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SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION AND REMEDIAL INVESTIGATION REPORT FOR HIGH PRIORITY SITES APPENDICES A THROUGH K NAS KEY WEST FL

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BROWN AND ROOT ENVIRONMENTAL

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Supplemental RCRA Facility Investigation and Remedial Investigation Report

Appendices A-K

for

Naval Air Station Key West High-Priority Sites

Boca Chica Key, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0007

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APPENDICES A - K

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SUPPLEMENTAL RCRA FACILITY INVESTIGATION AND REMEDIAL INVESTIGATION REPORT

NAVAL AIR STATION KEY WEST
HIGH-PRIORITY SITES
BOCA CHICA KEY, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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2155 Eagle Drive
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APPENDIX A

HUMAN HEALTH RISK ASSESSMENT SUPPORTING DOCUMENTATION

APPENDIX A

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PART 1 - Toxicological Profiles for NAS Key West COPCs

APPENDIX A, PART 1
TOXICOLOGICAL PROFILES FOR NAS KEY WEST COPCS

A.1 ALUMINUM

Noncancer Toxicity

Aluminum is not generally regarded as an industrial poison. Inhalation of finely divided powder has been reported as a cause of pulmonary fibrosis. Aluminum in aerosols has been implicated in Alzheimer's disease. As with other metals, the powder and dust are the most dangerous forms (Sax and Lewis, 1989). Most hazardous exposures to aluminum occur in refining and smelting processes. Aluminum dust is a respiratory and eye irritant (Genium, 1990).

A.2 ANTIMONY

Pharmacokinetics

Ingested antimony is absorbed slowly and incompletely from the gastrointestinal (GI) tract (Iffland 1988). Within a few days of acute exposure, highest tissue concentrations are found in the liver, kidney, and thyroid. Organs of storage include skin, bone, and teeth. Highest concentrations in deceased smelter workers (inhalation exposure) occurred in the lungs and skeleton. Excretion is largely via the urine or feces, although some is incorporated into the hair.

Noncancer Toxicity

Acute intoxication from ingestion of large doses of antimony induces GI disturbances, dehydration, and cardiac effects in humans (Iffland 1988). Chronic effects from occupational exposure include irritation of the respiratory tract, pneumoconiosis, pustular eruptions of the skin called "antimony spots," allergic contact dermatitis, and cardiac effects, including abnormalities of the electrocardiograph (ECG) and myocardial changes. Cardiac effects were also observed in rats and rabbits exposed by inhalation for six weeks and in animals (dogs, and possibly other species) treated by intravenous injection (Elinder and Friberg 1986a).

Chronic oral exposure studies in laboratory animals include two briefly reported lifetime drinking water studies in rats and mice (Kanisawa and Schroeder 1969; Schroeder et al. 1970). The only dose tested, 5 parts per

million (ppm) potassium antimony tartrate, resulted in reduced longevity in both species and in reduced mean heart weight in the rats. The U.S. Environmental Protection Agency (EPA) (1995a) verified a reference dose (RfD) of 0.0004 mg/kg/day for chronic oral exposure to antimony from the LOAEL of 5 ppm potassium antimony tartrate (0.35 mg antimony/kg body weight-day) in the lifetime study in rats (Schroeder et al. 1970). An uncertainty factor of 1000 was applied; factors of 10 each for inter- and intraspecies variation and to estimate a no observed adverse effects level (NOAEL) from a lowest observed adverse effect level (LOAEL). The heart is considered a likely target organ for chronic oral exposure of humans.

Carcinogenicity

Data were not located regarding the carcinogenicity of antimony to humans. Antimony fed to rats did not produce an excess of tumors (Goyer 1991), but a high frequency of lung tumors was observed in rats exposed by inhalation to antimony trioxide for one year (Elinder and Friberg 1986a). Antimony is classified in EPA cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (EPA 1987).

A.3 ARSENIC

Pharmacokinetics

Several studies confirm that soluble inorganic arsenic compounds and organic arsenic compounds are almost completely (>90 percent) absorbed from the GI tract in both animals and humans (Ishinishi et al. 1986). The absorption efficiency of insoluble inorganic arsenic compounds depends on particle size and stomach pH. Initial distribution of absorbed arsenic is to the liver, kidneys, and lungs, followed by redistribution to hair, nails, teeth, bone, and skin, which are considered tissues of accumulation. Arsenic has a longer half-life in the blood of rats, compared with other animals and humans, because of firm binding to the hemoglobin in erythrocytes.

Metabolism of inorganic arsenic includes reversible oxidation-reduction so that both arsenite (valence of 3) and arsenate (valence of 5) are present in the urine of animals treated with arsenic of either valence (Ishinishi et al. 1986). Arsenite is subsequently oxidized and methylated by a saturable mechanism to form mono- or dimethylarsenate; the latter is the predominant metabolite in the urine of animals or humans. Organic arsenic compounds (arsenilic acid, cacodylic acid) are not readily converted to inorganic arsenic. Excretion of organic or inorganic arsenic is largely via the urine, but considerable species variation exists. Continuously exposed humans appear to excrete 60 to 70 percent of their daily intake of arsenate or arsenite via the urine.

