vanadium	0.0061 J	0.01 J	0.01 J	0.012 J	0.0092 J	0.0064 J	0.0046 J	0.0077 J	0.0061 J
Zinc	0.02 U	0.02 U	0.02 U	0.0065 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Selenium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0063 J	0.01 U

APPENDIX D.12

SURFACE WATER DATA (DISSOLVED METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Site ID	7SW1	7SW2	7SW3	7SW4	7SW5	7SW6	7SW7	7SW8	7SW9
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/17/2002	1/16/2002	1/16/2002	1/16/2002
Metals - Dissolved (mg/L)									
Lead	0.005 U	0.005 U	0.005 U	0.0026 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Mercury	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.01 U	0.0049 J	0.01 U	0.01 U	0.01 U
Tin	0.0076 J	0.05 U	0.05 U	0.05 U	0.0091 J	0.0066 J	0.0086 J	0.0073 J	0.05 U
Antimony	0.02 U	0.02 U	0.02 U	0.0053 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Arsenic	0.004 J	0.0071 J	0.0036 J	0.01 U	0.01 U	0.0032 J	0.01 U	0.01 U	0.0077 J
Barium	0.0082 J	0.0089 J	0.021	0.011	0.0094 J	0.0075 J	0.0089 J	0.0086 J	0.0082 J
Beryllium	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Cadmium	0.005 U	0.00095 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cobalt	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Copper	0.0037 J	0.0038 J	0.0047 J	0.0084 J	0.0023 J	0.0021 J	0.0034 J	0.0023 J	0.0027 J
Vanadium	0.0068 J	0.02 U	0.01 J	0.012 J	0.02 U	0.0062 J	0.0052 J	0.02 U	0.0045 J
Zinc	0.0059 J	0.02 U	0.02 U	0.0082 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Selenium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D.13

SEDIMENT DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
Volatiles (mg/kg)													
Ethylbenzene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Styrene	0.004 J	0.008 U	0.0066 U	0.003 J	0.0084 U	0.004 J	0.007 U	0.0085 U	0.01	0.012 U	0.013 U	0.007 U	0.011 U
cis-1,3-Dichloropropene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
trans-1,3-Dichloropropene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
1,2-Dibromoethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Acrolein	0.16 R	0.16 R	0.13 R	0.15 R	0.17 R	0.19 R	0.15 R	0.17 R	0.18 R	0.23 R	0.26 R	0.14 R	0.21 R
3-Chloro-1-propene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
1,2-Dichloroethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Propionitrile	0.16 U	0.16 U	0.13 U	0.15 U	0.17 U	0.19 U	0.15 U	0.17 U	0.18 U	0.23 U	0.26 U	0.14 U	0.21 U
Acrylonitrile	0.16 U	0.16 U	0.13 U	0.15 U	0.17 U	0.19 U	0.15 U	0.17 U	0.18 U	0.23 U	0.26 U	0.14 U	0.21 U
Vinyl acetate	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
4-Methyl-2-pentanone	0.041 U	0.04 U	0.033 U	0.037 U	0.042 U	0.048 U	0.037 U	0.042 U	0.046 U	0.058 U	0.065 U	0.035 U	0.053 U
Toluene	0.006 J	0.007 J	0.006 J	0.015	0.0084 U	0.005 J	0.007 U	0.0085 U	0.011	0.031 J	0.013 U	0.007 U	0.011 U
Chlorobenzene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
trans-1,4-Dichloro-2-buten	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
Dibromochloromethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Methacrylonitrile	0.16 U	0.16 U	0.13 U	0.15 U	0.17 U	0.19 U	0.15 U	0.17 U	0.18 U	0.23 U	0.26 U	0.14 U	0.21 U
Chloroprene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Tetrachloroethene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Xylene	0.008 U	0.008 U	0.0066 U	0.006 J	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
trans-1,2-Dichloroethene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Carbon tetrachloride	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
2-Hexanone	0.041 U	0.04 U	0.033 U	0.037 U	0.042 U	0.048 U	0.037 U	0.042 U	0.046 U	0.058 U	0.065 U	0.035 U	0.053 U
1,1,1,2-Tetrachloroethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Acetone	0.062 J	0.036 J	0.041 J	0.12 J	0.044 J	0.07 J	0.11 J	0.1 J	0.059 J	0.13 J	0.19 J	0.068 J	0.082 J

APPENDIX D.13

SEDIMENT DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
Chloroform	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Benzene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
1,1,1-Trichloroethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Bromomethane	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
Chloromethane	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
Iodomethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Dibromomethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Chloroethane	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
Vinyl chloride	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
Acetonitrile	0.33 UJ	0.32 UJ	0.26 U	0.3 U	0.34 UJ	0.38 UJ	0.3 U	0.34 U	0.37 UJ	0.46 UJ	0.52 UJ	0.28 U	0.42 U
Methylene chloride	0.008 U	0.008 U	0.0066 U	0.003 J	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Carbon disulfide	0.008 U	0.005 J	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Bromoform	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Bromodichloromethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
1,1-Dichloroethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
1,1-Dichloroethene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Trichlorofluoromethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Dichlorodifluoromethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Pentachloroethane	0.041 U	0.04 U	0.033 U	0.037 U	0.042 U	0.048 U	0.037 U	0.042 U	0.046 U	0.058 U	0.065 U	0.035 U	0.053 U
Isobutanol	0.33 R	0.32 R	0.26 R	0.3 R	0.34 R	0.38 R	0.3 R	0.34 R	0.37 R	0.46 R	0.52 R	0.28 R	0.42 R
1,2-Dichloropropane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
2-Butanone	0.041 U	0.006 J	0.0089 J	0.028 J	0.025 J	0.013 J	0.013 J	0.014 J	0.01 J	0.024 J	0.04 J	0.01 J	0.012 J
1,1,2-Trichloroethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Trichloroethene	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
1,1,2,2-Tetrachloroethane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Methyl methacrylate	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U

APPENDIX D.13

SEDIMENT DATA (VOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
1,2-Dibromo-3-chloropropa	0.016 U	0.016 U	0.013 U	0.015 U	0.017 U	0.019 U	0.015 U	0.017 U	0.018 U	0.023 U	0.026 U	0.014 U	0.021 U
1,2,3-Trichloropropane	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U
Ethyl methacrylate	0.008 U	0.008 U	0.0066 U	0.007 U	0.0084 U	0.01 U	0.007 U	0.0085 U	0.009 U	0.012 U	0.013 U	0.007 U	0.011 U

APPENDIX D.14

SEDIMENT DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
Semivolatiles (mg/kg)													
2-Diallate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 R	0.63 R	0.57 U	0.66 U	0.57 R	0.78 R	0.82 R	0.58 R	0.69 U
4-Nitroaniline	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
4-Nitrophenol	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
Benzyl alcohol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosopiperidine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
4-Bromophenyl phenyl ether	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,4-Dimethylphenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosomethylethylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
1,4,-Dichlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
4-Chloroaniline	1.1 U	1.1 U	1 U	0.96 U	1.2 U	1.3 U	1.1 U	1.3 U	1.1 U	1.6 U	1.6 U	1.2 U	1.4 U
1,4-Phenylenediamine	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
Bis(2-chloroisopropyl)ether	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Phenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2-Picoline	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Pryridine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Bis(2-chloroethyl)ether	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Bis(2-chloroethoxy)methane	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Bis(2-ethylhexyl)phthalate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.25 J	0.18 J	0.25 J	0.58 U	0.69 U
Di-n-octylphthalate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Hexachlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
3,3'-Dimethylbenzidine	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
Isosafrole	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 R	0.66 R	0.57 U	0.78 U	0.82 U	0.58 U	0.69 R
1,2,4-Trichlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,4-Dichlorophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,4-Dinitrotoluene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U

APPENDIX D.14

SEDIMENT DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
A, A-Dimethylphenethylamir	110 U	110 U	100 U	97 U	120 U	130 U	120 U	130 U	120 U	160 U	170 U	120 U	140 U
1,4-Dioxane	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.04	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
o,o,o-Triethylphosphorothioat	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
1,4-Naphthoquinone	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Dimethylphthalate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
3&4-Methylphenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Dibenzofuran	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
1-Naphthylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Aramite	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Hexachloropropene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Diallate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Pronamide	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,4-Dinitrophenol	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
2-Acetylaminofluorene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
4,6-Dinitro-2-methylphenol	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
1,3-Dichlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosodiethylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
3-Methylcholanthrene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
4-Nitroquinoline-1-oxide	5.5 R	5.3 R	5.1 R	4.8 R	5.9 R	6.3 R	5.7 R	6.6 R	5.7 R	7.8 R	8.2 R	5.8 R	6.9 R
7,12-Dimethyl benz(a)anthra	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,3,4,6-Tetrachlorophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
4-Chloro-3-methylphenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosomorpholine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
p-Dimethylaminoazobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,6-Dinitrotoluene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Pentachlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U

APPENDIX D.14

SEDIMENT DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
Phenacetin	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Ethyl methanesulfonate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Aniline	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosodimethylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitroso-di-n-propylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Methyl methanesulfonate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Hexachloroethane	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Hexachlorophene	280 U	270 U	260 U	250 U	300 U	330 U	290 U	340 U	290 U	400 U	420 U	300 U	350 U
4-Chlorophenyl-Phenylether	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Hexachlorocyclopentadiene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Isophorone	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Pentachloronitrobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Diethylphthalate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Di-n-butylphthalate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Butylbenzylphthalate	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosodiphenylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,6-Dichlorophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Hexachlorobutadiene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Pentachlorophenol	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
2,4,6-Trichlorophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2-Nitroaniline	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
2-Nitrophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Dinoseb	0.55 U	0.53 U	0.51 U	0.48 U	0.59 UJ	0.63 UJ	0.57 U	0.66 U	0.57 U	0.78 U	0.82 UJ	0.58 U	0.69 U
2-Chloronaphthalene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2-Naphthalamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Methapyrilene	110 U	110 U	100 U	97 U	120 U	130 U	120 U	130 U	120 U	160 U	170 U	120 U	140 U

APPENDIX D.14

SEDIMENT DATA (SEMIVOLATILES) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
3,3'-Dichlorobenzidine	1.1 U	1.1 U	1 U	0.96 U	1.2 U	1.3 U	1.1 U	1.3 U	1.1 U	1.6 U	1.6 U	1.2 U	1.4 U
4-Aminobiphenyl	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitroso-di-n-butylamine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
n-Nitrosopyrrolidine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Safrole	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2-Methylphenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
1,2-Dichlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
o-Toluidine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2-Chlorophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
1,2,4,5-Tetrachlorobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
2,4,5-Trichlorophenol	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Acetophenone	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
Nitrobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
3-Nitroaniline	2.8 U	2.7 U	2.6 U	2.5 U	3 U	3.3 U	2.9 U	3.4 U	2.9 U	4 U	4.2 U	3 U	3.5 U
1,3,5-Trinitrobenzene	0.55 UJ	0.53 UJ	0.51 UJ	0.48 UJ	0.59 UJ	0.63 UJ	0.57 U	0.66 U	0.57 UJ	0.78 UJ	0.82 UJ	0.58 R	0.69 U
5-Nitro-o-toluidine	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U
m-Dinitrobenzene	0.55 U	0.53 U	0.51 U	0.48 U	0.59 U	0.63 U	0.57 U	0.66 U	0.57 U	0.78 U	0.82 U	0.58 U	0.69 U

APPENDIX D-15

SEDIMENT DATA (PAHs) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	3/12/2002	3/12/2002	1/16/2002	1/16/2002	1/16/2002	3/12/2002	3/12/2002
PAHs (mg/kg)													
Anthracene	0.011 U	0.0028 J	0.01 U	0.0097 U	0.0065 J	0.25	0.015 J	0.0069 J	0.013 J	0.032	0.21 J	0.041	0.013 J
Pyrene	0.011 U	0.016	0.011	0.0038 J	0.025	0.21	0.11	0.045	0.16	0.61 J	4.7	0.33 J	0.07
Benzo(g,h,i)perylene	0.011 U	0.014	0.0066 J	0.0038 J	0.018	0.069	0.048	0.028	0.06	0.24 J	1.4	0.19 J	0.04
Indeno(1,2,3-cd)pyren	0.011 U	0.012	0.0063 J	0.0033 J	0.014	0.054	0.048	0.026	0.048 J	0.19 J	1.3	0.2 J	0.036
Benzo(b)fluoranthene	0.011 U	0.03	0.024	0.014 J	0.032	0.28	0.14	0.077	0.19	0.59 J	2.4	0.87 J	0.13
Fluoranthene	0.011 U	0.014	0.0085 J	0.0097 U	0.036	0.24	0.14	0.056	0.18	0.9 J	5.8	0.26 J	0.082
Benzo(k)fluoranthene	0.011 U	0.046	0.023	0.013 J	0.032	0.23	0.11	0.07	0.15	0.58 J	2.5	1 J	0.12
Acenaphthylene	0.011 U	0.003 J	0.01 U	0.0097 U	0.003 J	0.015	0.0055 J	0.0041 J	0.012 J	0.014 J	0.34 U	0.032	0.0087 J
Chrysene	0.011 U	0.052	0.038	0.01	0.026	0.25	0.11	0.055	0.11	0.48 J	2.6	0.34 J	0.096
Benzo(a)pyrene	0.011 U	0.017	0.0095 J	0.0062 J	0.017	0.11	0.088	0.048	0.11	0.41 J	2.2	0.73 J	0.092
Dibenzo(a,h)anthracen	0.011 U	0.0027 J	0.01 U	0.0097 U	0.0056 J	0.026	0.025	0.012 J	0.021 J	0.096	0.53	0.14 J	0.022
Benzo(a)anthracene	0.011 U	0.0095 J	0.0066 J	0.0078 J	0.013	0.13	0.075	0.035	0.073	0.36 J	1.7	0.2 J	0.062
Acenaphthene	0.011 U	0.011 U	0.01 U	0.0097 U	0.0067 U	0.013 U	0.0038 J	0.013 U	0.058 U	0.009 J	0.14 J	0.012 J	0.015 U
Phenanthrene	0.011 U	0.011 U	0.01 U	0.0097 U	0.02	0.04	0.033	0.013	0.063	0.31 J	2.8	0.074	0.02
Fluorene	0.011 U	0.011 U	0.01 U	0.0097 U	0.003 J	0.005 J	0.016 U	0.013 U	0.058 U	0.01 J	0.14 J	0.0075 J	0.015 U
1-Methylnaphthalene	0.011 U	0.011 U	0.01 U	0.0097 U	0.0067 U	0.013 U	0.016 U	0.013 U	0.058 U	0.016 U	0.34 U	0.014 U	0.015 U
Naphthalene	0.011 U	0.011 U	0.01 U	0.0097 U	0.0067 U	0.013 U	0.016 U	0.013 U	0.058 U	0.016 U	0.34 U	0.014 U	0.015 U
2-Methylnaphthalene	0.011 U	0.011 U	0.01 U	0.0097 U	0.0067 U	0.0016 J	0.016 U	0.013 U	0.058 U	0.016 U	0.34 U	0.014 U	0.015 U

APPENDIX D.16

SEDIMENT DATA (METALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
Metals - Total (mg/kg)													
Lead	1.3 J	3.8	3	6.6	11 J	17 J	16	20	290 J	1300 J	300 J	55	26
Mercury	0.028 U	0.0092 J	0.022 J	0.01 J	0.013 J	0.036	0.052	0.02 J	0.048	0.062 J	0.068 J	0.036	0.075
Nickel	3.1 J	4.2 J	21	6.9	10	10	7.5	5.6 J	7.8	20 J	13 J	8.4	9.6
Silver	1.5 U	1.6 U	1.4 U	1.2 U	1.6 U	1.7 U	1.4 U	1.8 U	1.6 U	2 UJ	2.3 UJ	1.8 U	1.9 U
Thallium	1.5 U	1.6 U	1.4 U	0.96 J	1.6 J	1.7 U	1.4 U	1.8 U	1.6 U	2 UJ	2.3 UJ	1.8 U	1.9 U
Tin	7.6 U	8.1 U	7 U	6 U	8.1 U	8.7 U	7.2 U	9.1 U	7.8 U	9.3 J	11 UJ	8.8 U	9.5 U
Antimony	3 U	3.2 U	2.8 U	2.4 U	3.2 UJ	3.5 UJ	0.89 J	3.6 UJ	2.5 J	15 J	1.5 J	3.5 UJ	3.8 UJ
Arsenic	2.9 J	6.2	46	6.4	4.9 J	4.9 J	6.4	4.6	8 J	11 J	11 J	6.3	7.8
Barium	18	29	100	49	20	48	16	15	20	21 J	19 J	25	26
Beryllium	0.17 J	0.19 J	0.39 J	0.28 J	0.19 J	0.16 J	0.13 J	0.11 J	0.13 J	0.15 J	0.16 J	0.16 J	0.18 J
Cadmium	0.27 J	0.38 J	1.3	1	0.4 J	0.17 J	0.21 J	0.91 U	0.55 J	0.35 J	0.59 J	0.16 J	0.95 U
Chromium	11	17	39	27	24 J	22 J	26	14	24 J	47 J	28 J	18	26
Cobalt	3.6	4.8	31	12	15	15	10	6	4.4	7.1 J	6.2 J	9.6	9.6
Copper	10	13	31	18	76 J	130 J	57 J	46 J	58 J	140 J	210 J	60 J	77 J
Vanadium	56	84	200	190	130	97	86 J	42 J	33	44 J	47 J	69 J	64 J
Zinc	11	19	28	17	77	71	73	52	600	410 J	280 J	68	82
Selenium	1.5 U	1.6 U	1.3 J	0.8 J	1.6 U	1.7 U	1.4 U	1.8 U	1.6 U	2 UJ	2.3 UJ	1.8 U	1.9 U

APPENDIX D.17

SEDIMENT DATA (CONVENTIONALS) USED IN ECOLOGICAL RISK ASSESSMENT
CORRECTIVE MEASURES STUDY TASK 1 REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Site ID	7SD1	7SD2	7SD3	7SD4	7SD5	7SD6	7SD7	7SD8	7SD9	7SD11	7SD12	7SD13	7SD14
Depth (ft.)	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2	0.0-0.2
Sample Date	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/15/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002	1/16/2002
Conventionals (mg/kg)													
Total organic carbon	2200	3800	3000	2100	7300	6600	18000	16000	9900	18000	17000	11000	16000

APPENDIX E
ADDITIONAL DATA COLLECTION INVESTIGATION REPORT

APPENDIX F
UNIFIED DATA SET FOR TOW WAY FUEL FARM

APPENDIX G
FINAL GROUNDWATER MODEL REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

Final

Groundwater Model Report
Tow Way Fuel Farm

Naval Station Roosevelt Roads

RCRA/HSWA Permit No. PR2170027203

Ceiba, Puerto Rico

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1.0 INTRODUCTION

This document presents the groundwater model development and results for Solid Waste Management Unit (SWMU) 7/8, Tow Way Fuel Farm (TWFF), Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. This document has been prepared by Baker Environmental, Inc. (Baker) under contract to the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) Contract Number N62470-95-D-6007, Contract Task Order (CTO) 034. This document is Appendix G of the Corrective Measures Study (CMS) Task 1 Report.

1.1 Groundwater Modeling Objectives

There are three basic objectives for the groundwater flow and contaminant transport modeling at the TWFF, NSRR site:

- provide a basic understanding of the groundwater flow system with regard to the groundwater flow directions and velocities;
- assist in development and implementation of remedial technologies; and
- estimate remedial times and calculate mass recovery rates.