Noncancer Toxicity

A lethal dose of arsenic trioxide in humans is 70 to 180 mg (approximately 50 to 140 mg arsenic; Ishinishi et al. 1986). Acute oral exposure of humans to high doses of arsenic produce liver swelling, skin lesions, disturbed heart function, and neurological effects. The only noncancer effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyperpigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally occurring arsenic in well water (Tseng 1977; Tseng et al. 1968; EPA 1995a). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico (Cebrian et al. 1983; Southwick et al. 1983). Occupational (predominantly inhalation) exposure is also associated with neurological deficits, anemia, and cardiovascular effects (Ishinishi et al. 1986), but concomitant exposure to other chemicals cannot be ruled out. The EPA (1995a) derived an RfD of 0.3 mg/kg/day for chronic oral exposure, based on an NOAEL of 0.8 mg/kg/day for skin lesions from the Chinese data. The principal target organ for arsenic appears to be the skin. The nervous system and cardiovascular systems appear to be less significant target organs. Inorganic arsenic may be an essential nutrient, exerting beneficial effects on growth, health, and feed conversion efficiency (Underwood 1977).

Carcinogenicity

Inorganic arsenic is clearly a carcinogen in humans. Inhalation exposure is associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant (EPA 1995a). Oral exposure to high levels in well water is associated with increased risk of skin cancer (Tseng 1977; EPA 1995a). Extensive animal testing with various forms of arsenic given by many routes of exposure to several species, however, has not demonstrated the carcinogenicity of arsenic (International Agency for Research on Cancer [IARC] 1980). The EPA (1995a) classifies inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen) and derived an oral slope factor of 1.5 per mg/kg/day. The EPA (1995a) notes that the uncertainties associated with the oral unit risk are considerably less than those for most carcinogens, so that the unit risk might be reduced an order of magnitude. An inhalation unit risk of 0.0043 per mg/m^3 was derived for inorganic arsenic from the incidence of lung cancer in occupationally exposed men (EPA 1995a), which is equivalent to a RfD of 15.1 per mg/kg/day, assuming a 70 kg adult inhales 20 m^3 of air/day.

A.4 BARIUM

Noncancer Toxicity

Barium is a naturally occurring alkaline earth metal that comprises approximately 0.04 percent of the earth's crust (Reeves 1986a). Acute oral toxicity was manifested by GI upset, altered cardiac performance, and transient hypertension, convulsions, and muscular paralysis. Repeated oral exposures were associated with hypertension. Occupational exposure to insoluble barium sulfate induced benign pneumoconiosis (ACGIH 1991). The EPA (1995b) presented a verified chronic oral RfD of 0.07 mg/kg/day, based on an NOAEL of 0.21 mg/kg/day in a ten-week study in humans exposed to barium in drinking water and an uncertainty factor of 3. The EPA (1993b) presented the same value as a provisional RfD for subchronic oral exposure. A provisional chronic inhalation reference concentration (RfC) of 0.0005 mg/m^3 and a provisional subchronic inhalation RfC of 0.005 were based on a no observed effect level (NOEL) for fetotoxicity in a four-month intermittent-exposure inhalation study in rats (EPA 1995b). Uncertainty factors of 1000 and 100 were used for the chronic and subchronic RfC values, respectively. The chronic and subchronic inhalation RfC values are equivalent to 0.0001 and 0.001 mg/kg/day, assuming a human inhalation rate of 20 m^3/day and body weight of 70 kg. Barium is principally a muscle toxin. Its targets are the GI system, skeletal muscle, the cardiovascular system, and the fetus.

Carcinogenicity

The EPA (1995b) classifies barium as a cancer weight-of-evidence Group D substance (not classifiable as to carcinogenicity in humans). Cancer risk is not estimated for Group D substances.

A.5 BERYLLIUM

Noncancer Toxicity

Beryllium has a low order of toxicity when ingested because it is poorly absorbed from the GI tract (Reeves 1986b). Occupational exposure was associated with dermatitis, acute pneumonitis, and chronic pulmonary granulomatosis (berylliosis). Berylliosis was also observed in humans living in the vicinity of a beryllium plant. Similar pulmonary effects were observed in laboratory animals subjected to inhalation exposure. A verified chronic oral RfD value of 0.005 mg/kg/day was based on an NOAEL in a lifetime drinking water study in rats and an uncertainty factor of 100 (EPA 1995b). The EPA (1995b) presented the same value as a provisional subchronic oral RfD. The target organ for inhalation exposure appears to be the lung; a target organ is not identified for oral exposure.

Carcinogenicity

The EPA (1995b) classifies beryllium in cancer weight-of-evidence Group B2 (probable human carcinogen) based on inadequate human (occupational) cancer data and sufficient animal data. A significant increase in lung tumors occurred in rats and in rhesus monkeys subjected to inhalation exposure or intratracheal instillation of a variety of beryllium compounds. Osteogenic sarcomas were induced in rabbits and mice, but not in rats or guinea pigs, injected intravenously with various beryllium compounds. Oral studies in animals yielded inconclusive results. The EPA (1995a) derived an oral slope factor of 4.3 per mg/kg/day from a statistically nonsignificant increase in total tumors in a lifetime drinking water study in rats. An inhalation unit risk of 0.0024 per mg/m^3, equivalent to 8.4 per mg/kg/day (assuming an inhalation rate of 20 m^3/day and body weight of 70 kg for humans), was derived from an occupational study.

A.6 CADMIUM

Pharmacokinetics

Estimates of cadmium uptake by the respiratory tract range from 10 to 50 percent; uptake is greatest for fumes and small particles and least for large dust particles (Friberg et al. 1986; Goyer 1991). GI absorption of ingested cadmium is ordinarily 5 to 8 percent, but may reach 20 percent in cases of serious dietary iron deficiency. Highest tissue levels are normally found in the kidneys followed by the liver, although levels in the liver may exceed those in the kidneys of persons suffering from cadmium-induced renal dysfunction. The half-life of cadmium in the kidneys and liver may be as long as 10 to 30 years. Fecal and urinary excretion of cadmium are approximately equivalent in normal humans exposed to small amounts. Urinary excretion increases markedly in humans with cadmium-induced renal disease.

Noncancer Toxicity

Acute inhalation exposure to fumes or particles of cadmium induces respiratory symptoms, general weakness, and, in severe cases, respiratory insufficiency, shock, and death (Friberg et al. 1986). Acute oral exposure induces GI disturbances. Chronic inhalation exposure induces pulmonary emphysema, and chronic exposure by either route consistently produces renal tubular disease in humans and laboratory animals. Proteinuria is a reliable early indicator of cadmium-induced kidney disease. The combination of pulmonary emphysema and renal tubular disease, if severe, may result in early mortality. Painful osteomalacia and osteoporosis may arise from altered metabolism of bone minerals secondary to renal damage. The combination of renal and skeletal damage is called itai-itai disease in Japan. Cadmium exposure has been associated with liver damage, but the liver appears to be less sensitive than the kidney.

The kidney is the primary target organ of cadmium toxicity. The EPA (1995a) derived chronic oral RfD values of 0.5 mg/kg/day for cadmium ingested in water and 1 mg/kg/day for cadmium ingested in food, based on a toxicokinetic model that predicted NOAELs from renal cortical concentrations of cadmium. The different RfD values reflect assumed differences in GI absorption of cadmium from water (5 percent) and food (2.5 percent).

Carcinogenicity

Carcinogenicity data in humans consist of several occupational studies that associate cadmium exposure with lung cancer, but concomitant exposure to other carcinogenic chemicals and smoking were not adequately controlled. Other occupational studies reported significantly increased risk of prostatic cancer, but this effect was not observed in the largest occupational study of workers exposed to high levels (Thun et al. 1985). The animal data consist of an inhalation study in rats that showed a significant increase in lung tumors, and several parenteral injection studies that produced injection site tumors. No evidence of carcinogenicity, however, was observed in seven oral studies in rats and mice. The EPA (1995b) classifies cadmium a cancer weight-of-evidence Group B1 substance for inhalation exposure on the basis of limited evidence of carcinogenicity in humans and sufficient evidence in animals. The data were insufficient to classify cadmium as carcinogenic to humans exposed by the oral route. The EPA (1995a) derived an inhalation unit risk of 0.0018 mg/m^3 from the occupational exposure study by Thun et al. (1985).

A.7 CHROMIUM

Noncancer Toxicity

In nature, chromium (III) predominates over chromium (VI) (Langård and Norseth 1986). Little chromium (VI) exists in biological materials, except shortly after exposure, because reduction to chromium (III) occurs rapidly. Chromium (III) is considered a nutritionally essential trace element and is considerably less toxic than chromium (VI). No effects were observed in rats consuming 1800 mg chromium (III)/kg/day in the diet for over two years (EPA 1995b). The NOEL of 1800 mg/kg/day and an uncertainty factor of 1000 was the basis for a verified chronic oral RfD of 1 mg/kg/day (EPA 1995a). The same NOEL and an uncertainty factor of 100 was the basis for a provisional subchronic oral RfD of 1 mg/kg/day (EPA 1995b).