The steps involved in developing the conceptual and numerical groundwater flow model included the following:

- Collection and review of site information including geology, hydrogeology, precipitation, and site-specific water source and sink information.
- Development of a steady state groundwater flow model. Calibrate the model to average groundwater elevations.
- Collection and review of site information regarding phase-separated hydrocarbon (PSH) removal volumes and current thickness at well locations. Calculate the estimated volume of PSH for use in source zones in the fate and transport model.
- Development of a flow model for the PSH on top of the water table under pumping conditions.

Pumping and treatment of the groundwater is a potential alternative of the CMS Task 1 report (this report). While only a natural gradient, steady state scenario was run in the current modeling exercise, a pumping scenario can be done with the model should design of a pump and treatment option be considered as a preferred CMS alternative. PSH volumes on the water table were estimated using product thickness isopach contours.

1.2 Report Organization

This report is organized into seven sections, including this introduction. The second section discusses the collection and review of TWFF information related to the modeling effort. The third section describes the numerical groundwater model conceptualization, including boundary conditions. Section 4 presents the results of the model. The PSH volume calculations are given in Section 5, the conclusions are forwarded in Section 6, and references are given in Section 7.

2.0 SITE DATA COLLECTION AND REVIEW

This section discusses the collection and review of TWFF information related to the modeling effort.

2.1 Site Location and Background

Roosevelt Roads is an active U.S. Naval Station and is located near the town of Ceiba on the eastern end of Puerto Rico. The approximate location of the Naval Station is 18°15'00" latitude and 65°39'30" longitude.

The TWFF is bounded on the north by undeveloped land comprised of hills and forest and on the south by Ensenada Honda. Currently, seven fuel storage tanks, 82, 83, 84, 85, 1080, 1082, and 1088, comprise the TWFF. Figure 2-3 of the CMS Task 1 Report is a site map showing the topography and location of the fuel tanks at TWFF. In 1984 two underground storage tanks (USTs), 56A and 56B were removed. These were located near the Pump House. Since 1957, spills, leaks, and sludge disposal have resulted in releases of product. This discharge has impacted soil and groundwater at the site. According to the latest Quarterly Progress Report (Baker, 2002) there are areas of phase separated hydrocarbons (PSH) on the water table around several monitoring wells, including UGW2, MW01, 7MW08, 470MW01, and in most of the UGW and Recovery Wells (RW) along Forrestal Drive between Palau Street and Card Street. In addition, 7MW15, recently installed to replace UGW14, had PSH detected during the additional data collection effort. Thirty wells at TWFF have had product measured in them at some point or continually throughout the past four years. During the past fourteen months, approximately 100 gallons of PSH has been recovered from these wells.

During the CMS Investigation conducted in April 1998, TCE was detected at well 7MW07 at 2,000 μg/L. TCE was also detected in well 7MW08 at 3 μg/L. As a result, a TCE investigation was conducted in June 1999.

The additional data collection effort, conducted in January 2002, was performed to gather any remaining information and data necessary for the CMS. The results from this investigation are found in Appendix E of this report.

2.2 Climatology and Recharge

The climate of the Roosevelt Roads area is characterized as warm and humid, with frequent showers occurring throughout the year. A major factor affecting the weather is the pattern of trade winds associated with the Bermuda High, the center of which is in the vicinity of 30° North, 30° West. Uniform temperatures prevail, with small diurnal ranges as a result of insular exposure and the relatively small land area. The warmest months are August and September, while the coolest are January and February. Mean annual maximum temperature ranges from 82° Fahrenheit (° F) in January to 88.2° F in August. The mean annual minimum temperatures vary from 64.0°F in January to 73.2°F in June. Rain usually occurs at least nine days in every month, with an average of 60 to 75 inches per year, although a dry winter season occurs from December through April. The rainy season occurs during the months of August through November. About 22 thunderstorm-days occur per year, with maximum frequencies of three days per month from May through October. Approximately two tropical storms per year occur in the study area, one of which usually reaches hurricane intensity.

Rainfall data collected at the TWFF for the period of July 18, 2001 through April 12, 2002 showed that approximately 38.4 inches fell during these 39 weeks. This is a smaller amount of rainfall than would be expected based on the low mean of 60 inches per year given in the preceding paragraph. At this rate of rainfall, only about 52 inches of rain would fall at the TWFF during the course of the year. Considering that both the dry season and the rainy season are incorporated into these measurements, it appears that the TWFF is experiencing, on average, a dry year.

In the immediate area of the TWFF, elevations range from sea level to approximately 270 feet. Slopes of up to 60 degrees are common. Recharge to the aquifer is dependent on topography, soil type, and ground cover.

2.3 Geology and Hydrogeology

The underlying geology of the area at NSRR is predominantly volcanic as well as sedimentary. The volcanic rocks and interbedded limestones have been complexly faulted, folded, metamorphosed and variously intruded by dioritic rocks. The primary geologic formations on and near NSRR are various beach deposits, alluvium, quartz diorite and granodiorite, aquartz keratophyre, the Daguao Formation, and the Figuera Lava.

The geology in the area of TWFF can be divided into three categories: an upper zone of fill material, a zone of residual soil (weathered rock), and bedrock. The upper zone of fill material is composed of fine to medium grained sand with varying amounts of silt and clay. The fill material is generally encountered at the ground surface to depths below the ground surface ranging from 2 feet to over 25 feet, but may also be locally absent. The source of the fill material has not been definitively determined but it is most likely either natural soil excavated during tank construction or dredge material from Ensenada Honda.

Underlying the fill zone is a relatively thick layer of residual soil formed in place by the in-situ decomposition of bedrock. This residual soil was encountered at all of the soil borings and monitoring wells advanced at the site. This zone is comprised of clayey silt, silty clay, with fine to course rock fragments. With depth the percentage of rock fragments steadily increases until the zone grades to weathered rock fragments with occasional clay seams and eventually to competent bedrock. The thickness of this unit is variable and in places is in excess of 40 feet.

The third zone identified consists of bedrock. The bedrock is described as a gabbro, very broken to broken, massively bedded, hard to very hard and highly fractured due to tectonic deformation and subsequent weathering.

In addition to these three zones, a fourth zone of unconsolidated material was identified during the Corrective Measures Investigation (Baker, 2000) near the Ensenada Honda. This material consists of naturally occurring marine sediments, primarily silt with lesser amounts of sand and clay with coral and shell fragments.

It should be emphasized that there is not a well-defined contact between the residual soil and bedrock; rather, there is a gradational change of decreased weathering and fracturing with increasing depth.

A tidal study was conducted during the RCRA Facilities Investigation (Baker, 1997) to determine the effects of the tide on the groundwater flow patterns at TWFF. Fluctuations between high and

low readings in the wells in the study were generally less than 0.1 feet, indicating that tidal changes do not significantly affect the flow of groundwater at TWFF.

Thirty-two slug tests and two limited pump tests have been performed on wells at TWFF. The results of the slug and pump tests can be found in the RCRA Facilities Investigation (Baker, 1997), the Corrective Measures Investigation (Baker, 1999), and Appendix E of the CMS Task 1 report (this report). Hydraulic conductivity values ranged from 0.0113 ft/day to 12.34 ft/day, a range of four orders of magnitude. The two pump tests results were at the low end of this range, primarily because they were conducted on wells that are screened in the bedrock. The weathered bedrock would be expected to exhibit a higher hydraulic conductivity than the competent bedrock, although the difference is very slight (see Appendix E).

2.4 Summary of Previous Investigations and Reports

Several reports have been reviewed for the development of the conceptual groundwater and contaminant transport model at Tow-Way Fuel Farm. These include:

- "Underground Fuel Investigation, Final Report (1992) by O'Brien and Gere
- "Site Characterization, Site 1995" (1995), by Blasland, Bouck, and Lee, Inc.
- "Corrective Action Plan," Blasland, Bouck, and Lee, September, 1994
- "Site Characterization Report", Blasland, Bouck, and Lee, April, 1994
- “Site Characterization, TWFF-North Side,” Blasland, Bouck, and Lee, December, 1994
- "Hydraulic Characteristics Evaluation", McLaren/Hart, Inc., August, 1999
- "Draft Report of Findings Quantification of Product Release, Pier 1- TWFF," McLaren/Hart, March, 2000
- "Revised Draft RCRA Facility Investigation Report for Operable Unit 2," Baker, 1997
- "Final Corrective Measures Investigation Report," Baker, 1999
- "Quarterly Progress Reports for Tow-Way Fuel Farm" Baker, 1997-et seq.

2.4.1 Groundwater Elevation Data

The average water table elevations at the site were derived from the historical groundwater elevation data from 1997 to 2002 and are presented in Table 2-1. Data from eighty-two wells were used to delineate the water table. Figure 2-1 depicts the average groundwater elevations at TWFF. It should be noted that several rounds of data (at some wells, fifty readings were taken) were used to produce this average groundwater table. Two thousand water level elevations were compiled and used in this effort. This is a vast amount of data and, subsequently, greater confidence can be placed in the average water table elevations representing “average” conditions at TWFF. It should further be noted that these elevations are actual elevations above sea level,

and are not shown in the conventional manner with the +100 foot datum historically used at NSRR for depicting elevations.

In general, the direction of flow in the upper TWFF area is toward the west with an average hydraulic gradient of 0.0044 ft/ft, with radial flow to the northwest and southwest because of a local high average water table elevation at UGW02. It should be noted that the location of the local high for the average water table is different than what has been reported in the recent quarterly reports for the TWFF. In general, the current location for the groundwater divide is 7MW03. This is because of higher water table elevations in late 1998, early 1999, and again in late 1999, early 2000. Since then, the water table elevations have been lower at UGW02.

The direction of flow in the lower TWFF area is toward Ensenada Honda. The average calculated hydraulic gradient in the lower Tow-Way is 0.0093 ft/ft.

Because of the presence of PSH at TWFF, and the need to correct water table elevations for its presence, densities of both the groundwater and the PSH were obtained during the field effort. The densities obtained (water = 1 g/ml, PSH = 0.82 g/ml) were very close to the densities used for correction in the past (water = 1 g/ml, PSH = 0.811 g/ml) (see Appendix A, this report), and as a result, no global changes were made to the existing groundwater elevation corrections.

2.4.2 Ground Surface Elevation and Soil Boring Information

Ground surface elevations were taken from the digitized information available at NSRR. Over 4800 ground surface elevations were used to define the top layer of the model. Subsurface information was taken from 127 soil boring logs, including those from Site 1995. Thirty-five control points were used to further define the subsurface. In general, these were randomly scattered over the entire TWFF.

3.0 GROUNDWATER MODEL DESCRIPTION

This section describes the numerical groundwater model conceptualization and implementation.

3.1 Description of Numerical Groundwater Model

MODFLOW was used to simulate the existing groundwater flow regime around the entire area surrounding the TWFF. MODFLOW is the numerical finite-difference groundwater flow code developed by the U.S. Geological Survey (McDonald and Harbaugh, 1996, 1988). The numerical groundwater model input for MODFLOW was generated using the Groundwater Modeling System (GMS 3.1) authored by the Environmental Modeling Research Laboratory (EMRL, 2000) at Brigham Young University. GMS is a graphical pre- and post-processor that allows the user to construct, edit and print the finite-difference grid size and spacing, the hydrogeological input parameters, and the outputs from the groundwater model.

The code that was proposed for this work is MODFLOW-SURFACT. This code is essentially MODFLOW (McDonald and Harbaugh, 1988), but includes an enhanced matrix solution scheme, an enhanced recharge and cell re-wetting package, a fractured well package, and a robust contaminant transport package. The code is publicly available and interfaces with Groundwater Vistas®, which is a widely used pre- and post-processor for MODFLOW and other modeling packages. The code is used and accepted within the EPA. Many of the modules are the same as MODFLOW without any modifications. Initial set-up of the input files for the MODFLOW model and interpretation of the output files was done with the Groundwater Modeling System® software because of user familiarity.

MODFLOW-SURFACT is a fully integrated groundwater flow and solute transport code developed by HydroGeoLogic, Inc. It is based on the U.S. Geological Survey modular 3-dimensional groundwater flow modeling code, MODFLOW.

The SURF acronym in MODFLOW-SURFACT denotes the following:

- S – robust and efficient (matrix solution, nonlinear iterations with adaptive time stepping, output control and axi-symmetric) **S**chemes.
- U – rigorous treatment of **U**nconfined flow.
- R – non-ponding **R**echarge and seepage face boundary conditions.
- F – **F**racture well representation to provide rigorous treatment of well conditions.

The MODFLOW code utilizes a block-centered finite-difference approach to solve the groundwater flow equation. The flow domain is discretized into rows, columns, and layers such that each node represents a rectangular block of porous material that is referred to as a cell. A node in the resulting finite difference grid represents a no-flow, variable-head, or constant-head cell, and any hydraulic property associated with a cell is specified with respect to the corresponding node.

3.2 Model Grid and Boundary Conditions

Figure 3-1 depicts the model domain. The groundwater model domain includes an expanded area around the TWFF and part of Site 1995 on the western side. The Ensenada Honda bounds the

southern edge of the model domain. The northern and eastern edge of the model domain are bounded by Antietam and Valley Forge Roads in order to incorporate the additional groundwater elevation information from the TWFF-North Side site investigation wells. The cell size was approximately 16.8 feet by 18.7 feet.

In a three-dimensional model, several vertical layers can be modeled. Usually these are chosen according to stratigraphy at the site. Three different layers were used in the model domain to represent the unconsolidated overburden (Layer 1), the weathered rock (Layer 2), and the fractured rock (Layer 3). It should be noted that the use of MODFLOW in this case assumes an equivalent porous media for the weathered and unweathered bedrock layers.

The bottom elevations of Layers 1 and 2 were found from the boring logs of the various wells and soil borings that were done on site. The different layers were interpolated based on the elevations found in these borings. Where no borings were available, control points were added to obtain a reasonable three-layer grid configuration when interpolation was made. In the control points, the unconsolidated overburden was assumed to be two feet thick, and the weathered rock layer was assumed to be 15 feet thick. It should be noted that layer one is quite shallow over most of the site. The bottom elevation of the third layer was assumed to be –100 feet mean sea level (msl). The interpolation scheme used was the natural neighbor method with a constant nodal function.

Figure 3-2 depicts the locations of two cross sections of the initial layers as determined through interpolation routines on the weathered rock and bedrock boring information. The layers in the longitudinal and transverse flow directions are depicted in Figure 3-3.

The model boundary located on the Ensenada Honda is modeled as a constant head boundary in all three layers with the exception of the bulkhead area. The first two layers have a constant head of 0 feet along the Honda. The fractured rock layer was modeled with a constant head of 1.5 feet msl in order to model the upward movement of groundwater toward the Honda. At the bulkhead locations, the top two layers are modeled as horizontal flow barriers. These are solid concrete walls with a depth of about 20 feet below sea level. They are assumed to have a horizontal hydraulic conductivity of 0.0005 ft/day.

The remaining boundaries are also modeled as constant head boundaries with the constant head values ranging from 1 foot to 5 feet at several nodes along the boundary. There is very little water in the first two layers of the aquifer at the TWFF. As a result, these constant heads only apply to the third layer of the model.

3.3 Recharge

Recharge areas are shown in Figure 3-4. No recharge was allowed to occur directly under any of the fuel tanks, buildings, or large concrete areas. The amount of recharge to the model varied between 0 inches/year to 45 inches per year. In general, the wooded areas received 22.5 inches/year, the bowl area of the TWFF received 36 inches/year, the developed areas near hillsides received 12 inches/year, and the portion of the TWFF below Forrestal Road also received 12 inches/year. Even in the dry season, ponding is observed in the vicinity of and to the east of UGW14. For this reason, recharge was set at 45 inches/year in this area.

3.4 Hydraulic Conductivity

Hydraulic conductivity at the site varied with the layers. Because of the numerous slug test results obtained at this site, every effort was made to incorporate the slug test results into the model. In general, most slug test results were increased by an order of magnitude during calibration of the model. Vertical hydraulic conductivity was usually modeled at ten percent of the horizontal hydraulic conductivity.

Layer 1 hydraulic conductivity is shown in Figure 3-5. Since this layer is dry over most of the site, only the slug tests obtained from wells known to be screened in this layer were used. A range of 0.1 – 50.0 ft/day for horizontal conductivity and 0.01 – 50 ft/day for vertical conductivity was used in Layer 1. Layer 2 hydraulic conductivity is shown in Figure 3-6. Both the horizontal and the vertical conductivity ranged from 0.05 ft/day – 50 ft/day. Again, the slug test results from wells in this layer were used as initial estimates. A range of 0.05 – 20.0 ft/day was used for hydraulic conductivity in Layer 3 (Figure 3-7). Most of the groundwater flow occurs in this layer. For the entire model, hydraulic conductivity values used ranged from 0.01 to 50 ft/day with the highest value of 50 ft/day used only at the bulkhead areas. This compares favorably to the range of values obtained from the slug test information (0.01 - 12.34 ft/day).

The saltwater-freshwater interface was not modeled. In Puerto Rico there is a forty-foot column of freshwater below sea level for every foot of freshwater above sea level (http://capp.water.usgs.gov/gwo/ch_n/N-PR_VItext2.html). The depth to the water table at one location of concern along Forrestal Drive is approximately 5 feet above mean sea level. This means that there are approximately 5 x 40 feet, or 200 feet of fresh water below mean sea level at this location.

4.0 RESULTS

This section presents the MODFLOW results and the MODPATH pathline analysis in the following subsections.

4.1 MODFLOW Results

The model was calibrated to average measured groundwater elevations at the site by iteratively varying boundary conditions, recharge values, and hydraulic conductivity until a statistical fit was made to the groundwater targets (existing groundwater elevation data) for the site.

The simulated steady-state water table contours for the overburden groundwater (Layer 1) at the TWFF are shown in Figure 4-1. Graphical comparisons and statistical summaries of the observed versus the simulated heads in Layer 1 also are provided in Figure 4-1. The statistics were used to calibrate the model to the actual heads measured during the site-wide groundwater sampling events. The overall error is calculated by the equation:

$$RMS = [\Sigma(h_c-h_o)^2/n]^{½}$$

where:

RMS = root mean square (RMS) error statistic (feet)
h_c = computed head at a single well/piezometer (feet)
h_o = observed head at a single well/piezometer (feet)
n = number of wells/piezometers (unitless)

While there are no hard and fast rules regarding specific RMS error values to judge the degree of calibration of a model, an RMS error value less than the seasonal variation is considered as being sufficiently precise for this application. At the TWFF, the actual seasonal variations from 1997 to 2002 were much higher than the corresponding RMS values in each layer. Table 4-1 summarizes the calculated errors in the model for all three layers.

The calculated RMS error was 0.98 feet for Layer 1 (overburden), which is less than the maximum seasonal variation (5.6 feet, see Table 2-1) in that layer. Figure 4-1 shows the water table contours absent where the overburden is unsaturated. Also shown on this figure are the calibration targets for the wells screened in layer 1. The green bar indicates that these computed values are within an acceptable range for calibration purposes. The direction they are pointing indicates whether the computed values are above or below the observed values. Please refer to Table 4-1 for the actual values of groundwater head at each location. In a few cases the wells that were believed to be screened in a particular layer turned out to be dry in the model. This simply means that the modeled groundwater heads were located slightly below the bottom of the layer in question. For these cases, the calibration targets are not shown.

The calculated RMS error was 0.97 feet for Layer 2, which is less than the maximum seasonal variation (20.3 feet) in that layer. Figure 4-2 shows the water table contours in this layer. Again, where layer 2 was dry, no contours are present.

Figure 4-3 depicts the MODFLOW results for layer 3. These are quite similar to the average groundwater elevations shown on Figure 2-1. The RMS error for this layer was 0.80 feet, while the maximum seasonal variation in Layer 3 is 18.0 feet.

Overall, when all the layers are included in the calculation for RMS error, the RMS is 0.94 feet. This represents a good model calibration to the average water table at NSRR, TWFF.

4.1.1 Sensitivity Analysis

A sensitivity analysis was performed on the model. The horizontal hydraulic conductivity, vertical hydraulic conductivity, and recharge were varied and the resulting model errors were determined. Table 4-2 depicts the results of the sensitivity analysis.

The horizontal and vertical hydraulic conductivities were varied over the entire model by two orders of magnitude on each side of the final calibrated values. This was accomplished by using a multiplier in the modeling package. For instance, if the hydraulic conductivity was reduced by two orders of magnitude from the calibrated value, then the multiplier for this parameter was 0.01. In the same way, if the conductivity was increased by two orders of magnitude, the multiplier was 100. All changes were made to the model in a global manner; that is, over all three layers. During the variation of one parameter, all the other parameters were held constant at their calibrated values.

The results of the sensitivity analysis for horizontal hydraulic conductivity are shown in the first section of Table 4-2. As shown, the calibrated value (i.e. a multiplier of 1) yields the lowest error in the model. As the horizontal hydraulic conductivity is decreased, the groundwater builds up to unacceptable heights. As it is increased, the groundwater heads are too low.

The vertical hydraulic conductivity was also varied by two orders of magnitude on each side of the calibrated value. As shown on Table 4-2, there was not as marked of a difference in the errors in the model, although the calibrated value still yields the lowest error.

The recharge was varied by decreasing the recharge to one-half times and one-quarter times the calibrated values and increasing it by 1.25 and 1.5 times the calibrated values. All changes were done over the entire modeled area. The recharge was also doubled, with the result that there was too much water in the model. Again, as seen in the bottom section of Table 4-2, the calibrated values for recharge yields the lowest error in the model.

The results of the sensitivity analysis show that good calibration of the model to the observed values of groundwater head at TWFF, NSRR was accomplished.

4.2 MODPATH Pathline Analysis

Two locations were chosen on which to run a pathline analysis. These were: 1) near the 470 wells, both of which had benzene concentrations detected in them, and 2) near 7MW07 where trichloroethene was detected. Particles were started in layers 2 and 3 only, because layer 1 is dry in those locations.

The MODPATH simulation results are shown on Figure 4-4. In general and as would be expected, the pathlines indicate that the particles move directly toward the Honda. The time of travel from the 470 series well locations to the Honda was approximately 4 to 32 years, depending on which layer the particles were started in. The time of travel from 7MW07 to the Honda was approximately 5 to 6 years. It should be noted that these times are not indicative of contaminant transport travel times, only water movement. Contaminant transport includes many other factors that retard contaminant movement, such as dispersion, adsorption, and degradation. Therefore, these are “worst case scenario” times. In addition, it is noted that steady state calibration of the model to observed heads resulted in a slightly higher gradient computed in the lower TWFF when compared to actual gradients. The MODPATH analysis result from this potential error is also conservative.

Pumping scenario pathlines and travel times were not evaluated at this time because a steady state pumping scenario model was not constructed. Should a pumping scenario be done for the CMS, travel times and pathlines in the lower TWFF will be computed based on the new groundwater heads resulting from the pumping.

5.0 PHASE SEPARATED HYDROCARBON

Previous modeling studies (TWFF Quarterly Report No. 8, 1999) of the PSH movement in two dimensions showed that any water extraction from under the PSH only increases the smear zone of the PSH, increasing the amount of PSH that becomes unrecoverable. In a similar fashion, greater movement of PSH can be accomplished under a positive pressure head. If there is negative pore pressure in the soil voids, i.e. the PSH is held in place by capillary action, then no movement of the PSH can occur. Movement of PSH will occur, however, when the negative pore pressure is broken, as in the case of a well screen through the PSH, allowing PSH to flow into a well casing.

Because the PSH can flow into a well casing screened across the layer of PSH and depress the water table, the amount of product in the wells with product in them is usually larger than the thickness of the product in the formation. A brief discussion of the various empirical methods used to estimate the actual thickness of PSH in the aquifer formation given the product thickness in a well is found in Weidemeier, et al., 1995. These are only approximations because many factors influence the relationship between measured and apparent PSH thickness. Some of these factors are: 1) uncertainty in capillary fringe height in the formation, 2) trapping of PSH below the water table during recharge, 3) soil containing mobile PSH may not be 100-percent saturated.

The simplest method to be used for correcting for thickness is the method of de Pastrovich et al., (1979, from Weidemeier, et al, 1995). The corrected thickness in the formation is given in the following equation:

$$H_f = [h_m (r_w - r_{PSH})] / r_{PSH}$$

Where H_f = height of the product in formation

h_m = height of the product in the monitoring well

$?_w$ = density of water

$?_{PSH}$ = density of PSH

The density of water was measured at the TWFF and found to be 1.0 g/ml. The density of the PSH was measured and found to be 0.82 g/ml.

The TWFF Quarterly Progress Report from May 2002 summarizes the PSH thickness and recovery at several wells from the period of February 2001 through April 2002. These thicknesses were averaged for each well and used to construct an isopach contour drawing. Table 5-1 summarizes the average thickness and volume of PSH removed from the wells during this period. Figure 5-1 depicts the isopach map. The contours for the different thicknesses were mapped into polygons to determine the area of a certain thickness contour. (These are labeled in Figure 5-1) When this area (usually a doughnut shape) is multiplied by the average thickness of PSH in that contour, a total volume of PSH-impacted soil is found. If this volume is completely saturated with PSH, the volume of voids will represent the volume of PSH. When the total volume is multiplied by the porosity, the volume of PSH can be found.

The results of these calculations are given in Table 5-2 in the first set of results. The porosity was assumed to be 0.3. The worst-case volume of PSH at the TWFF is approximately 362,000 gallons. When the method of de Pastrovich is used, the volume is decreased by 78 percent,

resulting in approximately 79,750 gallons. Most likely, the actual volume of PSH is between these two values.

6.0 CONCLUSIONS

A compilation of all available information from the TWFF and surrounding sites was made in order to develop a reasonable groundwater flow model for this site. Geologic and hydrogeologic information, as well as site-specific climatological information was incorporated into the conceptual model for groundwater flow.

MODFLOW-SURFACT was the computer program used to simulate steady-state groundwater movement. The results of the model are in agreement with the average of the actual measured groundwater elevations at the site with an overall RMS error of 0.94 foot.

MODPATH was used to simulate water particle movement toward the Ensenada Honda from two areas of concern. Results show that water from the area near the 470 series wells will reach the Honda in approximately 4 to 32 years. From 7MW07 water will flow toward the Honda and reach it in approximately 5 to 6 years. These results do not reflect actual contaminant transport times. A contaminant transport analysis was not done during this modeling effort, but may be done in a future effort.

Because a pumping scenario was not retained in the CMS Task 1 Report, the movement of the PSH on the water table was not modeled. Current PSH volumes were calculated using average PSH thickness information from February 2001 through April 2002. The volume of PSH at TWFF obtained without any empirical adjustments to the apparent PSH thickness in a well was 362,000 gallons. When empirical adjustments are made to the apparent PSH thickness in a well (done because the PSH depresses the water table, causing it to appear to be thicker than it actually is in formation), the volume of PSH is reduced to 79,700 gallons. It is expected that the actual volume is somewhere in between these two results.

7.0 REFERENCES

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TABLES

TABLE 2-1

AVERAGE GROUNDWATER ELEVATIONS AND STATISTICS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Well	Layer	Average Groundwater Elevation (ft msl)	Standard Deviation	Min	Max	Difference	
7MW06	1	0.54	0.66	-1.37	1.90	3.27	
UGW-10	1	1.19	0.70	-0.23	4.05	4.28	
UGW-11	1	0.79	0.46	-0.33	2.49	2.82	
UGW-20R	1	0.52	1.29	-2.80	2.80	5.60	Max
7MW-10	1	0.73	Statistics not meaningful				
7MW-12	1	0.33					
7MW-13	1	1.9					
7MW-14	1	1.15					
7MW05	2	2.12	1.04	1.18	5.62	4.44	
7MW09	2	5.59	3.43	-2.76	17.54	20.30	Max
GW-02	2	3.17	1.06	1.71	6.97	5.26	
GW-03	2	3.14	1.13	1.60	6.18	4.58	
GW-04	2	4.07	0.90	1.73	5.73	4.00	
GW-06	2	2.04	0.54	1.23	3.50	2.27	
MW-1	2	5.52	1.56	3.64	12.14	8.50	
MW-2	2	5.18	1.59	3.01	10.61	7.60	
MW-3	2	7.33	4.18	2.02	17.54	15.52	
MW-4	2	7.34	2.82	3.56	13.53	9.97	
PW-1	2	5.89	2.14	2.73	15.38	12.65	
PW-2	2	4.81	1.52	3.07	10.25	7.18	
PW-3	2	5.59	2.92	1.34	16.24	14.90	
PW-4	2	5.84	4.24	2.66	15.65	12.99	
PW-5	2	4.81	2.27	1.25	14.17	12.91	
PW-6	2	6.86	3.05	2.45	17.69	15.24	
RW-1	2	5.67	3.78	2.49	20.55	18.06	
RW-2	2	6.95	3.56	3.11	17.01	13.90	
RW-4	2	4.44	2.23	1.01	10.97	9.97	
RW-5	2	2.18	1.60	-3.07	8.87	11.94	
RW-7	2	2.25	1.68	0.63	8.59	7.97	
RW-8	2	1.60	1.06	-0.10	4.97	5.07	
UGW-1	2	4.87	2.19	2.11	11.71	9.60	
UGW-12	2	3.38	1.33	1.64	8.00	6.36	
UGW-13	2	2.15	1.16	0.72	7.38	6.67	
UGW-15	2	1.27	0.82	0.48	4.42	3.94	
UGW-16	2	2.06	0.82	0.87	3.78	2.91	
UGW-17	2	2.16	1.30	0.65	7.49	6.84	
UGW-18	2	2.72	1.22	1.11	4.69	3.58	
UGW-19	2	2.03	1.43	0.35	8.20	7.85	
UGW-20	2	0.49	0.20	0.17	0.87	0.70	
UGW-22	2	4.87	2.00	2.13	8.96	6.83	
UGW-5	2	4.55	1.53	2.49	10.06	7.58	
UGW-6	2	1.96	0.72	0.60	4.60	4.00	
UGW-7	2	2.31	0.81	0.94	4.04	3.10	
UGW-8	2	2.30	0.99	0.49	5.34	4.85	
UGW-9	2	3.07	2.11	-0.25	9.45	9.70	
UGW-27	2	3.485	0.13	3.39	3.58	0.19	
7MW-11	2	2.43	Statistics not meaningful				
7MW-15	2	5.713					
7MW-16	2	12.92					
7MW-20	2	1.65					

TABLE 2-1

AVERAGE GROUNDWATER ELEVATIONS AND STATISTICS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Well	Layer	Average Groundwater Elevation (ft msl)	Standard Deviation	Min	Max	Difference	
7MW01A	3	2.84	1.61	-1.29	8.01	9.30	
7MW02A	3	5.31	2.71	2.22	16.51	14.29	
7MW03	3	6.84	2.58	3.87	13.84	9.97	
7MW04	3	5.28	2.29	2.22	10.20	7.98	
7MW07	3	1.85	1.27	0.28	8.20	7.92	
7MW08	3	1.65	1.96	0.28	11.33	11.05	
RW-6	3	2.49	2.01	0.26	7.87	7.61	
UGW-14	3	4.61	2.11	2.55	11.99	9.44	
UGW-2	3	7.46	2.82	4.12	15.73	11.61	
UGW-21	3	1.86	1.39	0.37	7.02	6.65	
UGW-23	3	6.16	3.70	3.18	21.18	18.00	Max
UGW-24	3	5.22	2.00	2.44	10.63	8.19	
UGW-25	3	4.72	1.62	2.31	9.96	7.66	
UGW-26	3	2.68	0.99	0.74	5.09	4.35	
UGW-3	3	5.00	2.39	-0.58	11.71	12.29	
UGW-4	3	4.65	2.16	1.56	12.64	11.08	
470-MW1	3	4.37	1.95	1.44	11.28	9.84	
470-MW3	3	3.18	1.46	-0.25	7.85	8.10	
UGW-28	3	3.22	0.07	3.17	3.27	0.10	
UGW-31	3	3.405	0.02	3.39	3.42	0.03	
UGW-32	3	5.705	0.35	5.46	5.95	0.49	
UGW-33	3	4.48	Statistics not meaningful				
UGW-34	3	4.41					
7MW-17	3	4.51					
7MW-18	3	4.59					
7MW-19	3	4.38					

TABLE 4-1
SUMMARY OF MODEL ERRORS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Well Name	Layer	Observed	Computed	Residual
7MW06	1	0.54	1.78	1.24
UGW-11	1	0.79	1.26	0.47
UGW-20R	1	0.52	dry	dry
7MW-10	1	0.73	2.40	1.67
7MW-12	1	0.33	0.08	-0.25
7MW-13	1	1.90	dry	dry
7MW-14	1	1.15	0.72	-0.43
Mean error	**1**	**0.54**		
Mean absolute error	**1**	**0.81**		
Root mean square error	**1**	**0.98**		

note: all values are feet above mean sea level

TABLE 4-1
SUMMARY OF MODEL ERRORS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Well Name	Layer	Observed	Computed	Residual
7MW06	2	0.54	1.78	1.24
UGW-10	2	1.19	0.87	-0.32
7MW-14	2	1.15	0.72	-0.43
UGW-20	2	0.49	0.92	0.43
7MW05	2	2.12	dry	dry
GW-02	2	3.17	3.71	0.54
GW-03	2	3.14	5.47	2.33
GW-04	2	4.07	3.49	-0.58
GW-06	2	2.04	1.47	-0.57
MW-1	2	5.52	dry	dry
MW-2	2	5.18	4.57	-0.61
MW-3	2	7.33	5.14	-2.19
MW-4	2	7.34	5.06	-2.28
PW-1	2	5.89	dry	dry
PW-2	2	4.81	dry	dry
PW-3	2	5.59	5.13	-0.46
PW-4	2	5.84	5.00	-0.84
PW-5	2	4.81	5.11	0.30
PW-6	2	6.86	5.15	-1.71
RW-1	2	5.67	dry	dry
RW-2	2	6.95	dry	dry
RW-4	2	4.44	3.69	-0.75
RW-5	2	2.18	3.22	1.04
RW-7	2	2.25	3.13	0.88
RW-8	2	1.60	dry	dry
UGW-1	2	4.87	5.09	0.22
UGW-12	2	3.38	3.81	0.43
UGW-13	2	2.15	3.31	1.16
UGW-15	2	1.27	1.96	0.69
UGW-16	2	2.06	dry	dry
UGW-17	2	2.16	3.19	1.03
UGW-18	2	2.72	2.89	0.17
UGW-19	2	2.03	3.16	1.13
UGW-22	2	4.87	dry	dry
UGW-5	2	4.55	dry	dry
UGW-6	2	1.96	2.83	0.87
UGW-7	2	2.31	2.04	-0.27
UGW-8	2	2.30	2.08	-0.22
UGW-9	2	3.07	2.33	-0.74
1995-MW2	2	3.43	4.08	0.65
1995-MW3	2	2.83	3.51	0.68
1995-MW5	2	3.17	2.94	-0.23
UGW-27	2	3.49	5.04	1.55
7MW-11	2	2.43	1.49	-0.94
7MW-15	2	5.71	5.49	-0.22
7MW-20	2	1.65	3.08	1.43
Mean error	**2**	**0.09**		
Mean absolute error	**2**	**0.84**		
Root mean square error	**2**	**1.02**		

note: all values are feet above mean sea level

TABLE 4-1
SUMMARY OF MODEL ERRORS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

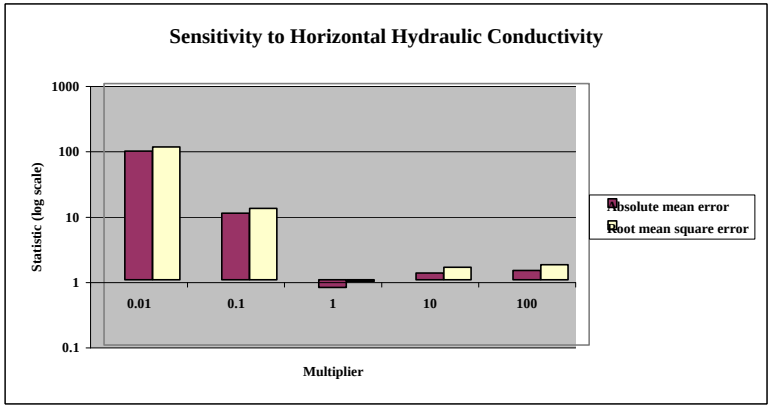
Well Name	Layer	Observed	Computed	Residual
7MW09	3	5.59	5.30	-0.29
1995-MW5	3	3.17	2.94	-0.23
7MW-11	3	2.43	1.49	-0.94
7MW07	3	1.85	2.68	0.83
UGW-3	3	5.00	5.19	0.19
UGW-4	3	4.65	4.46	-0.19
470-MW3	3	3.18	3.99	0.81
UGW-28	3	3.22	5.01	1.79
UGW-31	3	3.41	4.93	1.52
UGW-32	3	5.71	5.21	-0.50
UGW-33	3	4.48	4.83	0.35
UGW-34	3	4.41	5.44	1.03
7MW-17	3	4.51	5.51	1.00
7MW-18	3	4.59	5.26	0.67
7MW-19	3	4.38	5.22	0.84
7MW01A	3	2.84	4.24	1.40
7MW02A	3	5.31	5.10	-0.21
7MW03	3	6.84	6.72	-0.12
7MW04	3	5.28	5.48	0.20
7MW08	3	1.65	2.93	1.28
RW-6	3	2.49	3.07	0.58
UGW-14	3	4.61	4.88	0.27
UGW-2	3	7.46	7.21	-0.25
UGW-21	3	1.86	3.00	1.14
UGW-23	3	6.16	4.88	-1.28
UGW-24	3	5.22	5.56	0.34
UGW-25	3	4.72	5.10	0.38
UGW-26	3	2.68	2.75	0.07
1995-MW1	3	3.80	4.32	0.52
470-MW1	3	4.37	4.47	0.10
Mean error	**3**	**0.38**		
Mean absolute error	**3**	**0.64**		
Root mean square error	**3**	**0.80**		

Mean error	**all**	**0.27**
Mean absolute error	**all**	**0.76**
Root mean square error	**all**	**0.94**

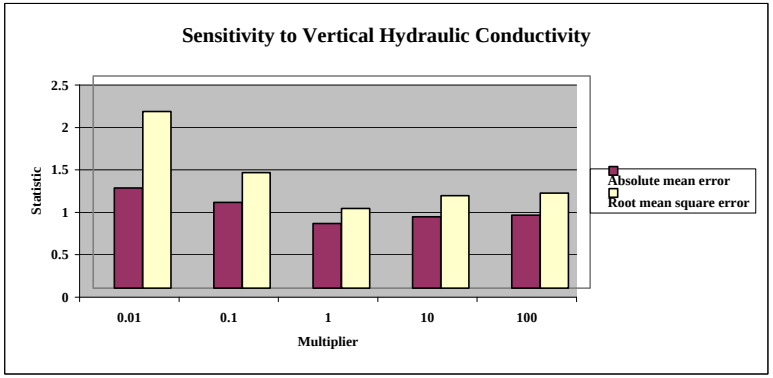
note: all values are feet above mean sea level

TABLE 4-2
SENSITIVITY ANALYSIS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

		STATISTICS		
Parameter	**Multiplier**	**Mean error**	**Absolute mean error**	**Root mean square error**
Kh	0.01	92.88	92.88	107.36
Kh	0.1	10.42	10.42	12.29
Kh	1	0.27	0.76	0.94
Kh	10	-0.94	1.26	1.55
Kh	100	-1.07	1.39	1.7