Acute oral exposure of humans to high doses of chromium (VI) induced neurological effects, GI hemorrhage and fluid loss, and kidney and liver effects. Parenteral dosing of animals with chromium (VI) is selectively toxic to the kidney tubules. An NOAEL of 2.4 mg chromium (VI)/kg/day in a one-year drinking water study in rats and an uncertainty factor of 500 was the basis of a verified RfD of 0.005 mg/kg/day for chronic oral

exposure (EPA 1995a). The same NOAEL and an uncertainty factor of 100 was the basis of a provisional subchronic oral RfD of 0.02 mg/kg/day (EPA 1995b).

Occupational (inhalation and dermal) exposure to chromium (III) compounds induced dermatitis (ACGIH 1991). Similar exposure to chromium (VI) induced ulcerative and allergic contact dermatitis, irritation of the upper respiratory tract including ulceration of the mucosa and perforation of the nasal septum, and possibly kidney effects. Inhalation RfC values were not located.

A target organ was not identified for chromium (III). The kidney appears to be the principal target organ for repeated oral dosing with chromium (VI). Additional target organs for dermal and inhalation exposure include the skin and respiratory tract.

Carcinogenicity

Data were not located regarding the carcinogenicity of chromium (III). The EPA (1995a) classifies chromium (VI) in cancer weight-of-evidence Group A (human carcinogen), based on the consistent observation of increased risk of lung cancer in occupational studies of workers in chromate production or the chrome pigment industry. Parenteral dosing of animals with chromium (VI) compounds consistently induced injection-site tumors. There is no evidence that oral exposure to chromium (VI) induces cancer. An inhalation unit risk of 0.012 per mg/m^3, equivalent to 42 per mg/kg/day, assuming humans inhale 20 m^3/day and weigh 70 kg, was based on increased risk of lung cancer deaths in chromate production workers.

A.8 COBALT

Noncancer Toxicity

Acute high oral or parenteral doses of cobalt in humans or animals induced myocardial degeneration often leading to mortality, erythropoiesis, enlarged thyroid, and, in animals, renal tubular degeneration (Elinder and Friberg 1986c). Chronic ingestion from the consumption of beer containing high concentrations of cobalt was associated with "beer-drinkers cardiomyopathy," which includes polycythemia and goiter, as well as marked myocardial degeneration and mortality. The therapeutic use of 0.16 to 0.32 mg cobalt/kg/day in anemic, anephric dialysis patients for 12 to 32 weeks induced a significant, but reversible, rise in blood hemoglobin concentration (EPA 1992b).

Occupational (inhalation and dermal) exposure was associated with allergic dermatitis, chronic interstitial pneumonitis, reversibly impaired lung function, occupational asthma, and myocardial effects (ACGIH 1991).

Cobalt was determined to be the etiologic factor in hard metal disease, the syndrome of respiratory symptoms, and pneumoconiosis associated with inhalation exposure to dusts containing tungsten carbide with cobalt powder as a binder (Elinder and Friberg 1986c). The lowest occupational air concentration of cobalt associated with hard metal disease was 0.003 mg cobalt/m^3 (Sprince et al. 1988). It should be noted that the workers were also exposed to tungsten and sometimes to titanium, tantalum, and niobium (Elinder and Friberg 1986c). Similar lung effects were seen in animals exposed to cobalt by inhalation.

The developmental toxicity of cobalt was tested in rodents treated orally with cobalt chloride (EPA 1992b). Maternal effects (unspecified) were reported in rats treated with 5.4 to 21.8 mg cobalt/kg/day from gestation day 14 through lactation day 21. Effects on the offspring included stunted growth at 5.4 mg cobalt/kg/day and reduced survival at 21.8 mg cobalt/kg/day. In rats treated with 6.2, 12.4, or 24.8 mg cobalt/kg/day on gestation days 6 through 15, maternal effects included reduced food consumption and body weight gain and altered hematologic parameters, although it is unclear at what dose level(s) these effects occurred. There were no effects on fetal survival, although a nonsignificant increase in fetal stunting was observed in rats treated with $\geq$ 12.4 mg cobalt/kg/day. Mice treated with 81.7 mg cobalt/kg/day had reduced maternal weight gain, but no fetal effects.

Several studies reported testicular degeneration and atrophy in rats treated with cobalt chloride in the diet or drinking water at concentrations equivalent to doses of 5.7 to 30.2 mg cobalt/kg/day (EPA 1992b).

Cobalt is nutritionally essential as a cofactor in cyanocobalamin (vitamin B12) (EPA 1992b). Cobalt is universally present in the diet. Average daily adult dietary intakes of cobalt range from 0.16 to 0.58 mg/day (0.002 to 0.008 mg/kg/day, assuming adults weigh 70 kg) (Tipton et al. 1966; Schroeder et al. 1967). In 9- to 12-year-old children, dietary intakes of cobalt range from 0.3 to 1.77 mg/day (Murthy et al. 1971; National Research Council 1989). Assuming an average weight for children in this age range of 28 kg (National Research Council, 1989), the dietary intakes are equivalent to 0.01 to 0.06 mg/kg/day.