		STATISTICS		
Parameter	**Multiplier**	**Mean error**	**Absolute mean error**	**Root mean square error**
Kv	0.01	0.88	1.18	2.08
Kv	0.1	0.71	1.01	1.36
Kv	1	0.27	0.76	0.94
Kv	10	0.05	0.84	1.09
Kv	100	0.01	0.86	1.12



		STATISTICS		
Parameter	**Multiplier**	**Mean error**	**Absolute mean error**	**Root mean square error**
Recharge	0.25	-0.74	1.13	1.49
Recharge	0.5	-0.46	0.97	1.25
Recharge	1	0.27	0.76	0.94
Recharge	1.25	0.64	0.9	1.06
Recharge	1.5	1.03	1.16	1.37
Recharge	2	nm	nm	nm

Kh= horizontal hydraulic conductivity
Kv= vertical hydraulic conductivity
nm= not meaningful, approaches infinity
final model statistics
all statistics are in feet above mean sea level

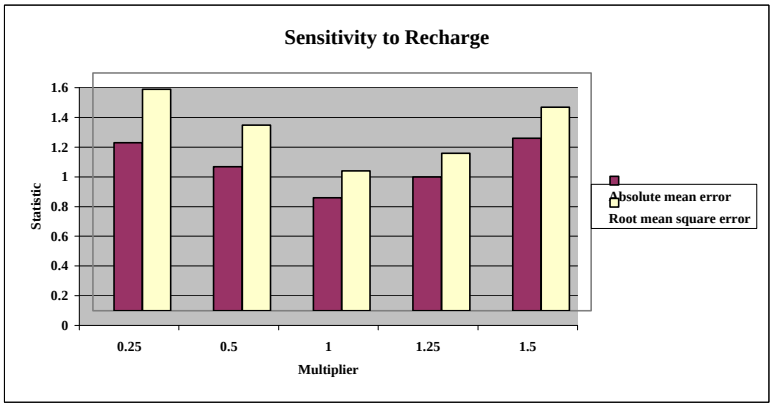


TABLE 5-1

SUMMARY OF PSH INFORMATION - FEBRUARY 2001 - APRIL 2002
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Well	Average Thickness (ft)	Total gallons recovered
RW-01	1.34	7.15
RW-02	0.03	nm
RW-05	1.84	14.63
RW-08	0.03	0.16
TrenchRW	0.00	0.01
TrenchMW	0.00	0.01
UGW-1	0.77	1.35
UGW-2	0.23	0.22
UGW-3	0.24	0.54
UGW4	0.01	0.01
UGW5	0.00	0.01
UGW8	0.06	nm
UGW-12	2.43	4.32
UGW-13	4.88	8.75
UGW-17	0.98	1.60
UGW-19	0.50	0.89
UGW-21	1.13	1.94
UGW-25	1.70	7.82
PW-2	0.18	1.30
PW-3	0.25	0.44
PW-5	0.28	1.87
PW-6	0.51	3.29
MW-1	0.16	0.38
MW-3	0.14	1.04
MW-4	0.23	0.56
7MW08	0.91	1.82
7MW15	0.11	nm
470-MW1	0.12	0.14
MTMW1	3.66	6.90
MTMW2	4.98	9.10
MTMW3	2.16	3.83
MTMW4	4.94	9.07
AW1	2.34	3.84
AW2	3.32	5.48

nm = not measurable

TABLE 5-2

PSH VOLUME CALCULATIONS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Polygon	Area (sq ft)	Average Actual Thickness (ft)	Total Volume (cu ft)	Volume of Product (cu ft) Porosity = 0.3		Empirically Adjusted Thickness (ft) (1)	Total Adjusted Volume (cu ft)	Adjusted Volume of Product (cu ft)	
1	736.73	4.5	3,315.29	994.59		0.99	729.36	218.81	
2	811.53	4.25	3,449.00	1,034.70		0.935	758.78	227.63	
3	1,052.15	3.75	3,945.56	1,183.67		0.825	868.02	260.41	
4	1,933.24	3	5,799.72	1,739.92		0.66	1,275.94	382.78	
5	7,799.19	2.25	17,548.18	5,264.45		0.495	3,860.60	1,158.18	
6	12,588.96	1.75	22,030.68	6,609.20		0.385	4,846.75	1,454.02	
7	22,788.36	1.25	28,485.45	8,545.64		0.275	6,266.80	1,880.04	
8	32,729.68	0.75	24,547.26	7,364.18		0.165	5,400.40	1,620.12	
9	90,383.81	0.25	22,595.95	6,778.79		0.055	4,971.11	1,491.33	
3a	76.30	3.75	286.13	85.84		0.825	62.95	18.88	
8a	141.21	0.75	105.91	31.77		0.165	23.30	6.99	
			Subtotal	**39,632.74**	**296,294.34 gallons**		**Subtotal**	**8,719.20**	**65,184.75 gallons**
10	12,440.36	0.25	3,110.09	933.03		0.055	684.22	205.27	
11	28,483.64	0.25	7,120.91	2,136.27		0.055	1,566.60	469.98	
12	3,145.66	0.25	786.42	235.92		0.055	173.01	51.90	
			Subtotal	**3,305.22**	**24,709.86 gallons**		**Subtotal**	**727.15**	**5,436.17 gallons**
13	36.12	0.75	27.09	8.13		0.165	5.96	1.79	
14	4,321.24	0.25	1,080.31	324.09		0.055	237.67	71.30	
			Subtotal	**332.22**	**2,483.68 gallons**		**Subtotal**	**73.09**	**546.41 gallons**
15	133.69	2.25	300.80	90.24		0.495	66.18	19.85	
16	224.45	1.75	392.79	117.84		0.385	86.41	25.92	
17	334.59	1.25	418.24	125.47		0.275	92.01	27.60	
18	511.77	0.75	383.83	115.15		0.165	84.44	25.33	
			Subtotal	**448.70**	**3,354.46 gallons**		**Subtotal**	**98.71**	**737.98 gallons**

(1) method of de Pastrovich, density of water = 1.0 g/ml, density of PSH = 0.82 g/ml

TABLE 5-2

PSH VOLUME CALCULATIONS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

Polygon	Area (sq ft)	Average Actual Thickness (ft)	Total Volume (cu ft)	Volume of Product (cu ft) Porosity = 0.3		Empirically Adjusted Thickness (ft) (1)	Total Adjusted Volume (cu ft)	Adjusted Volume of Product (cu ft)	
19	93.76	4.5	421.92	126.58		0.99	92.82	27.85	
20	134.13	4.25	570.05	171.02		0.935	125.41	37.62	
21	192.23	3.75	720.86	216.26		0.825	158.59	47.58	
22	252.29	3.25	819.94	245.98		0.715	180.39	54.12	
23	773.65	2.5	1,934.13	580.24		0.55	425.51	127.65	
24	1,252.41	1.75	2,191.72	657.52		0.385	482.18	144.65	
25	2,260.81	1.25	2,826.01	847.80		0.275	621.72	186.52	
			Subtotal	**2,331.54**	**17,430.59 gallons**		**Subtotal**	**512.94**	**3,834.73 gallons**
26	50.83	1.25	63.54	19.06		0.275	13.98	4.19	
27	25.61	1.25	32.01	9.60		0.275	7.04	2.11	
			Subtotal	**28.67**	**214.30 gallons**		**Subtotal**	**6.31**	**47.15 gallons**
28	4,214.80	0.75	3,161.10	948.33		0.165	695.44	208.63	
29	1,937.37	0.75	1,453.03	435.91		0.165	319.67	95.90	
30	12,221.61	0.25	3,055.40	916.62		0.055	672.19	201.66	
			Subtotal	**2,300.86**	**17,201.22 gallons**		**Subtotal**	**506.19**	**3,784.27 gallons**
31	186.1	0.75	139.58	41.87		0.165	30.71	9.21	
32	855.7	0.25	213.93	64.18		0.055	47.06	14.12	
			Subtotal	**106.05**	**792.83 gallons**		**Subtotal**	**23.33**	**174.42 gallons**
				TOTAL:	**362,481.27 gallons**		**ADJUSTED**	**TOTAL:**	**79,745.88 gallons**

(1) method of de Pastrovich, density of water = 1.0 g/ml, density of PSH = 0.82 g/ml

FIGURES

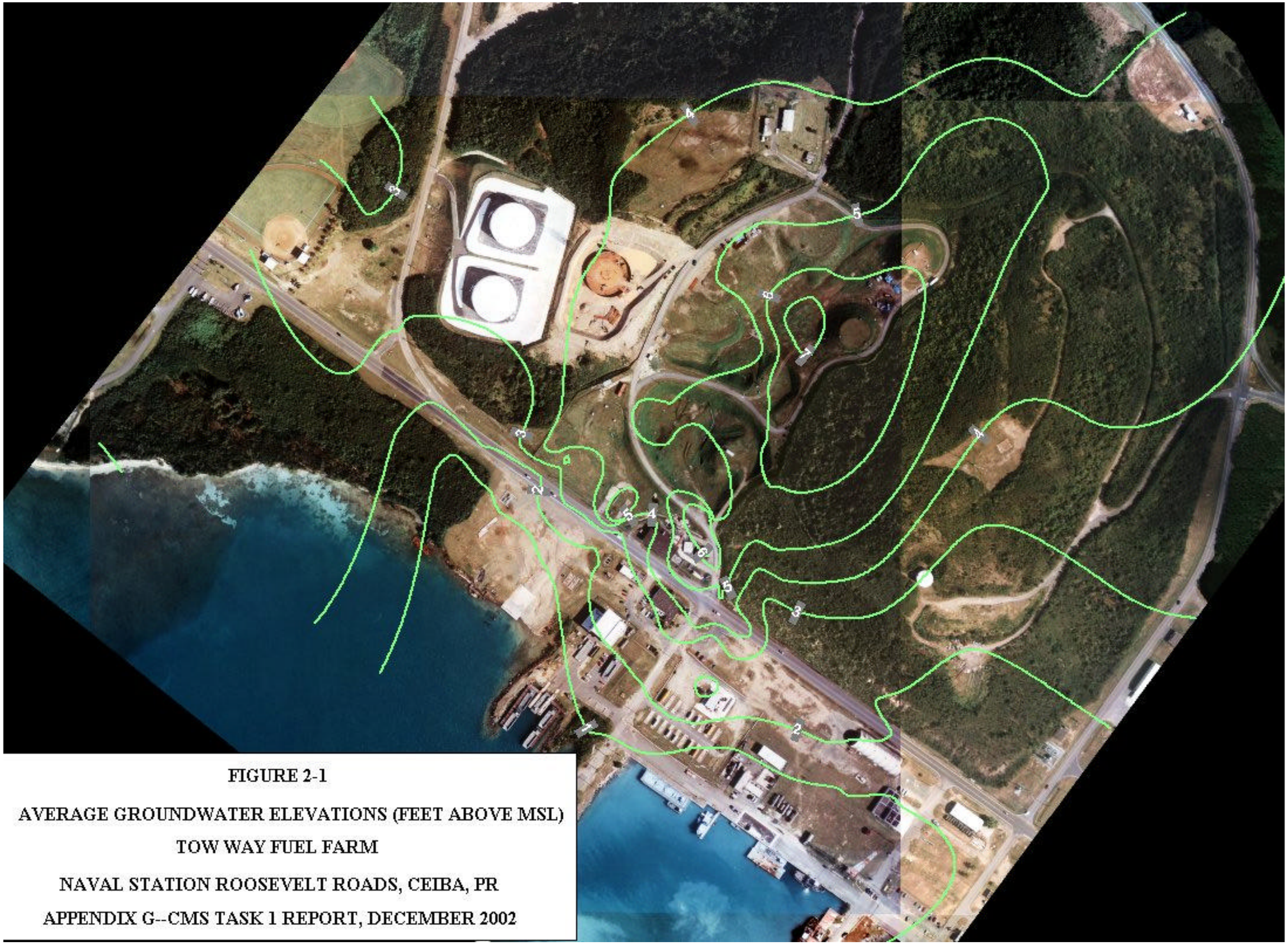


FIGURE 2-1

AVERAGE GROUNDWATER ELEVATIONS (FEET ABOVE MSL)

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

FIGURE 3-1

MODEL DOMAIN

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

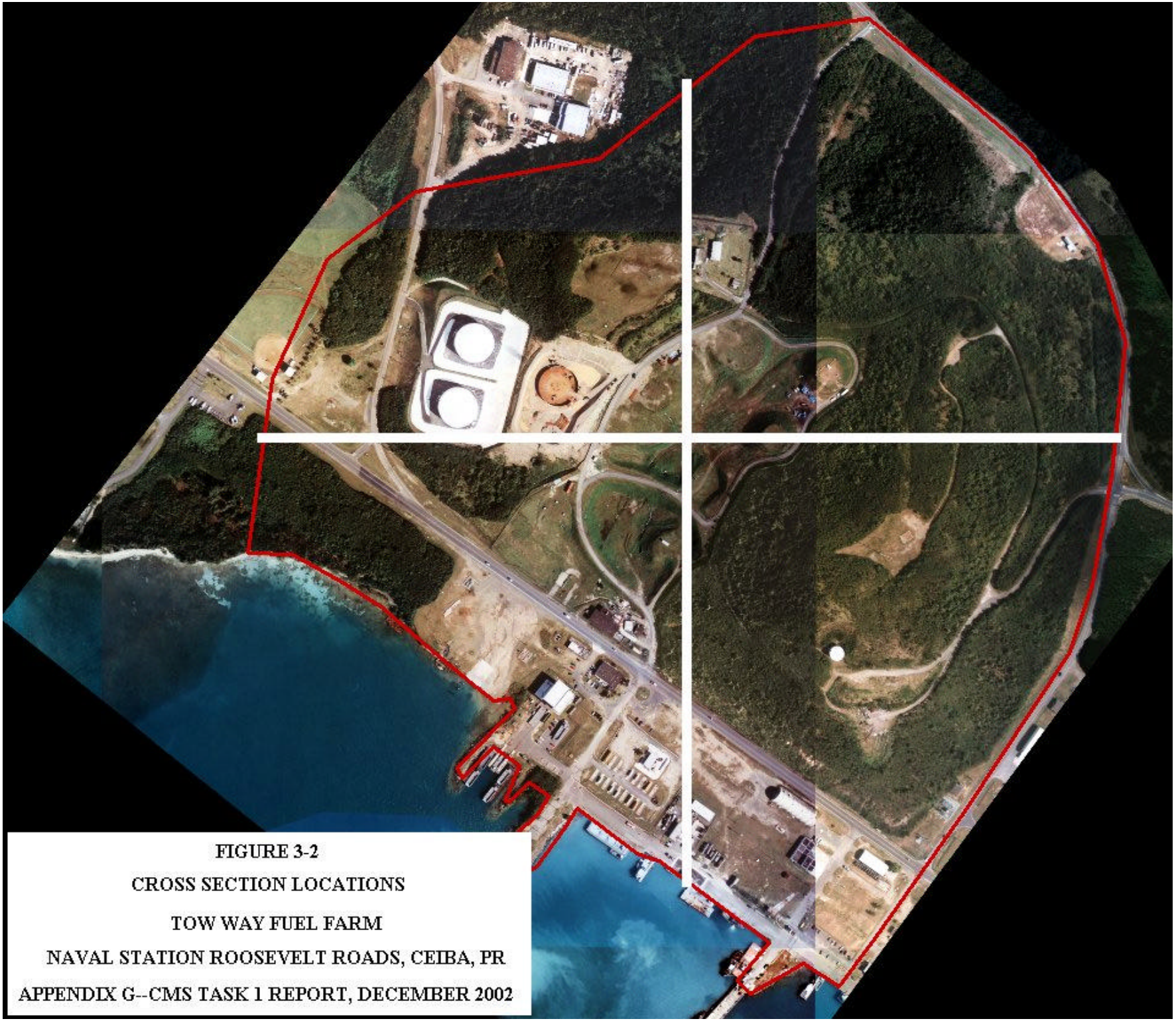


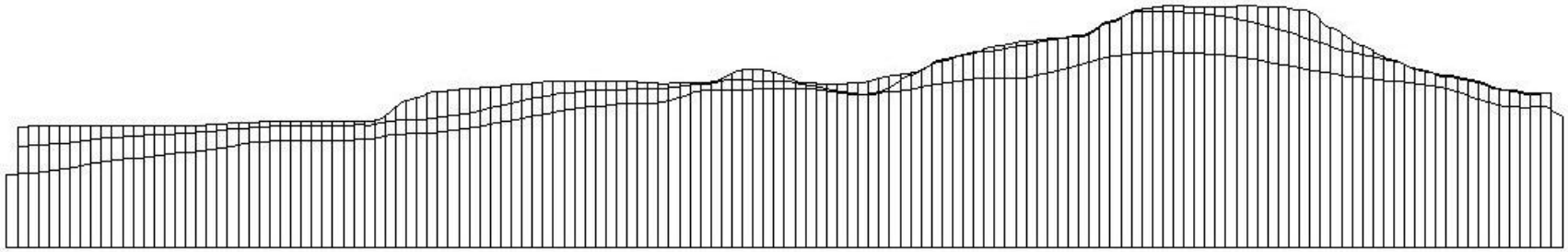
FIGURE 3-2

CROSS SECTION LOCATIONS

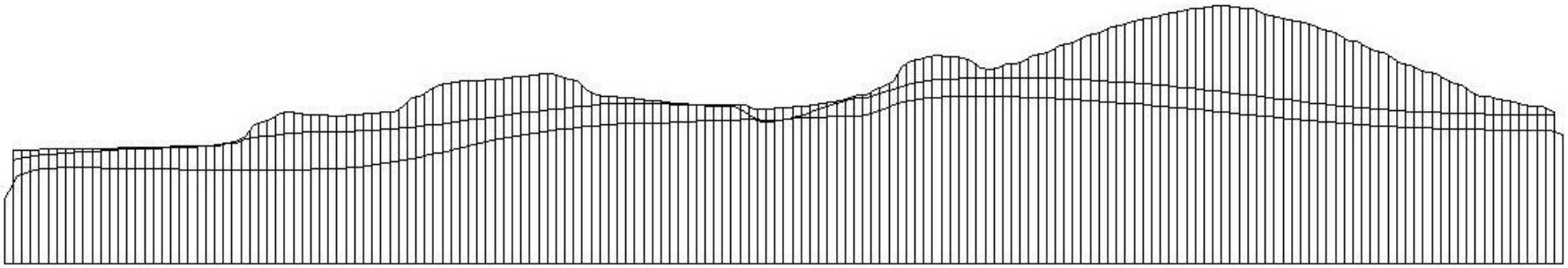
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002