The EPA (1992b) concluded that the oral toxicity data were insufficient for derivation of an oral RfD for cobalt. The relatively well characterized dietary intake data, however, can provide useful guidance. The EPA (1992b) noted that the upper range of dietary intake for children, 0.06 mg/kg/day, was below the level associated with enhanced erythropoiesis in anephric patients. Therefore, the upper range of dietary intake, 0.06 mg cobalt/kg/day, can be considered a guidance level for the oral intake of cobalt and can be used in place of an oral RfD in Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and Resource Conservation and Recovery Act (RCRA) baseline risk assessments.

The EPA (1990b) derived an interim inhalation RfC from the LOAEL of 0.003 mg cobalt/m^3 associated with hard metal disease in occupationally exposed humans (Sprince et al. 1988). Correcting for intermittent occupational exposure (10 m^3 of air inhaled per work day/20 m^3 of air inhaled per day x 5 work days per week/7 days per week) yielded an adjusted LOAEL of 0.001 mg/m^3. Application of an uncertainty factor of 1000 resulted in an interium chronic inhalation RfC of 1E-06 mg/m^3. Assuming humans inhale 20 m^3 of air/day and weigh 70 kg, the RfC is equivalent to 2.9E-07 mg/kg/day, rounded to 3E-07 mg/kg/day.

Important target organs in orally exposed humans are the heart, erythrocyte, and thyroid. Target organs for occupational exposure are the skin, lungs, and heart.

Carcinogenicity

Data regarding the carcinogenicity of cobalt were not located.

A.9 COPPER

Noncancer Toxicity

Copper is a nutritionally essential element that functions as a cofactor in several enzyme systems (Aaseth and Norseth 1986). Acute exposure to large oral doses of copper salts was associated with GI disturbances, hemolysis, and liver and kidney lesions. Chronic oral toxicity in humans has not been reported. Chronic oral exposure of animals was associated with an iron-deficiency type of anemia, hemolysis, and lesions in the liver and kidneys. Occupational exposure may induce metal fume fever, and, in cases of chronic exposure to high levels, hemolysis and anemia (ACGIH 1991). Neither oral nor inhalation RfD or RfC values were located for copper. The target organs for copper are the erythrocyte, liver, and kidney, and, for inhalation exposure, the lung.

Carcinogenicity

Copper is classified in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (EPA 1995a). Quantitative risk estimates are not derived for Group D chemicals.

A.10 CYANIDE

Noncancer Toxicity

Acute exposure to cyanide induced histotoxic hypoxia (inability of the tissues to use oxygen); death was due to central respiratory arrest (Smith 1991). Chronic dietary exposure to cyanide was associated with reduced body weight gain, decreased thyroid activity, myelin degeneration, and reduced fertility in rats (EPA 1995a). The EPA (1995a) presented a verified RfD of 0.02 mg/kg/day for oral exposure to cyanide, based on an NOAEL in a two-year study in rats that consumed food fumigated with hydrogen cyanide, and an uncertainty factor of 500. The same value was adopted as the provisional RfD for subchronic oral exposure (EPA 1995b). The target organs for acute exposure are the central nervous system (CNS), respiratory system, and cardiovascular system (ACGIH 1991). Target organs for chronic oral exposure to cyanide appear to be the thyroid and nervous system.

Carcinogenicity

The EPA (1995a) classifies cyanide as a cancer weight-of-evidence Group D substance (not classifiable as to carcinogenicity to humans). Quantitative risk estimates are not derived for Group D chemicals.

A.11 DDD [1,1-BIS(4-CHLOROPHENYL)-2,2-DICHLOROETHANE]

Noncancer Toxicity

DDD is considered a poison through ingestion. Moderately toxic by skin contact (Sax and Lewis 1989).

Short-term exposure to high doses of DDT primarily affects the nervous system. Rashes, irritation to the eyes, nose and throat were observed in some people exposed to DDT. People exposed a long time to DDT exhibited changes in the level of liver enzymes. Tests in animals have suggested that short term exposure to DDT may have a harmful effect on reproduction (ATSDR 1989).

No RfDs or RfCs were established for DDD.

Carcinogenicity

With respect to carcinogenicity, EPA (1995a) has assigned DDD a weight-of evidence of B2, meaning the EPA regards DDD as a "possible" human carcinogen. This classification is based of an increased incidence

of lung tumors in male and female mice, liver tumors in male mice and thyroid tumors in male rats. DDD is structurally similar to, and is a known metabolite of DDT, a probable human carcinogen (EPA 1995a). The evidence for carcinogenicity in humans of DDT is based on autopsy studies relating tissue levels of DDT to cancer incidence. Human epidemiological data are not available for DDD.

Tomatis et al. (1974) fed DDD for 130 weeks at 250ppm to mice. A statistically significant increase in incidence of lung tumors was observed. In males, a statistically significant increase in incidence of liver tumors was also observed. An increased incidence of thyroid tumors was observed in male rats fed DDD (EPA 1995a).

An oral slope factor for DDD is 0.24 per mg/kg/day (EPA 1995a). An inhalation slope factor is not available.

A.12 DDE [2,2-BIS(P-CHLOROPHENYL)-1,1-DICHLOROETHYLENE]

Noncancer Toxicity

DDE is considered a poison through ingestion. Reproductive effects were observed in DDE studies (Sax and Lewis 1989). Refer to the discussion on DDT for systemic effects.

RfDs and RfCs are not available for this compound.

Carcinogenicity

DDE is classified as cancer weight-of-evidence B2, a "probable" human carcinogen based on increased incidence of liver tumors (Tomatis 1974), including carcinomas in two strains of mice and in hamsters and the presence of thyroid tumors in female rats fed DDE in the diet. Rossi et al. (1983) administered DDE in feed to hamsters and a statistically significant increase in incidence of neoplastic nodules of the liver were observed. An increased incidence of thyroid tumors was observed in females (NCI 1978).

The oral slope factor derived is 0.34 per mg/kg/day. An inhalation slope factor is not available.

DDE was mutagenic in mouse lymphoma cells and chinese hamster cells. DDE is structurally similar to and a metabolite of DDT which is a probable human carcinogen.

A.13 DDT (4,4'-DICHLORODIPHENYL-TRICHLOROETHANE)

Pharmacokinetics

Dichlorodiphenyltrichlorothane (DDT) is readily absorbed when dissolved in oils, fats, or lipid solvents, but is poorly absorbed as dry powder or aqueous suspension. Once absorbed, DDT concentrates in adipose tissue. Storage in fat is protective because it decreases the amount of chemicals at the site of toxic action, the brain. At a constant rate of intake, concentrations in adipose tissue reach a steady state and remain relatively constant. When exposure ceases, DDT is slowly eliminated. The rate of elimination is estimated to be 1 percent of stored DDT excreted per day (Gartrell et al. 1985).

After absorption in mammals, DDT degrades by dehydrochlorination to unsaturated DDE and by substitution of hydrogen for one chlorine atom yielding DDD. DDD is further metabolized through a series of intermediates yielding DDA. DDA is relatively water soluble and excreted primarily in the urine. Ingestion studies of DDT administered to volunteers demonstrated that within 24 hours, urinary DDA excretion increased detectably. Excretion of DDT as DDA appeared to be totally dependent on preferential reductive dechlorination of DDT to DDD (rather than DDE) and then to DDA (Clayton 1981).

Noncancer Toxicity

The CNS is an important target organ in humans acutely exposed to DDT. Symptoms include altered sensory perception, headache, nausea, disequilibrium, confusion, tremors, and convulsions (Hayes 1982; ATSDR 1989). Tremors and hyperirritability were observed in chronically exposed animals (NCI 1978c; Rossi et al. 1977). The liver appears to be the other important target organ, at least in animals. Liver effects include enzyme induction, increased liver weight, increased serum levels of liver enzymes, hepatocellular hypertrophy, and necrosis (ATSDR 1989). The EPA (1995a) derived an RfD of 0.5 mg/kg/day for chronic oral exposure from an NOEL of 0.05 mg/kg/day for liver effects in a 15- to 27-week feeding study in rats (Laug et al. 1950). An uncertainty factor of 100 was applied with factors of 10 each for inter- and intraspecies variation.

Dermal exposure has been associated with no illness and usually no irritation. Subcutaneous injection of colloidal suspensions of DDT in saline up to 30 ppm caused no irritation. Studies of DDT-impregnated clothing have found it to cause no irritation (Hayes 1982). The earliest symptom of acute DDT poisoning is paresthesia of the mouth and lower part of the face. This is followed by paresthesia of same areas and of the tongue and then dizziness, and tremors of extremities, confusion, malaise, headache, fatigue, and delayed vomiting. Vomiting is probably of central origin and not due to local irritation. Convulsions occur only in

severe poisoning. Onset may be as soon as 30 minutes after ingestion of a large dose or as late as six hours after smaller but still-toxic doses. Recovery from mild poisoning usually is essentially complete in 24 hours, but recovery from severe poisoning requires several days (Hayes 1982).

There is no documented evidence that dietary absorption of DDT, alone or in combination with insecticides of the aldrin-toxaphene group, has caused cancer in the general population. No evidence has been presented that DDT has caused cancer among the millions of individuals (almost entirely men) who have been handling or spraying DDT (as dust, solution, and suspension) in all parts of the world and under all possible climatic conditions.

DDT is a mixture of p,p'-DDT and related compounds. One of the more important of the DDT isomers is o,p'-DDT. These agents have prominent estrogenic effects that have been well-characterized in a number of assay systems (Johnson et al. 1988). The estrogenicity of DDT has lead to the supposition that it may adversely affect reproductive outcome by causing birth defects, increasing pregnancy complications, or affecting fertility (RTC 1990).