TOW WAY FUEL FARM--SOUTH-NORTH CROSS SECTION



TOW WAY FUEL FARM--WEST-EAST CROSS SECTION

FIGURE 3-3
CROSS-SECTIONS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

FIGURE 3-4

RECHARGE AREAS USED IN MODEL

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

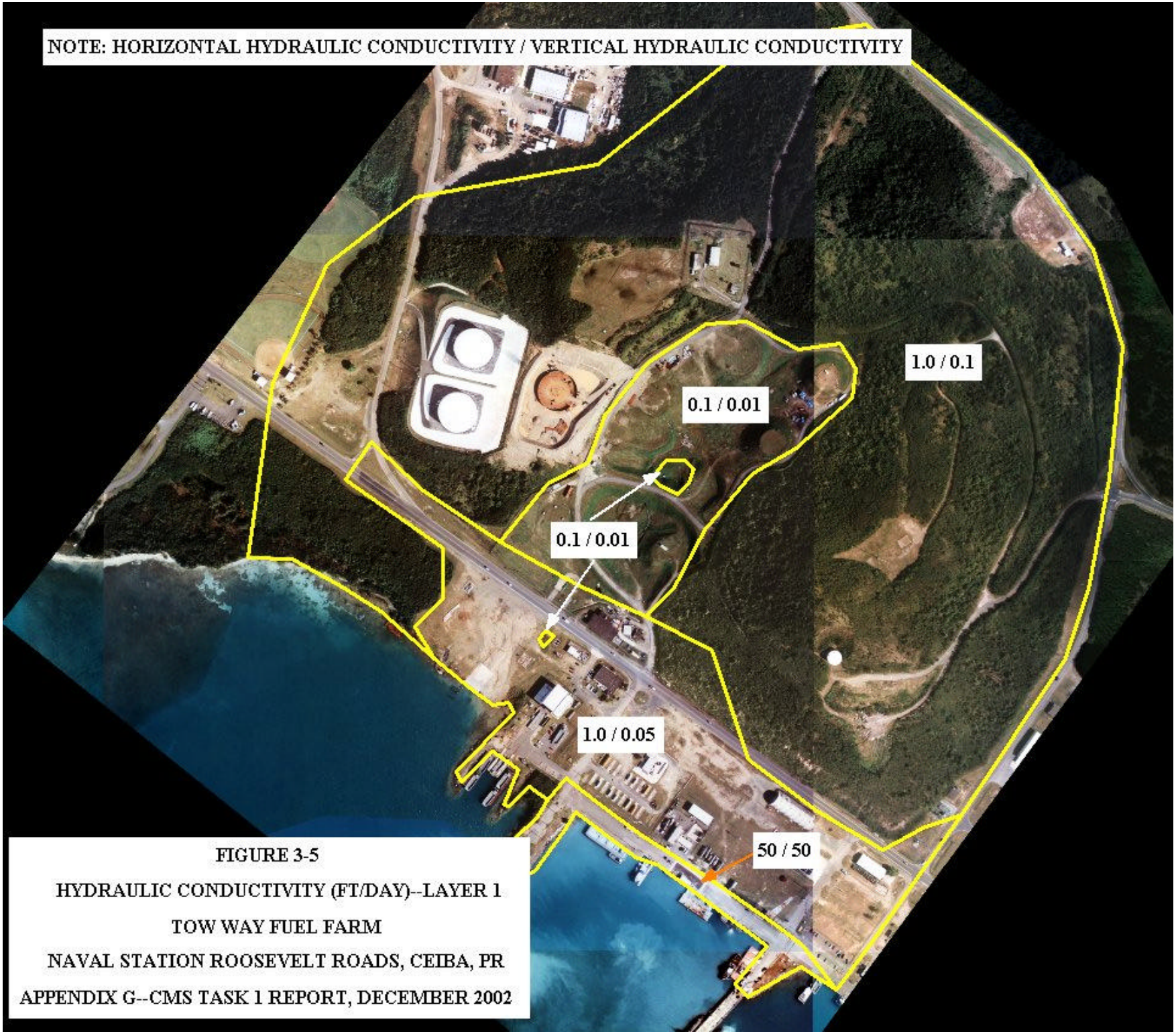


FIGURE 3-5

HYDRAULIC CONDUCTIVITY (FT/DAY)--LAYER 1

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

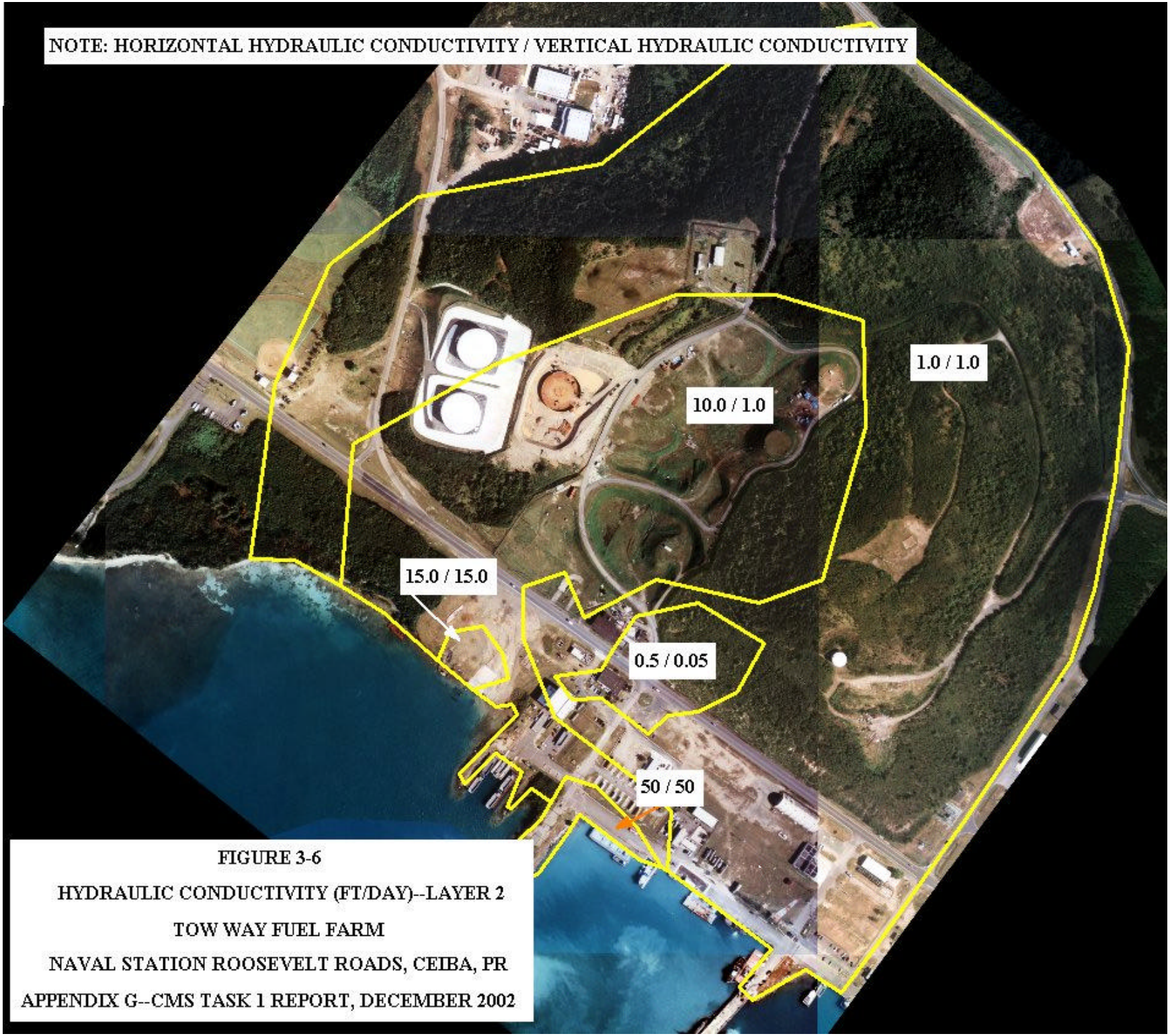


FIGURE 3-6

HYDRAULIC CONDUCTIVITY (FT/DAY)--LAYER 2

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

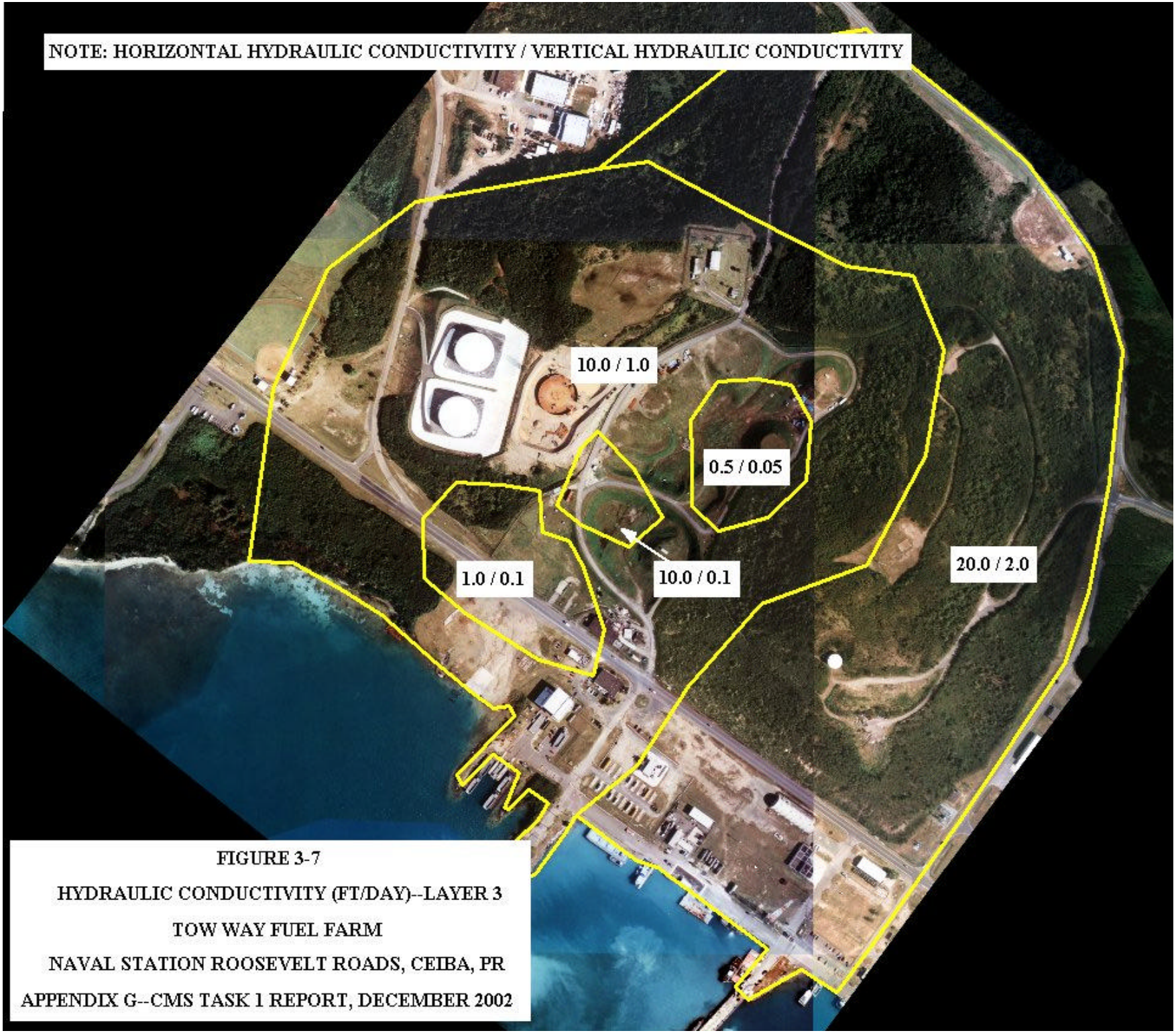


FIGURE 3-7

HYDRAULIC CONDUCTIVITY (FT/DAY)--LAYER 3

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

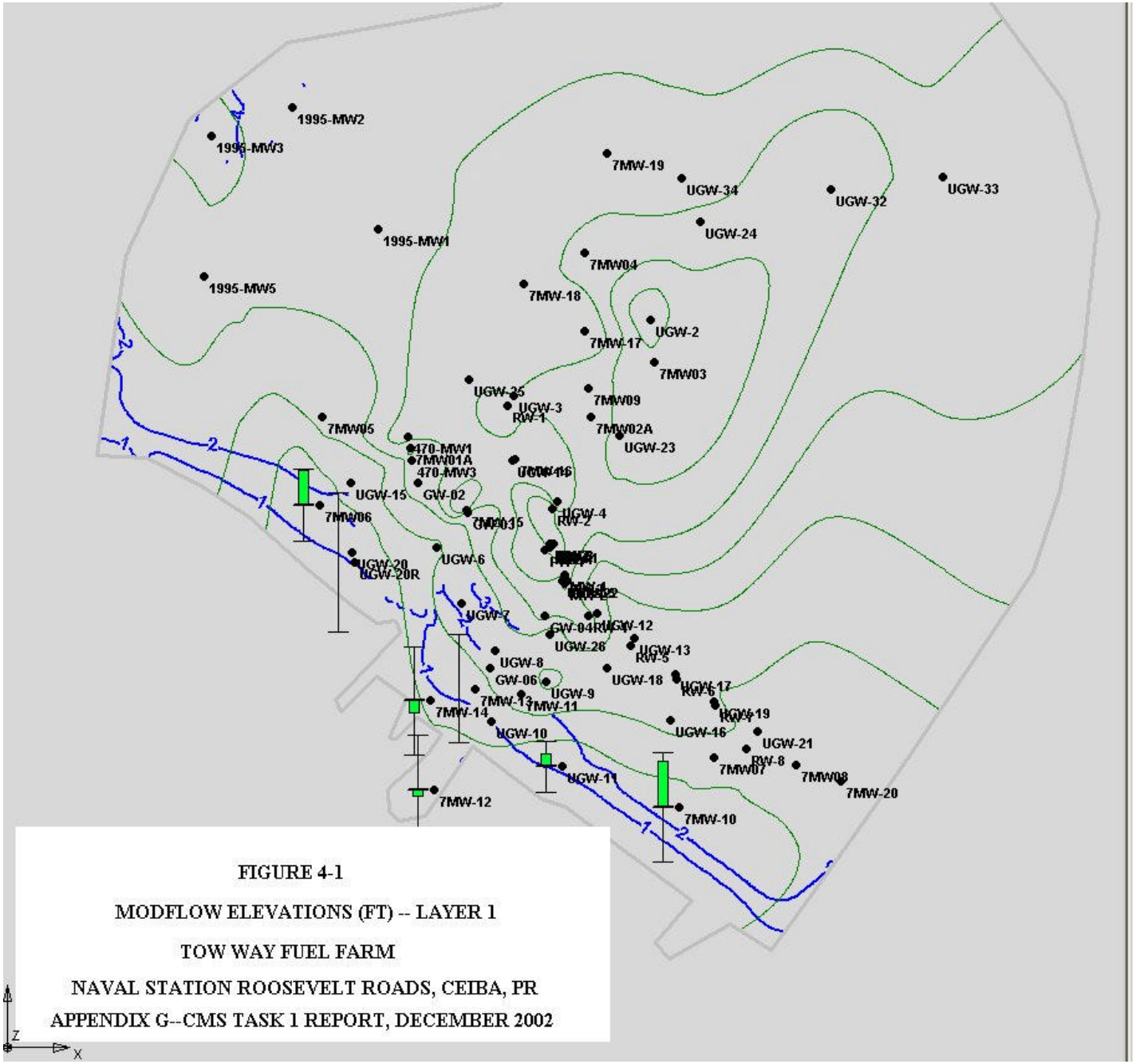


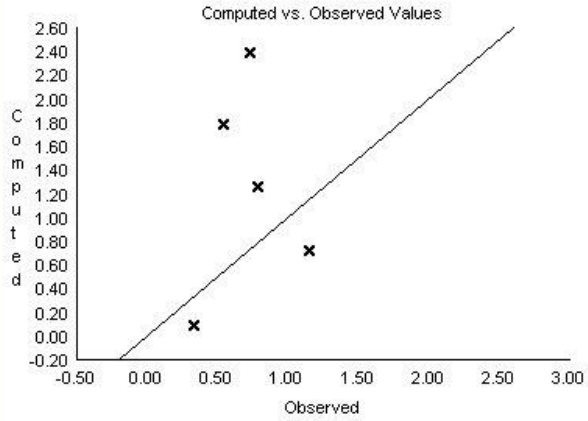
FIGURE 4-1

MODFLOW ELEVATIONS (FT) -- LAYER 1

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002



Error Summary

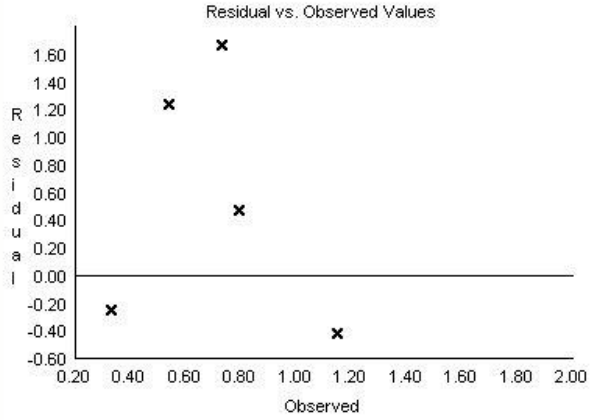
Solution / Data set: 258 / 258_Heads

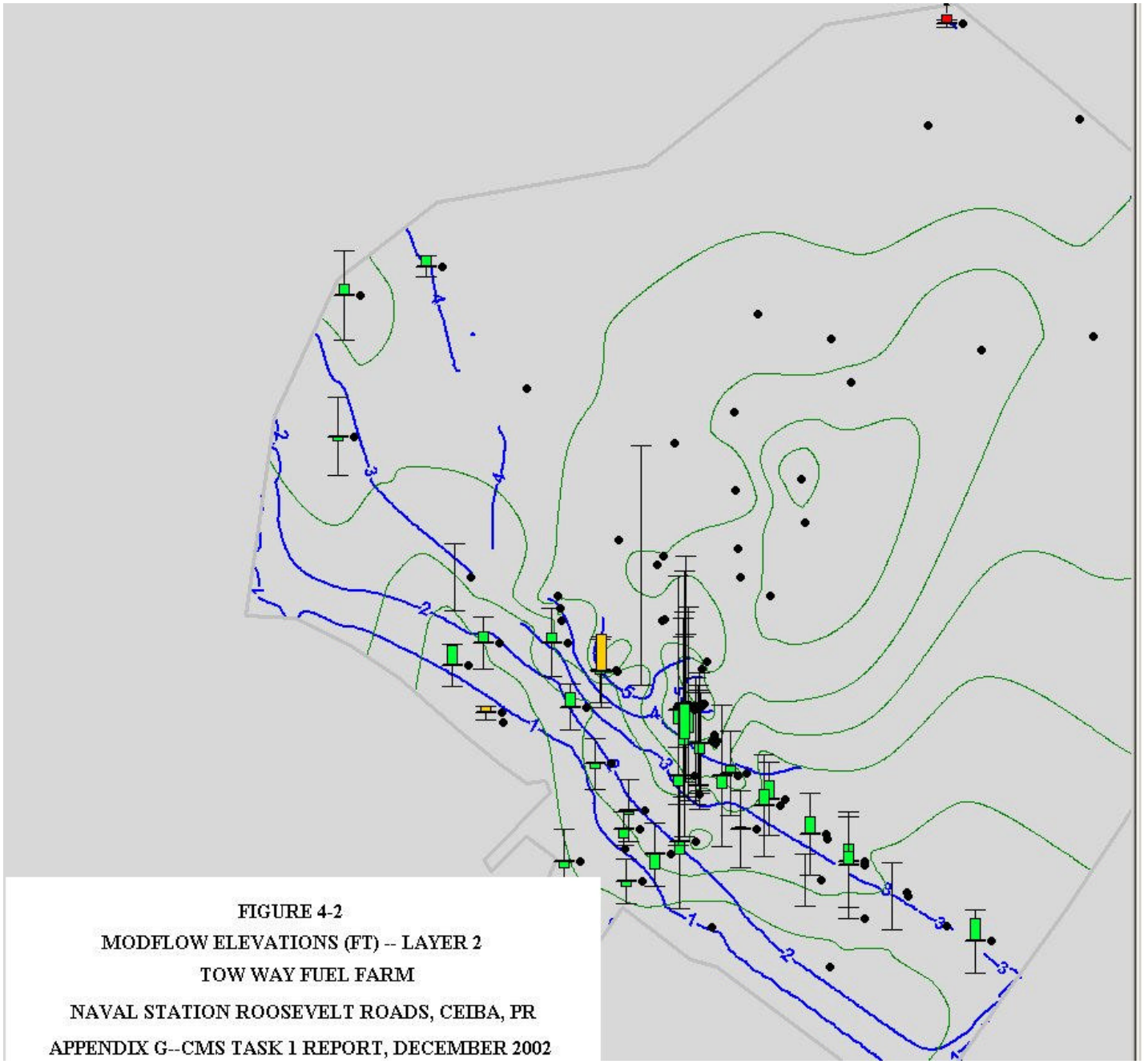
Observed measurement: head

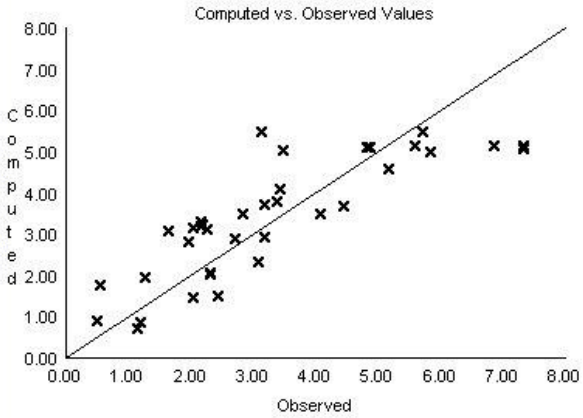
Mean error: 0.54

Mean abs. error: 0.81

Root mean sq. error: 0.98







Error Summary

Solution / Data set: 258 / 258_Heads

Observed measurement: head

Mean error: 0.09

Mean abs. error: 0.84

Root mean sq. error: 1.02

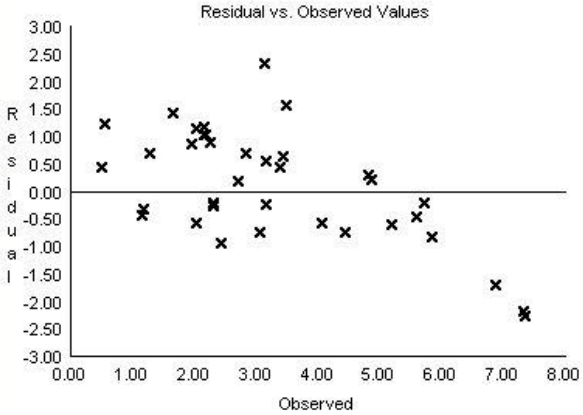


FIGURE 4-2
MODFLOW ELEVATIONS (FT) -- LAYER 2
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