A verified chronic oral RfD value of 0.0005 mg/kg/day (EPA 1995a) was based on a NOEL of 0.05 mg/kg/day in a 27-week rat feeding study and on an uncertainty factor of 100.

Carcinogenicity

The EPA (1995b) has classified DDT in cancer weight-of-evidence Group B2 (probable human carcinogen) based on the observation of tumors (generally of the liver) in seven studies in various mouse strains and in three studies in rats. The EPA (1995a) derived an oral slope factor of 0.34 per mg/kg/day from liver tumors in oral (diet) studies in the mouse and the rat. An inhalation unit risk of 9.7E-05 per mg/m^3, equivalent to 0.34 per mg/kg/day (assuming a 70 kg adult inhales 20 m^3 of air/day), was derived from the same oral (diet) studies.

A.14 ENDOSULFAN (SULFATE)

Toxicity information is not available for endosulfan sulfate. Therefore, data for endosulfan are presented in this section.

Noncancer Toxicity

Endosulfan is highly toxic by acute oral exposure, with a lethal dose estimated to be between 50 and 500 mg/kg (EPA 1996b). Major signs of toxicity include gagging, vomiting, diarrhea, agitation, convulsions, foaming at the mouth, dyspnea, apnea, cyanosis, unconsciousness, and death. Numerous repeated-dose studies have been conducted with endosulfan, using various animal species. In a two-year rat feeding study, effects included reduced body weight gain, marked glomerulonephrosis, and blood vessel aneurysms. The LOAEL was 75 ppm (2.9 mg/kg/day); The NOAEL was 15 ppm (0.6 mg/kg/day). Dogs fed endosulfan for one year had decreased weight gain and evidence of neurologic effects. The reported LOAEL was 30 ppm (1.9 mg/kg/day), with a NOAEL of 10 ppm (1.9 mg/kg/day). On the basis of these studies, an RfD of 6E-3 mg/kg/day was determined, with an uncertainty factor of 100.

Carcinogenicity

Carcinogenicity assessment of endosulfan is under review by the EPA.

A.15 ENDRIN (ALDEHYDE/KETONE)

Toxicity information is not available for endrin aldehyde or endrin ketone. Therefore, data for endrin are presented in this section.

Pharmacokinetics

Endrin is apparently well absorbed orally, with distribution primarily to the fat and skin (ATSDR, 1994). Excretion is through the urine and feces. Metabolism of endrin produces anti-12-hydroxyendrin and corresponding sulfate and glucuronide products. Animal studies and case studies also indicate substantial absorptions by the inhalation and dermal routes.

Noncancer Toxicity

Endrin has a high degree of acute toxicity and may produce symptoms within 20 minutes to 12 hours after exposure (EPA 1996b). Doses of 1 mg/kg may produce effects. Symptoms of endrin poisoning include headache, nausea, vomiting, dizziness, tremors, convulsions, unconsciousness, hypertension, fever, frothing from the mouth, deafness, coma, and death. A two-year dietary inclusion study in the dog resulted in mild histologic lesions of the liver, increased relative liver weights and intermittent convulsions. (Another long-term feeding study, 18 months - 2 years, indicated that both kidneys and livers were target organs.) The

LOAEL was 2 ppm (0.05 mg/kg/day) and the NOAEL was 1 ppm (0.025 mg/kg/day). Using an uncertainty factor of 100, the RfD was calculated to be 3E-4 mg/kg/day.

Carcinogenicity

The weight of evidence classification for endrin is D (not classifiable as to human carcinogenicity) (EPA, 1996b). A human carcinogenicity study (evaluation of pesticide manufacturer workers) and several rodent carcinogenicity studies were judged to be inadequate. Some of the animal work resulted in a variety of tumors that could not clearly be attributed to treatment . Several in vitro studies indicated that endrin was not genotoxic or mutagenic.

A.16 HEPTACHLOR/HEPTACHLOR EPOXIDE

Noncancer Toxicity

Results from mutagenicity bioassays suggest that these compounds may have genotoxic activity. Reproductive and teratogenic effects in rats include decreased litter size, shortened life span of suckling rats, and development of cataracts in offspring.

Tests with laboratory animals, primarily rodents, demonstrate acute and chronic toxic effects due to heptachlor exposure. Although heptachlor and heptachlor epoxide are absorbed most readily through the gastrointestinal tract, inhalation and skin contact are also potential routes of exposure. Acute exposure by various routes can cause development of hepatic vein thrombi and can effect the central nervous system and cause death. Chronic exposure induces liver changes, affects hepatic microsomal enzyme activity, and causes increased mortality in offspring. The oral LD50 in the rat is 40 mg/kg for heptachlor and 47 mg/kg for heptachlor epoxide. A two-year dietary study with rats derived a chronic oral RfD of 0.5 µg/kg/day from a NOEL of 0.15 mg/kg/day for heptachlor. A chronic oral RfD of 0.0125 mg/kg/day was derived from a 60-week dog feeding study with a LOAEL of 0.013 µg/kg/day and uncertainty factor of 1,000 for heptachlor epoxide.