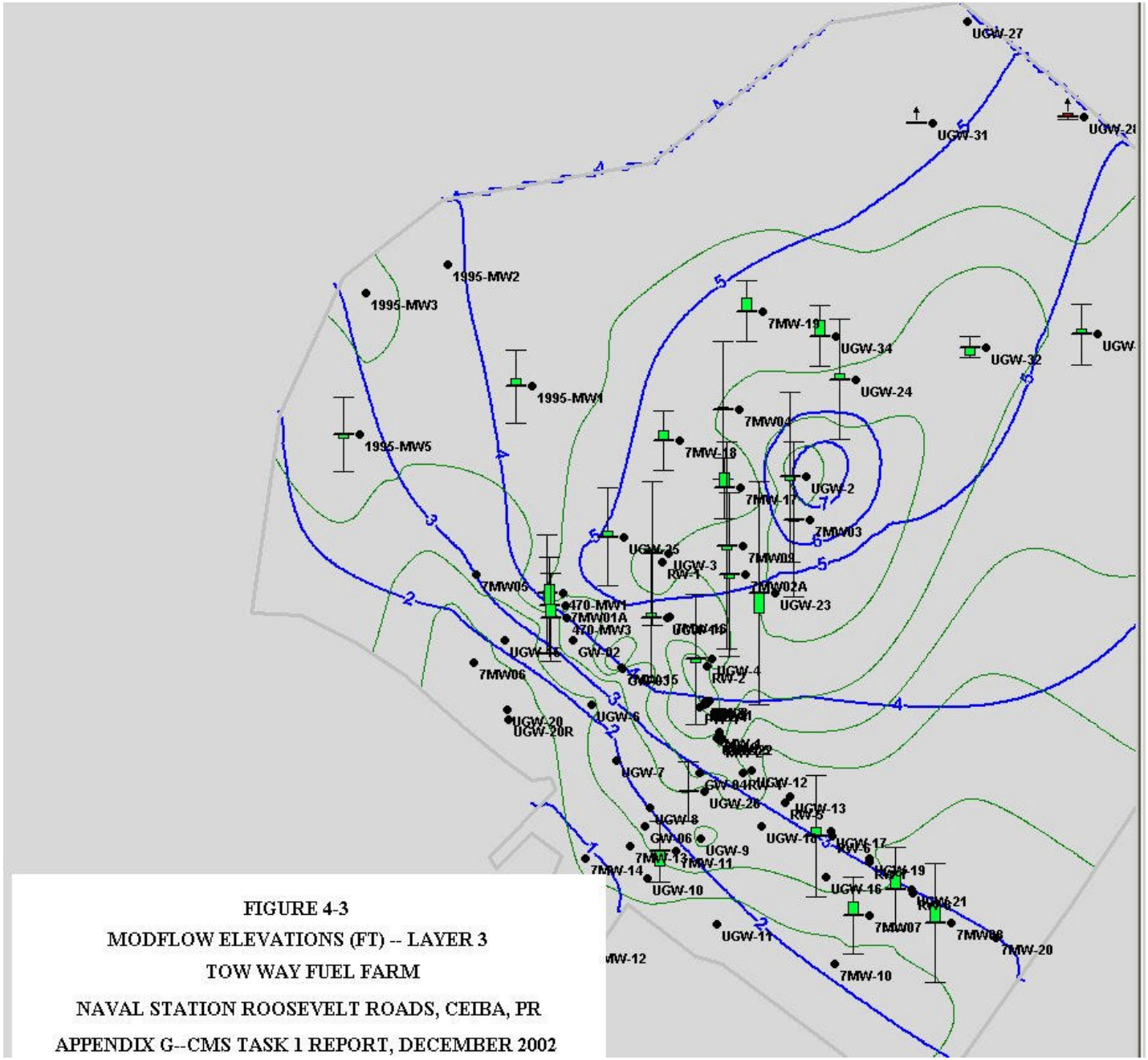
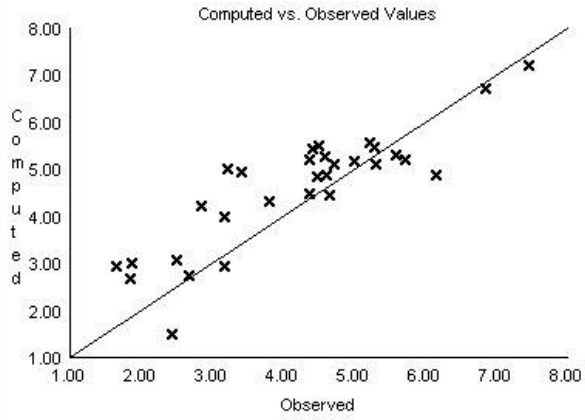


FIGURE 4-3
MODFLOW ELEVATIONS (FT) -- LAYER 3
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002



Error Summary

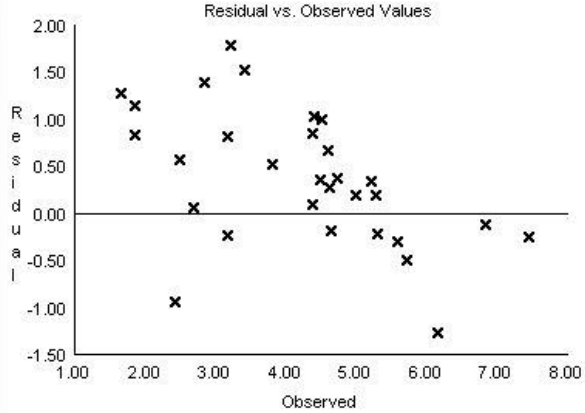
Solution / Data set: 258 / 258_Heads

Observed measurement: head

Mean error: 0.38

Mean abs. error: 0.64

Root mean sq. error: 0.80



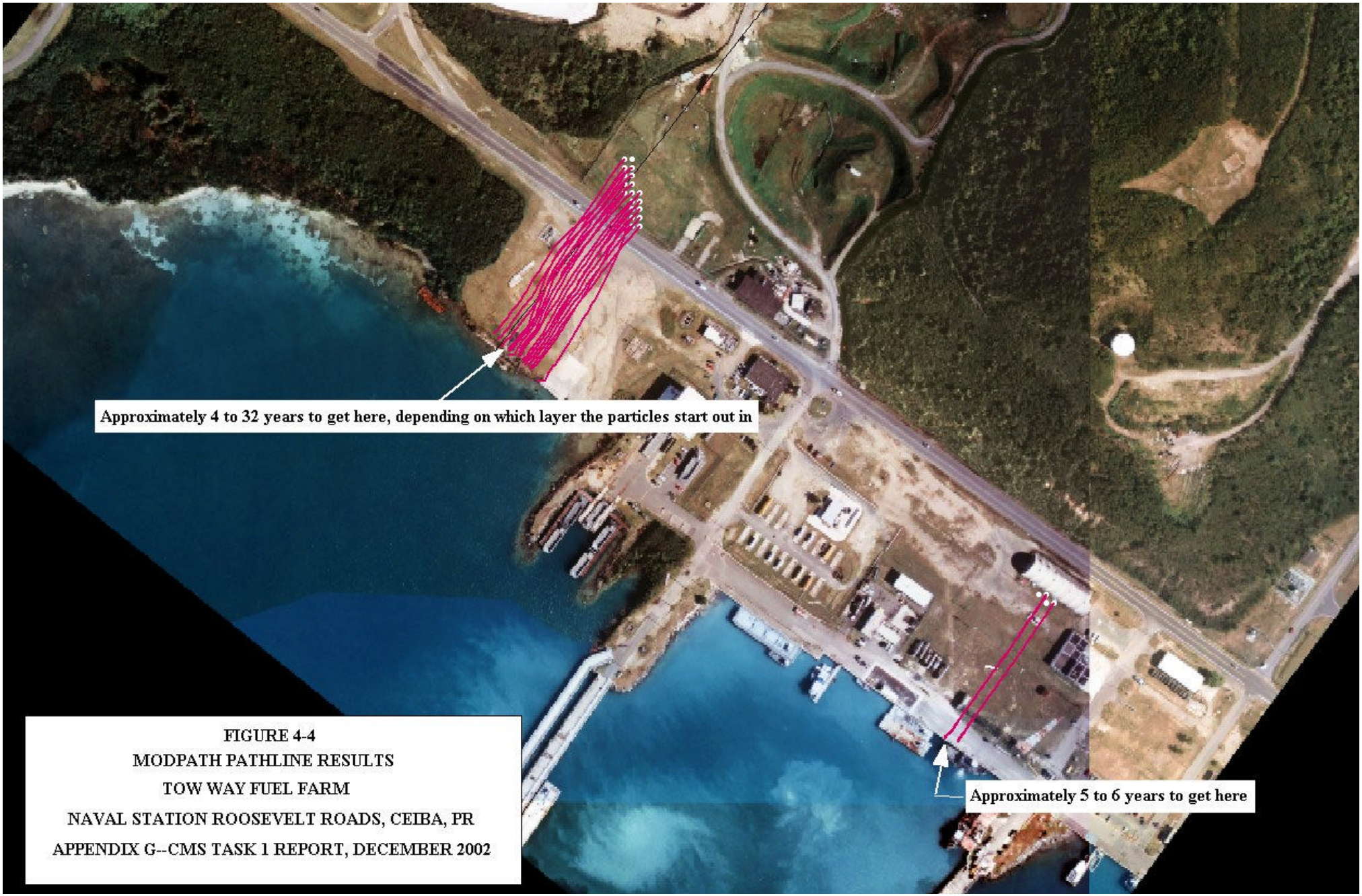


FIGURE 4-4
MODPATH PATHLINE RESULTS
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PR
APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

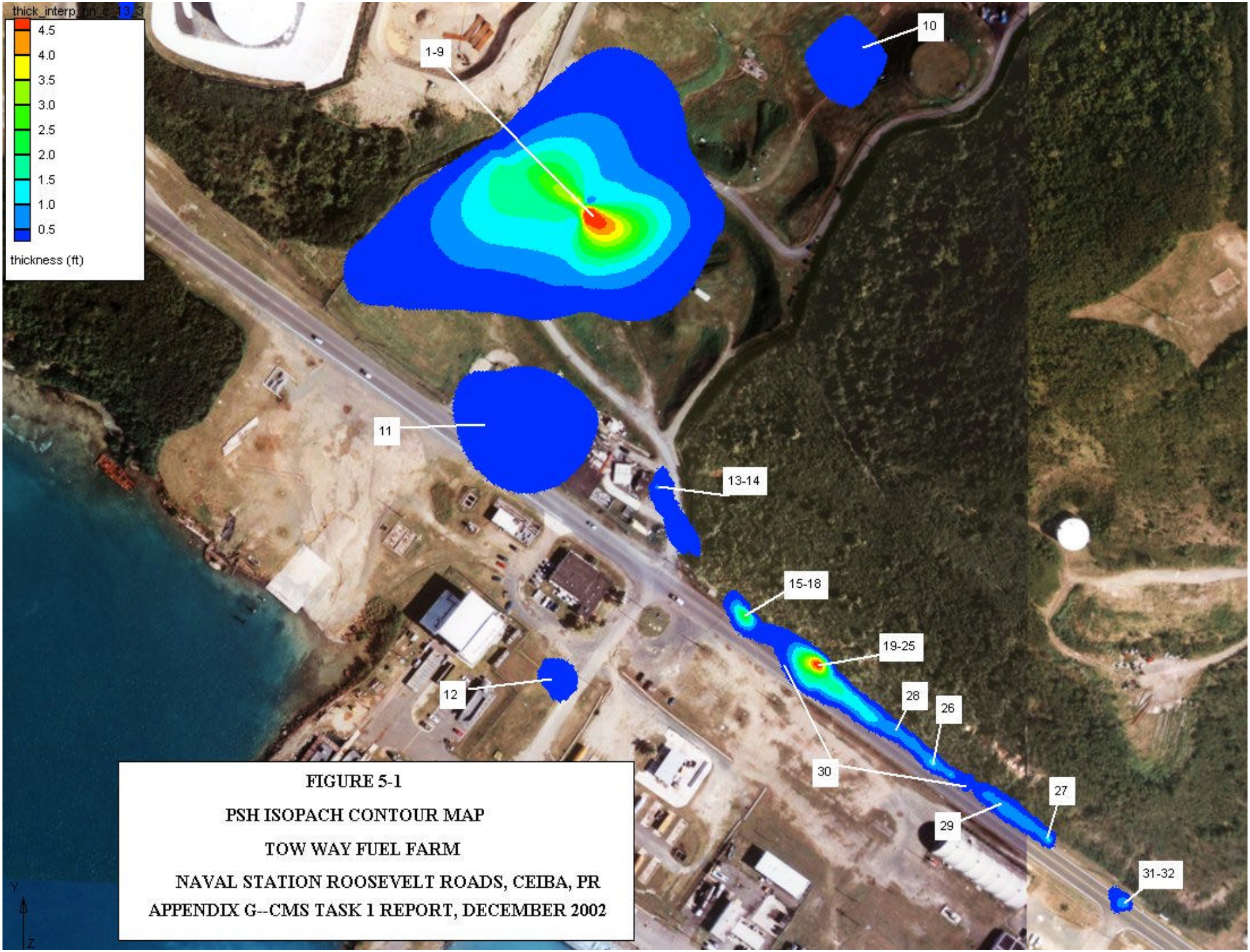


FIGURE 5-1

PSH ISOPACH CONTOUR MAP

TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS, CEIBA, PR

APPENDIX G--CMS TASK 1 REPORT, DECEMBER 2002

APPENDIX H
CORRECTIVE ACTION OBJECTIVE (CAO) CALCULATIONS

TABLE H-1

CORRECTIVE ACTION OBJECTIVES (CAOs)
SOIL INGESTION - FUTURE INDUSTRIAL WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	Analyte	CAOs (mg/kg) at Target Risk Levels			CAOs (mg/kg) at Target HQ = 1.0
			1E-06	1E-05	1E-04	
		Metals:				
1.5E+00	3.0E-04	Arsenic	3.82E+00	3.82E+01	3.82E+02	6.13E+02
	1.5E+00	Chromium (+3)	--	--	--	3.07E+06
	3.0E-03	Chromium (+6)	--	--	--	6.13E+03
	8.0E-05	Thallium	--	--	--	1.64E+02
	7.0E-03	Vanadium	--	--	--	1.43E+04
		Semivolatiles:				
7.3E-01		Benzo(a)anthracene	7.84E+00	7.84E+01	7.84E+02	--
7.3E+00		Benzo(a)pyrene	7.84E-01	7.84E+00	7.84E+01	--
7.3E-01		Benzo(b)fluoranthene	7.84E+00	7.84E+01	7.84E+02	--
7.3E-01		Indeno(1,2,3-cd)pyrene	7.84E+00	7.84E+01	7.84E+02	--

'--' Indicates that the relevant health effects criteria are unavailable.

Variable	Units	Value
Risk	none	1E-06
BWa	kg	70
ATNC	days	9125
ATC	days	25550
IRa	mg/day	50
CF	kg/mg	1E-06
FI	none	1
EF	days/yr	250
EDa	yrs	25
HI	none	1

TABLE H-2

CORRECTIVE ACTION OBJECTIVES (CAOs)
DUST INHALATION - FUTURE INDUSTRIAL WORK RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	Analyte	CAOs (mg/kg) at Target Risk Levels			CAOs (mg/kg) at Target HQ = 1.0
			1E-06	1E-05	1E-04	
		Metals:				
1.5E+01		Arsenic	1.98E+03	1.98E+04	1.98E+05	--
		Chromium (+3)	--	--	--	--
4.1E+01	2.9E-05	Chromium (+6)	7.25E+02	7.25E+03	7.25E+04	3.04E+05
		Thallium	--	--	--	--
		Vanadium	--	--	--	--
		Semivolatiles:	--	--	--	--
		Benzo(a)anthracene	--	--	--	--
3.1E+00		Benzo(a)pyrene	9.59E+03	9.59E+04	9.59E+05	--
		Benzo(b)fluoranthene	--	--	--	--
		Indeno(1,2,3-cd)pyrene	--	--	--	--

'--' Indicates that the relevant health effects criteria are unavailable.

Variable	Units	Value
Risk	none	1E-06
ATNC	days	9125
ATC	days	25550
ET	hrs/day	8
EF	days/yr	250
ED	yrs	25
HI	none	1
BW	kg	70
IR	m3/hour	1.3

TABLE H-3

CORRECTIVE ACTION OBJECTIVES (CAOs)
VAPOR INHALATION - FUTURE INDUSTRIAL WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	VF (m3/kg)	Analyte	CAOs (mg/kg) at Target Risk Levels			CAOs (mg/kg) at
				1E-06	1E-05	1E-04	Target HQ = 1.0
			Metals:				
1.5E+01			Arsenic	N/A	N/A	N/A	N/A
			Chromium (+3)	N/A	N/A	N/A	N/A
4.1E+01	2.9E-05		Chromium (+6)	N/A	N/A	N/A	N/A
			Thallium	N/A	N/A	N/A	N/A
			Vanadium	N/A	N/A	N/A	N/A
			Semivolatiles:				
			Benzo(a)anthracene	--	--	--	--
3.1E+00		3.89E+07	Benzo(a)pyrene	3.46E+02	3.46E+03	3.46E+04	--
			Benzo(b)fluoranthene	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--

'--' Indicates that the relevant health effects criteria are unavailable.
N/A - Not applicable because volatilization model only applies to organics.

Variable	Units	Value
Risk	none	1E-06
ATNC	days	9125
ATC	days	25550
ET	hrs/day	8
EF	days/yr	250
ED	yrs	25
HI	none	1
BW	kg	70
IR	m^3/hour	1.3

TABLE H-4 Revised: January 3, 2003

CORRECTIVE ACTION OBJECTIVES (CAOs)
SOIL DERMAL ABSORPTION - FUTURE INDUSTRIAL WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	Dermal SF	Dermal RfD	G-I Abs.	Der. ABS	Analyte	CAOs (mg/kg) at Target Risk Levels 1E-06	1E-05	1E-04	CAOs (mg/kg) at Target HQ = 1.0
						Metals:				
1.50E+00	3.0E-04	1.5E+00	3.0E-04	1.0E+00	0.03	Arsenic	9.64E+00	9.64E+01	9.64E+02	1.55E+03
	1.5E+00		2.0E-02	1.3E-02		Chromium (+3)	--	--	--	N/A
	3.0E-03		7.5E-05	2.5E-02		Chromium (+6)	--	--	--	N/A
	8.0E-05		8.0E-05	1.0E+00		Thallium	--	--	--	N/A
	7.0E-03		1.8E-04	2.6E-02		Vanadium	--	--	--	N/A
						Semivolatiles:				
7.30E-01		7.3E-01		1.0E+00	0.13	Benzo(a)anthracene	4.57E+00	4.57E+01	4.57E+02	--
7.30E+00		7.3E+00		1.0E+00	0.13	Benzo(a)pyrene	4.57E-01	4.57E+00	4.57E+01	--
7.30E-01		7.3E-01		1.0E+00	0.13	Benzo(b)fluoranthene	4.57E+00	4.57E+01	4.57E+02	--
7.30E-01		7.3E-01		1.0E+00	0.13	Indeno(1,2,3-cd)pyrene	4.57E+00	4.57E+01	4.57E+02	--

'--' Indicates that the relevant health effects criteria are unavailable.
N/A - Not applicable because of lack of information of ABS factor.

Variable	Units	Value
Risk	none	1E-06
BW	kg	70
ATNC	days	9125
ATC	days	25550
AF	mg/cm^2	0.2
CF	kg/mg	1E-06
SA	cm^2	3300
EV	events/day	1
EF	days/yr	250
ED	yrs	25
HI	none	1

TABLE H-5 Revised: January 3, 2003

CAOs FOR THE TWFF - SURFACE SOIL (mg/kg)
FUTURE LAND USE - INDUSTRIAL WORKER
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Ingestion	Dermal	Inhalation-Vapor	Inhalation-Dust	Combination (a)
Metals:					
Arsenic	3.82E+00	9.64E+00	N/A	1.98E+03	2.73E+00
Chromium (+3)	3.07E+06	N/A	N/A	--	3.07E+06
Chromium (+6)	6.13E+03	N/A	N/A	7.25E+02	7.25E+02 (b)
Thallium	1.64E+02	N/A	N/A	--	1.64E+02
Vanadium	1.43E+04	N/A	N/A	--	1.43E+04
Semivolatiles:					
Benzo(a)anthracene	7.84E+00	4.57E+00	--	--	2.89E+00
Benzo(a)pyrene	7.84E+00	4.57E+00	3.46E+03	9.59E+04	2.88E+00 ©
Benzo(b)fluoranthene	7.84E+00	4.57E+00	--	--	2.89E+00
Indeno(1,2,3-cd)pyrene	7.84E+00	4.57E+00	--	--	2.89E+00

'--' Indicates that the relevant health effects criteria are unavailable.
(a) - Values are based on 1/[(1/Ingestion CAO) + (1/Dermal CAO) + (1/Inhalation CAO)].
(b) - Carcinogenic and noncarcinogenic effects cannot be combined. Therefore, the more conservative carcinogenic-based CAO from inhalation exposure is listed.
© - Target risk is 1×10^{-5} for benzo(a)pyrene but 1×10^{-6} for all other analytes (see text for details).
N/A - Not applicable because volatilization model only applies to organics and no ABS factor for dermal.

TABLE H-6

CORRECTIVE ACTION OBJECTIVES (CAOs)
SOIL INJESTION - FUTURE CONSTRUCTION WORKER
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	Analyte	CAOs (mg/kg) at Target Risk Levels 1E-06	1E-05	1E-04	CAOs (mg/kg) at Target HQ = 1.0
		Metals:				
1.5E+00	3.0E-04	Arsenic	6.62E+01	6.62E+02	6.62E+03	4.26E+02
	1.0E+00	Chromium (+3)	--	--	--	1.42E+06
	2.0E-02	Chromium (+6)	--	--	--	2.84E+04
	8.0E-04	Thallium	--	--	--	1.14E+03
	7.0E-03	Vanadium	--	--	--	9.94E+03
		Semivolatiles:				
7.3E-01		Benzo(a)anthracene	1.36E+02	1.36E+03	1.36E+04	--
7.3E+00		Benzo(a)pyrene	1.36E+01	1.36E+02	1.36E+03	--
7.3E-01		Benzo(b)fluoranthene	1.36E+02	1.36E+03	1.36E+04	--
7.3E-01		Indeno(1,2,3-cd)pyrene	1.36E+02	1.36E+03	1.36E+04	--
	2.0E-02	**2-Methylnaphthalene**	--	--	--	2.84E+04
	2.0E-02	**Naphthalene**	--	--	--	2.84E+04

'--' Indicates that the relevant health effects criteria are unavailable.
COPCs in bold are identified in subsurface soil but not in surface soil.

Variable	Units	Value
Risk	none	1E-06
BW	kg	70
ATNC	days	365
ATC	days	25550
IR	mg/day	100
CF	kg/mg	1E-06
FI	none	1
EF	days/yr	180
ED	yrs	1
HI	none	1

TABLE H-7

CORRECTIVE ACTION OBJECTIVES (CAOs)
DUST INHALATION - FUTURE CONSTRUCTION WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	Analyte	CAOs (mg/kg) at Target Risk Levels			CAOs (mg/kg) at Target HQ = 1.0
			1E-06	1E-05	1E-04	
		Metals:				
1.50E+01		Arsenic	6.88E+04	6.88E+05	6.88E+06	--
		Chromium (+3)	--	--	--	--
4.10E+01	2.9E-05	Chromium (+6)	2.52E+04	2.52E+05	2.52E+06	4.22E+05
		Thallium	--	--	--	--
		Vanadium	--	--	--	--
		Semivolatiles:				
		Benzo(a)anthracene	--	--	--	--
3.10E+00		Benzo(a)pyrene	3.33E+05	3.33E+06	3.33E+07	--
		Benzo(b)fluoranthene	--	--	--	--
		Indeno(1,2,3-cd)pyrene	--	--	--	--
		2-Methylnaphthalene	--	--	--	--
	9.0E-04	**Naphthalene**	--	--	--	(a)

(a) - No CAO listed because the calculated CAO is greater than one million parts per million (µg/g).
'--' Indicates that the relevant health effects criteria are unavailable.
COPCs in **bold** are identified in subsurface soil but not in surface soil.

Variable	Units	Value
Risk	none	1E-06
ATNC	days	365
ATC	days	25550
ET	hrs/day	8
EF	days/yr	180
ED	yrs	1
HI	none	1.0
BW	kg	70
IR	m3/hour	1.30
PEF	m3/kg	1.08E+09

TABLE H-8

CORRECTIVE ACTION OBJECTIVES (CAOs)
VAPOR INHALATION - FUTURE CONSTRUCTION WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	VF (m^3/kg)	Analyte	CAOs (mg/kg) at Target Risk Levels			CAOs (mg/kg) at Target HQ = 1.0
				1E-06	1E-05	1E-04	
			Metals:				
1.5E+01			Arsenic	N/A	N/A	N/A	N/A
			Chromium (+3)	N/A	N/A	N/A	N/A
4.1E+01	2.9E-05		Chromium (+6)	N/A	N/A	N/A	N/A
			Thallium	N/A	N/A	N/A	N/A
			Vanadium	N/A	N/A	N/A	N/A
			Semivolatiles:				
			Benzo(a)anthracene	--	--	--	--
3.1E+00		7.79E+06	Benzo(a)pyrene	2.40E+03	2.40E+04	2.40E+05	--
			Benzo(b)fluoranthene	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--
			2-Methylnaphthalene	--	--	--	--
	9.0E-04	2.79E+04	**Naphthalene**	--	--	--	3.42E+02

'--' Indicates that the relevant health effects criteria are unavailable.
COPCs in **bold** are identified in subsurface soil but not in surface soil.
N/A - Not applicable because volatilization model only applies to organics.

Variable	Units	Value
Risk	none	1E-06
ATNC	days	365
ATC	days	25550
ET	hrs/day	8
EF	days/yr	180
ED	yrs	1
HI	none	1.0
BW	kg	70
IR	m3/hour	1.30

TABLE H-9

CORRECTIVE ACTION OBJECTIVES (CAOs)
SOIL DERMAL ABSORPTION - FUTURE CONSTRUCTION WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Rfd	Dermal SF	Dermal RfD	G-I Abs.	Der. ABS	Analyte	CAOs (mg/kg) at Target Risk Levels 1E-06	1E-05	1E-04	CAOs (mg/kg) at Target HQ = 1.0
						Metals:				
1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.0E+00	0.03	Arsenic	3.35E+02	3.35E+03	3.35E+04	2.15E+03
	1.0E+00		1.3E-02	1.3E-02		Chromium (+3)	--	--	--	N/A
	2.0E-02		5.0E-04	2.5E-02		Chromium (+6)	--	--	--	N/A
	8.0E-04		8.0E-04	1.0E+00		Thallium	--	--	--	N/A
	7.0E-03		1.8E-04	2.6E-02		Vanadium	--	--	--	N/A
						Semivolatiles:				
7.3E-01		7.3E-01		1.0E+00	0.13	Benzo(a)anthracene	1.59E+02	1.59E+03	1.59E+04	--
7.3E+00		7.3E+00		1.0E+00	0.13	Benzo(a)pyrene	1.59E+01	1.59E+02	1.59E+03	--
7.3E-01		7.3E-01		1.0E+00	0.13	Benzo(b)fluoranthene	1.59E+02	1.59E+03	1.59E+04	--
7.3E-01		7.3E-01		1.0E+00	0.13	Indeno(1,2,3-cd)pyrene	1.59E+02	1.59E+03	1.59E+04	--
	2.0E-02		2.0E-02	1.0E+00	0.13	**2-Methylnaphthalene**	--	--	--	3.31E+04
	2.0E-02		2.0E-02	1.0E+00	0.13	**Naphthalene**	--	--	--	3.31E+04

'--' Indicates that the relevant health effects criteria are unavailable.
N/A - Not applicable because of lack of information of ABS factor.
COPCs in bold are identified in subsurface soil but not in surface soil.

Variable	Units	Value
Risk	none	1E-06
BWa	kg	70
ATNC	days	365
ATC	days	25550
AF	mg/cm^2	0.2
CF	kg/mg	1E-06
SA	cm^2	3300
EV	events/day	1
EF	days/yr	180
EDa	yrs	1
HI	none	1

TABLE H-10

CAOs FOR THE TWFF-TOTAL SOIL (mg/kg)
FUTURE LAND USE - CONSTRUCTION WORKER
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Analyte	Ingestion	Dermal	Inhalation-Vapor	Inhalation-Dust	Combination (a)
Metals:					
Arsenic	6.62E+01	3.35E+02	N/A	6.88E+04	5.52E+01
Chromium (+3)	1.42E+06	N/A	N/A	--	1.42E+06
Chromium (+6)	2.84E+04	N/A	N/A	4.22E+05	2.84E+04
Thallium	1.14E+03	N/A	N/A		1.14E+03
Vanadium	9.94E+03	N/A	N/A	--	9.94E+03
Semivolatiles:					
Benzo(a)anthracene	1.36E+02	1.59E+02	--	--	7.33E+01
Benzo(a)pyrene	1.36E+01	1.59E+01	2.40E+03	3.33E+05	7.30E+00
Benzo(b)fluoranthene	1.36E+02	1.59E+02	--	--	7.33E+01
Indeno(1,2,3-cd)pyrene	1.36E+02	1.59E+02	--	--	7.33E+01
2-Methylnaphthalene	2.84E+04	3.31E+04	--	--	1.53E+04
Naphthalene	2.84E+04	3.31E+04	3.42E+02	1.62E+07	3.35E+02

'--' Indicates that the relevant health effects criteria are unavailable.
(a) - Values are based on 1/[(1/Ingestion CAO) + (1/Dermal CAO) + (1/Inhalation CAO)].
N/A - Not applicable because volatilization model only applies to organics and no ABS factor for dermal.
COPCs in **bold** are identified in surface soil but not in subsurface soil.

TABLE H-11

CORRECTIVE ACTION OBJECTIVES (CAOs)
GROUNDWATER INGESTION - FUTURE CONSTRUCTION WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	RfD	Analyte	CAOs (mg/L) at Target Risk Levels			CAOs (mg/L) at Target HQ = 1.0
			1E-06	1E-05	1E-04	
		Metals:				
1.5E+00	3E-04	Arsenic	1.32E+03	1.32E+04	1.32E+05	8.52E+03
	7E-02	Barium	--	--	--	1.99E+06
	5E-04	Cadmium	--	--	--	1.42E+04
	1E+00	Chromium (+3)	--	--	--	2.84E+07
	2E-02	Chromium (+6)	--	--	--	5.68E+05
		Lead	--	--	--	--
	3E-04	Mercury				8.52E+03
	8E-04	Thallium				2.27E+04
	7E-03	Vanadium				1.99E+05
		Volatiles:				
6.0E-01	9E-03	1,1-Dichloroethene	3.31E+03	3.31E+04	3.31E+05	2.56E+05
5.7E-02	4E-02	1,1,2-Trichloroethane	3.49E+04	3.49E+05	3.49E+06	1.14E+06
	5E-02	1,2,4-Trimethylbenzene	--	--	--	1.42E+06
	5E-02	1,3,5-Trimethylbenzene	--	--	--	1.42E+06
	2E-02	Acrolein	--	--	--	5.68E+05
5.5E-02	3E-03	Benzene	3.61E+04	3.61E+05	3.61E+06	8.52E+04
6.2E-02	2E-02	Bromodichloromethane	3.21E+04	3.21E+05	3.21E+06	5.68E+05
	4E-02	n-Butylbenzene	--	--	--	1.14E+06
	4E-02	sec-Butylbenzene	--	--	--	1.14E+06
6.1E-03	1E-02	Chloroform	3.26E+05	3.26E+06	3.26E+07	2.84E+05
1.3E-02		Chloromethane	1.53E+05	1.53E+06	1.53E+07	--
	1E-01	Ethylbenzene	--	--	--	2.84E+06
	3E-01	Isobutanol	--	--	--	8.52E+06
	4E-01	Isopropylbenzene	--	--	--	1.14E+07
7.5E-03	6E-02	Methylene chloride	2.65E+05	2.65E+06	2.65E+07	1.70E+06
		Methyl tert-butyl ether	--	--	--	--
	4E-02	n-Propylbenzene	--	--	--	1.14E+06
	2E+00	Toluene	--	--	--	5.68E+07
4.0E-01	3E-04	Trichloroethene	4.97E+03	4.97E+04	4.97E+05	8.52E+03
	4E-01	Xylenes	--	--	--	1.01E+07
		Semivolatiles:				
	2E-02	2-Methylnaphthalene	--	--	--	5.68E+05
	5E-03	3&4-Methylphenol	--	--	--	1.42E+05
1.4E-02	2E-02	Bis(2-ethylhexyl)phthalate	1.42E+05	1.42E+06	1.42E+07	5.68E+05
	2E-02	Naphthalene	--	--	--	5.68E+05

'--' Indicates that the relevant health effects criteria are unavailable.

Variable	Units	Value
Risk	none	1E-06
BW	kg	70
ATNC	days	365
ATC	days	25550
IR	l/day	0.05
EF	days/yr	18
ED	yrs	1
HI	none	1
CF	mg/ug	0.001

TABLE H-12

CORRECTIVE ACTION OBJECTIVES (CAOs)
GROUNDWATER INHALATION OF VAPORS - FUTURE CONSTRUCTION WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

			CAOs (mg/L) at Target Risk Levels			CAOs (mg/L) at
SFi	**RfDi**	**Analyte**	**1E-06**	**1E-06**	**1E-06**	**Target HQ = 1.0**
		Metals:				
1.5E+01		Arsenic	N/A	N/A	N/A	N/A
	1.4E-03	Barium	N/A	N/A	N/A	N/A
		Cadmium	N/A	N/A	N/A	N/A
		Chromium (+3)	N/A	N/A	N/A	N/A
4.1E+01	2.9E-05	Chromium (+6)	N/A	N/A	N/A	N/A
		Lead	N/A	N/A	N/A	N/A
	3E-04	Mercury	N/A	N/A	N/A	N/A
	8E-04	Thallium	N/A	N/A	N/A	N/A
	7E-03	Vanadium	N/A	N/A	N/A	N/A
		Volatiles:				
1.8E-01		1,1-Dichloroethene	8.74E+02	8.74E+03	8.74E+04	--
5.6E-02		1,1,2-Trichloroethane	2.73E+03	2.73E+04	2.73E+05	--
	1.7E-03	1,2,4-Trimethylbenzene	--	--	--	3.71E+03
	1.7E-03	1,3,5-Trimethylbenzene	--	--	--	3.71E+03
	5.7E-06	Acrolein	--	--	--	1.24E+01
2.9E-02	1.7E-03	Benzene	5.27E+03	5.27E+04	5.27E+05	3.71E+03
		Bromodichloromethane	--	--	--	--
		n-Butylbenzene	--	--	--	--
		sec-Butylbenzene	--	--	--	--
8.1E-02	8.6E-05	Chloroform	1.89E+03	1.89E+04	1.89E+05	1.88E+02
3.5E-03	8.6E-02	Chloromethane	4.37E+04	4.37E+05	4.37E+06	1.88E+05
3.9E-03	2.9E-01	Ethylbenzene	3.97E+04	3.97E+05	3.97E+06	6.33E+05
		Isobutanol	--	--	--	--
	2.6E-02	Isopropylbenzene	--	--	--	5.72E+04
1.7E-03	8.6E-01	Methylene chloride	9.26E+04	9.26E+05	9.26E+06	1.88E+06
	8.6E-01	Methyl tert-butyl ether	--	--	--	1.87E+06
		n-Propylbenzene	--	--	--	--
	2.6E-01	Toluene	--	--	--	5.68E+05
4.0E-01	1.0E-02	Trichloroethene	3.82E+02	3.82E+03	3.82E+04	2.18E+04
		Xylenes	--	--	--	--
		Semivolatiles:				
		2-Methylnaphthalene	--	--	--	--
		4-Methylphenol	--	--	--	--
1.4E-02		Bis(2-ethylhexyl)phthalate	1.09E+04	1.09E+05	1.09E+06	--
	9.0E-04	Naphthalene	--	--	--	1.97E+03

'--' Indicates that the relevant health effects criteria are unavailable.
N/A - Not applicable because volatilization model only applies to organics.

Variable	**Value**	**Units**
CF	1.E-03	mg/ug
EV	1	event/day
EF	18	days/yr
ED	1	years
BW	70	kg
ATC	25550	days
ATNC	365	days
IR	1.3	m^3/hr
ET	1	hr/event
K	0.5	none
Risk	1E-06	none
HI	1	none

TABLE H-13

CORRECTIVE ACTION OBJECTIVES (CAOs)
GROUNDWATER DERMAL ABSORPTION - FUTURE CONSTRUCTION WORKER RECEPTOR
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

SF	Sfder	RfD	RfDder	GIabs	DAF	Analyte	CAOs (mg/L) at Target Risk Levels 1E-06	1E-05	1E-04	CAOs (mg/L) at Target HQ = 1.0
						Metals:				
1.5E+00	1.5E+00	3E-04	3.0E-04	1.0E+00	1.00E-03	Arsenic	6.62E+03	6.62E+04	6.62E+05	4.26E+04
		7E-02	4.9E-03	7.0E-02	1.00E-03	Barium	--	--	--	6.96E+05
		5E-04	1.3E-05	2.5E-02	1.00E-03	Cadmium	--	--	--	1.77E+03
		1E+00	1.3E-02	1.3E-02	1.00E-03	Chromium (+3)	--	--	--	1.85E+06
		5E-03	1.3E-04	2.5E-02	2.00E-03	Chromium (+6)	--	--	--	8.87E+03
					1.00E-03	Lead	--	--	--	--
		3E-04	3.0E-04	1.0E+00	1.00E-03	Mercury	--	--	--	4.26E+04
		8E-04	8.0E-04	1.0E+00	1.00E-03	Thallium	--	--	--	1.14E+05
		7E-03	1.8E-04	2.6E-02	1.00E-03	Vanadium	--	--	--	2.58E+04
						Volatiles:				
6.0E-01	6.0E-01	9E-03	9.0E-03	1.0E+00	2.07E-02	1,1-Dichloroethene	7.99E+02	7.99E+03	7.99E+04	6.16E+04
5.7E-02	5.7E-02	4E-03	4.0E-03	1.0E+00	1.35E-02	1,1,2-Trichloroethane	1.29E+04	1.29E+05	1.29E+06	4.19E+04
		5E-02	5.0E-02	1.0E+00	2.05E-01	1,2,4-Trimethylbenzene	--	--	--	3.47E+04
		5E-02	5.0E-02	1.0E+00	1.18E-01	1,3,5-Trimethylbenzene	--	--	--	6.00E+04
		2E-02	2.0E-02	1.0E+00	9.47E-04	Acrolein	--	--	--	3.00E+06
5.5E-02	5.5E-02	3E-03	3.0E-03	1.0E+00	2.39E-02	Benzene	7.57E+03	7.57E+04	7.57E+05	1.79E+04
6.2E-02	6.2E-02	2E-02	2.0E-02	1.0E+00	1.18E-02	Bromodichloromethane	1.35E+04	1.35E+05	1.35E+06	2.40E+05
		4E-02	4.0E-02	1.0E+00	3.99E-01	n-Butylbenzene	--	--	--	1.42E+04
		4E-02	4.0E-02	1.0E+00	4.00E-01	sec-Butylbenzene	--	--	--	1.42E+04
6.1E-03	6.1E-03	1E-02	1.0E-02	1.0E+00	1.31E-02	Chloroform	1.24E+05	1.24E+06	1.24E+07	1.08E+05
1.3E-02	1.3E-02			1.0E+00	4.63E-03	Chloromethane	1.65E+05	1.65E+06	1.65E+07	--
		1E-01	1.0E-01	1.0E+00	1.07E-01	Ethylbenzene	--	--	--	1.33E+05
		3E-01	3.0E-01	1.0E+00	2.96E-03	Isobutanol	--	--	--	1.44E+07
		4E-01	4.0E-01	1.0E+00	1.34E-01	Isopropylbenzene	--	--	--	4.25E+05
7.5E-03	7.5E-03	6E-02	6.0E-02	1.0E+00	5.81E-03	Methylene chloride	2.28E+05	2.28E+06	2.28E+07	1.47E+06
				1.0E+00	1.54E-02	Methyl tert-butyl ether	--	--	--	--
		4E-02	4.0E-02	1.0E+00	1.63E-01	n-Propylbenzene	--	--	--	3.49E+04
		2E+00	2.0E+00	1.0E+00	5.28E-02	Toluene	--	--	--	5.38E+06
4.0E-01	4.0E-01	3E-04	3.0E-04	1.0E+00	2.41E-02	Trichloroethene	1.03E+03	1.03E+04	1.03E+05	1.77E+03
		4E-01	4.0E-01	1.0E+00	1.17E-01	Xylenes	--	--	--	4.86E+05
						Semivolatiles:				
		2E-02	2.0E-02	1.0E+00	3.02E-01	2-Methylnaphthalene	--	--	--	9.40E+03
		5E-03	5.0E-03	1.0E+00	1.31E-02	3&4-Methylphenol	--	--	--	5.42E+04
1.4E-02	1.4E-02	2E-02	2.0E-02	1.0E+00	2.15E-01	Bis(2-ethylhexyl)phthalate	3.29E+03	3.29E+04	3.29E+05	1.32E+04
		2E-02	2.0E-02	1.0E+00	9.36E-02	Naphthalene	--	--	--	3.03E+04

'--' Indicates that the relevant health effects criteria are unavailable.

	Value	Units
SA (RME)	10000	cm2
EV	1	event/day
EF	18	days/yr
ED (RME)	1	years
BW	70	kg
ATC	25550	days
ATNC (RME)	365	days
Cfm	1E-03	mg/ug
CFv	1E-03	l/cm3
Kp (inorg.)	0.001	cm/hr
T (RME)	1	hour/event
Risk	1E-06	none
HI	1	none

TABLE H-14

CAOs FOR THE TWFF - GROUNDWATER (mg/L)
FUTURE LAND USE - CONSTRUCTION WORKER
CORRECTIVE MEASURES STUDY - TASK I REPORT
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Analyte	Ingestion	Inhalation	Dermal	Combination (a)
Metals:				
Arsenic	1.32E+03	N/A	6.62E+03	1.10E+03
Barium	1.99E+06	N/A	6.96E+05	5.15E+05
Cadmium	1.42E+04	N/A	1.77E+03	1.58E+03
Chromium (+3)	2.84E+07	N/A	1.85E+06	1.73E+06
Chromium (+6)	5.68E+05	N/A	8.87E+03	8.74E+03
Lead	--	N/A	--	--
Mercury	8.52E+03	N/A	4.26E+04	7.10E+03
Thallium	2.27E+04	N/A	1.14E+05	1.89E+04
Vanadium	1.99E+05	N/A	2.58E+04	2.29E+04
Volatiles:				
1,1-Dichloroethene	3.31E+03	8.74E+02	7.99E+02	3.71E+02
1,1,2-Trichloroethane	3.49E+04	2.73E+03	1.29E+04	2.12E+03
1,2,4-Trimethylbenzene	1.42E+06	3.71E+03	3.47E+04	3.35E+03
1,3,5-Trimethylbenzene	1.42E+06	3.71E+03	6.00E+04	3.49E+03
Acrolein	5.68E+05	1.24E+01	3.00E+06	1.24E+01
Benzene	3.61E+04	5.27E+03	7.57E+03	2.86E+03
Bromodichloromethane	3.21E+04	--	1.35E+04	9.52E+03
n-Butylbenzene	1.14E+06	--	1.42E+04	1.40E+04
sec-Butylbenzene	1.14E+06	--	1.42E+04	1.40E+04
Chloroform	2.84E+05	1.88E+02	1.08E+05	1.87E+02
Chloromethane	1.53E+05	4.37E+04	1.65E+05	2.82E+04
Ethylbenzene	2.84E+06	3.97E+04	1.33E+05	3.97E+04
Isobutanol	8.52E+06	--	1.44E+07	5.35E+06
Isopropylbenzene	1.14E+07	5.72E+04	4.25E+05	5.02E+04
Methylene chloride	2.65E+05	9.26E+04	2.28E+05	5.28E+04
Methy tert-butyl ether	--	1.87E+06	--	1.87E+06
n-Propylbenzene	1.14E+06	--	3.49E+04	3.38E+04
Toluene	5.68E+07	5.68E+05	5.38E+06	5.09E+05
Trichloroethene	4.97E+03	3.82E+02	1.03E+03	2.64E+02
Xylenes	1.01E+07	--	4.86E+05	4.63E+05
Semivolatiles:				
2-Methylnaphthalene	5.68E+05	--	9.40E+03	9.25E+03
3&4-Methylphenol	1.42E+05		5.42E+04	3.92E+04
Bis(2-ethylhexyl)phthalate	1.42E+05	1.09E+04	3.29E+03	2.49E+03
Naphthalene	5.68E+05	1.97E+03	3.03E+04	1.84E+03

'--' Indicates that the relevant health effects criteria are unavailable.
(a) - Values are based on 1/[(1/Ingestion CAO) + (1/Dermal CAO) + (1/Inhalation CAO)].
(b) - Carcinogenic and noncarcinogenic effects cannot be combined. Therefore, the more conservative carcinogenic-based CAO from inhalation exposure is listed.
N/A - Not applicable because volatilization model only applies to organics.

APPENDIX I
RESULTS OF JOHNSON AND ETTINGER 1991 MODEL-SUMMARY AND RESULTS TO BE USED FOR GROUNDWATER CAOS

APPENDIX I – Use of the Johnson and Ettinger (1991) Model for Vapor Intrusion into Buildings from Groundwater for the Tow Way Fuel Farm, Naval Station Roosevelt Roads

I.1 Introduction

Volatilization of contaminants in groundwater, and the subsequent mass transport of these vapors into indoor spaces is a potential inhalation exposure pathway at the TWFF. Johnson and Ettinger (1991) introduced a screening-level model which incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from subsurface soils or groundwater into indoor spaces located directly above or in close proximity to the contaminant source. The Johnson and Ettinger model is a one-dimensional analytical solution to convective and diffusive vapor transport and provides an estimated attenuation coefficient relating the vapor concentration in the indoor space to the vapor concentration at the contaminant source. Inputs to the model include chemical properties of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building (USEPA, 2000).

EPA (2000) placed the Johnson and Ettinger model into MICROSOFT EXCEL spreadsheets and provided a "User's Guide" for instructions on using the model. For the TWFF, the tier-2 groundwater model is used in its risk-based concentration mode. Default variables were used unless when site-specific conditions suggested otherwise. The fundamentals of the model, the equation derivations, discussion of sensitivity of the model to input parameters, detailed model application and examples are well presented in the "User's Guide" (USEPA, 2000) and will not be summarized here. This version of the User' Guide is an update of the model used in the previous submission of this Appendix (Baker, 2001b). The principal changes are in the soil water retention parameters and the soil saturated hydraulic conductivity values.

The following sections describe the site-specific parameters used for the TWFF site and a brief discussion of site-specific parameter sensitivity. The model results follow the text and are simply printouts of the DATENTER and RESULTS worksheets in the GWTIER2 (with site-specific modifications) workbook for each groundwater COPC with inhalation toxicity criteria.

I.2 Site-Specific Parameters

The DATENTER worksheet shows all of the model parameters, while the CHEMPROPS worksheet shows all of the chemical properties necessary for the model. The following site-specific parameters are used for the TWFF replacing the default parameters.

- Depth to groundwater - 300 cm is used for the site-specific depth to groundwater replacing the default value of 400 cm. The depth is based on the approximate average of measured depths from eleven monitoring wells located south of Forrestal Drive. The data includes ten measurements from each well between April 27, 1999 and March 18, 2000. The average depth to groundwater varies for the eleven wells from seven to thirteen feet below ground level.

  The area south of Forrestal Drive is included in the model for two reasons. The first is that it is flat and already has buildings on it and is suitable for potential new buildings. The area north of Forrestal Drive is hilly and has few buildings. The second is that the depth to groundwater is considerably more shallow to the south so that volatilization is more conservatively modeled.

- Thickness of soil layers - The model includes three layers of soil above the groundwater surface. The default thickness of these layers from top to bottom is 300 cm, 50 cm, and 50 cm. Based on the logs for seven borings advanced during the CMS Investigation, there is no apparent structure to the soil in the region south of Forrestal Drive. Therefore, it was assumed that the layers are each 100 cm (i.e., a total of 300 cm).

- Soil type by layer - The model uses the SCS soil textural classification system. Seven samples from the CMS Investigation with grain-size analysis were plotted on the SCS classification triangle provided in the model. The SCS type is based on the percent sand, silt, and clay (gravel was included with sand). Of the seven samples two were silt loams, two clay loams, two loams, and one on the line between clay loam and loam. The silt loam and clay loam classifications produce nearly the same acceptable groundwater result, so the silt loam was assumed for all three layers of soil. The default soil type for the model was sandy clay and clay.

- Building characteristics - For building dimensions, the office building near the corner of Forrestal Drive and Palau Street at the TWFF was used. The dimensions are 3,000 cm, by 1,800 cm, by 244 cm (or 8 feet). This differs from the default average two story residence size used in the model of 961 cm, by 961 cm, by 488 cm. Other building characteristics assumed such as slab-on-grade construction, are default values.

- Indoor air exchange rate - This parameter is in units of total building air exchanges per hour. It is used with the building dimensions to calculate the building ventilation rate. The default value, based on the 50th percentile of measurements of U.S. homes, is 0.45/hr. The site-specific value is one exchange per hour based on a calculation converting the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standard 62-1989 for office buildings of 20 $ft.^3$/min. per

seven persons per 1,000 $ft.^2$ to $ft.^3$/hr. and comparing to the TWFF office building dimensions. This number is conservative compared to the 2/hr. recommended by Michigan Department of Environmental Quality's for air exchange rate for commercial/industrial buildings (MDEQ, 1998). The justification for the value is that approximately one exchange per hour is contributed from mechanical system rates for total supply air in a general office that will be supplemented by factors such as natural ventilation, infiltration, and occupancy entrance and egress.

- Averaging time and exposure duration - These standard risk assessment parameters were reduced from the 30 years default to 25 years to account for industrial exposure rather than residential. Both values are high-end selections (90 to 95th percentile) from distributions of data on duration of occupancy and duration of employment.

- Added chemicals - The model uses ancillary worksheets to display intermediate calculations, lookup tables, and chemical properties. The User's Guide includes instructions on how to add chemical and toxicological properties for chemicals that are not included in the model's lookup tables (VLOOKUP). Data from VLOOKUP are retrieved by CAS number into other worksheets in the model. Data was added into VLOOKUP for 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, chloromethane, isopropylbenzene, and methyl tert-butyl ether. Data requirements included CAS number, organic carbon partition coefficient, diffusivities in air and water, solubility, Henry's constant, Henry's constant reference temperature, boiling point, critical temperature, enthalpy of vaporization at the boiling point, unit risk, and reference concentration.

I.3 Model Uncertainty and Sensitivity

In their article, Johnson and Ettinger (1991) reported that the model results were in qualitative agreement with published experimental case histories and in good quantitative and qualitative agreement with three-dimensional numerical modeling of radon transport into homes (USEPA, 2000). That being said the model is still only a screening-level model with gross assumptions about complex chemical and physical processes. These assumptions and uncertainties related to individual parameters used in the model cause the results to be highly uncertain. Some of the model assumptions that are probably significant in this application at the TWFF are: all vapors originating from below the building will enter the building unless the floors and walls are perfect vapor barriers; diffusion dominates vapor transport between the contaminant source and the building zone of influence; all soil properties are laterally homogeneous; the model does not account for degradation of contaminants; the building ventilation rates and dynamic pressure differences between building interior and soil are constants; and vapor transport occurs in the absence of convective water movement in the soil column (i.e., evaporation or infiltration), and in absence of mechanical dispersion (USEPA, 2000). An empirical study was performed that compared

modeled results using Johnson and Ettinger with measured concentrations inside of buildings. (Fitzpatrick and Fitzgerald, 1997) this study showed that the model tended to over-predict non-chlorinated chemicals (e.g., benzene and toluene) and under-predicted chlorinated chemicals. The authors suspected the cause of this discrepancy to be the significant biodegradation of the non-chlorinated volatiles.

A simple sensitivity analysis was done on the TWFF model by changing single model parameters and noting the difference in the result (i.e., the groundwater concentration that produce an acceptable concentration in the overlying building).

- Soil class - Changing the soil class from silty loam to a clay loam had nearly no effect. While changing to a more permeable loam, decreased the concentration by a factor of more than two and one-half.

- Depth to groundwater - Reducing the depth from three meters to two had virtually no effect on the result.

- Water-filled porosity - Changing from the default surface porosity (an associated increases in two layers towards the groundwater) from 0.2 to 0.15 decreased the concentration by about ten percent.

- Building dimensions - Changing from the measured TWFF building to the default home produced an increase in the resulting concentration of 45 percent.

- Soil-building pressure differential - Changing from the 40 g/cm-s^2 default to a potentially more realistic value of 20 g/cm- s^2 increased the calculated concentration nearly 50 percent.

- Indoor air exchange rate - Modifying this parameter produced a linear effect. Doubling the air exchange rate doubled the concentration.

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79005		1,1,2-Trichloroethane

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.69E+03	NA	1.69E+03	4.42E+06	1.69E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75354		1,1-Dichloroethylene

MORE ↓	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_{WT} (cell D28)							
	10	15	300	100	100	100	C	sil	sil		

MORE ↓	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
	1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓	ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
	15	40	3000	1800	244	0.1	1

MORE ↓	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
	70	25	25	250	1.0E-06	1
					Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.60E+01	NA	1.60E+01	2.25E+06	1.60E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
95636		1,2,4-Trimethylbenzene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	1.28E+04	1.28E+04	5.70E+04	1.28E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
108678		1,3,5-Trimethylbenzene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	9.48E+03	9.48E+03	4.82E+04	9.48E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432		Benzene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
5.50E+02	NA	5.50E+02	1.75E+06	5.50E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75274		Bromodichloromethane

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.11E+03	NA	1.11E+03	6.74E+06	1.11E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
117817		Bis(2-ethylhexyl)phthalate

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
5.31E+07	NA	5.31E+07	3.40E+02	NOC

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The groundwater conc. at or above the solubility limit is not of concern for this pathway.
MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
67663		Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
2.51E+02	NA	2.51E+02	7.92E+06	2.51E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
74873		Chloromethane

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
4.06E+04	2.38E+08	4.06E+04	5.32E+06	4.06E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

GW-ADV
Version 2.3; 03/01

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
100414		Ethylbenzene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.02E+03	1.40E+06	1.02E+03	1.69E+05	1.02E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
98828		Isopropylbenzene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	5.13E+05	5.13E+05	6.13E+04	NOC

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The groundwater conc. at or above the solubility limit is not of concern for this pathway.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75092		Methylene chloride

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.92E+04	9.66E+06	1.92E+04	1.30E+07	1.92E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
1634044		Methyl tert-butyl ether

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	3.61E+07	3.61E+07	5.10E+07	3.61E+07

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
91203		Naphthalene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	7.08E+04	7.08E+04	3.10E+04	NOC

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The groundwater conc. at or above the solubility limit is not of concern for this pathway.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
108883		Toluene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	5.70E+05	5.70E+05	5.26E+05	NOC

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The groundwater conc. at or above the solubility limit is not of concern for this pathway.

SCROLL DOWN TO "END"

END

GW-ADV
Version 2.3; 03/01

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016		Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D28)							
10	15	300	100	100	100	C	sil	sil		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.43	0.27	1.7	0.43	0.3

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	3000	1800	244	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
2.24E+01	3.20E+04	2.24E+01	1.10E+06	2.24E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

APPENDIX J
SUPPORTING CALCULATIONS FOR CONSTRUCTION WORKER EXPOSURE TO GROUNDWATER

The average labor hours for 53 different pipe repair scenarios is 1.367 hours per 8-hour day (RSMeans 1999). No more than 1 hour of that time would the construction worker be actually exposed to potential groundwater within the excavation.

RSMeans 1999. Site Work & Landscape Cost Data. 18th Edition. 027-156-0010 Pipe Repair. Kingston, MA: RSMeans Company, Inc., 1999.