Although there are reports of acute and chronic toxicity in humans, with symptoms including tremors, convulsions, kidney damage, respiratory collapse, and death, details of such episodes are not well documented. Heptachlor epoxide has been found in a high percentage of human adipose tissue samples, and also in human milk samples and biomagnification of heptachlor/heptachlor epoxide occurs. This compound also has been found in the tissues of stillborn infants, suggesting an ability to cross the placenta and bioaccumulate in the fetus.

Carcinogenicity

Heptachlor and heptachlor epoxide are liver carcinogens when administered orally to mice. EPA classifies both with a cancer weight-of-evidence B2. Heptachlor has an oral slope factor of 4.5 per mg/kg/day based on the observation of liver carcinomas in mice exposed during an oral diet study. An inhalation unit risk of 0.0013 $\mu g/m^3$ which is equivalent to 4.55 per mg/kg/day assuming a 70 kg adult inhales 20 m^3/day. Heptachlor epoxide in an 18- to 24-month dietary study in two strains of mice derived an oral slope factor of 9.1 per mg/kg/day and an inhalation slope factor of 9.1 per mg/kg/day through route extrapolation.

A.17 BETA-, DELTA-, AND GAMMA-BENZENE HEXACHLORIDE (BHC)

Health Effects

The alpha, beta, and gamma isomers of benzene hexachloride (BHC) have all been shown to cause liver tumors in mice but not in other tested species. BHC has not been thoroughly tested for genotoxic effects but does not appear to be mutagenic. The alpha, beta, and delta isomers have not been tested for their teratogenic or reproductive toxicological potential. Lindane (gamma-BHC) has been tested and was not teratogenic, but in two studies it decreased the number of live young produced (Earl et al. 1973). Alpha-BHC has been shown to cause nonmalignant lesions in the liver of test animals at doses below those required to induce tumors. Lindane has been associated with the development of aplastic anemia in humans (West 1967).

DELTA - BHC

Noncancer Toxicity

Neither an oral nor an inhalation RfD has been determined for this material. The gamma isomer (lindane) has been more extensively evaluated and its toxicologic characteristics are described below. Delta-BHC has been generically described as a CNS depressant with an unknown mechanism of action (Ecobichon, 1996). There was a reported rat study in which 78 weeks of treatment with 1000 mg/kg in the diet produced liver hypertrophy (EPA 1980).

Exposure to lindane causes tremors, ataxia, convulsions, respiratory stimulation, and prostration (Ecobichon, 1996). In a subchronic dietary study (rat), 12 to 18 weeks of exposure produced liver hypertrophy, kidney tubular degeneration, hyaline droplets, tubular distension, interstitial nephritis, and basophilic tubules (EPA 1996b). The LOAEL was 20 ppm (1.55 mg/kg/day). No significant effects were reported at 4 ppm (0.29 to

0.33 mg/kg/day). Rats dosed with gamma-BHC in the diet for two years developed slight liver and kidney damage (100 ppm) and a NOAEL was determined to be 50 ppm (2.5 mg/kg/day). In dogs, two years of dietary inclusion resulted in increased alkaline phosphatase and enlarged dark friable livers at a level of 100 ppm. A dose level of 50 ppm (1.6 mg/kg/day) was determined to be the NOAEL. Based on the 0.33 mg/kg/day NOAEL from the subchronic rat study, and applying an uncertainty factor of 1,000, the oral RfD for Lindane was calculated to be 3E-4 mg/kg/day.

Carcinogenicity

Delta-BHC is classified as a cancer weight of evidence Group D compound (not classifiable as to human carcinogenicity) based on the lack of definitive carcinogenicity data (EPA 1996b). In two reported mouse studies, with treatment periods of 26 or 110 weeks, 400 to 600 mg/kg in the diet resulted in hepatic tumors and lung metastases (EPA 1980b). The oral slope factor for gamma-BHC (lindane) is under review by the EPA, but is listed by HEAST (EPA 1995b) as 1.3 E+0 per mg/kg/day based on a 2-year mouse study (EPA 1996b). The dietary inclusion study was reported to produce tumors in the livers of treated mice. The weight of evidence Group B2-C (possible to probably human carcinogen) was assigned to gamma-BHC.

A.18 HEXACHLOROPHENE

Noncancer Toxicity

Hexachlorophene is highly toxic by ingestion, with a reported lethal dose of 250 mg/kg for a child and an LD^{50} of 60 mg/kg in the rat (Sax and Lewis, 1984). It is moderately toxic by dermal contact (guinea pig LD^{50} = 1100 mg/kg) and is considered to be an irritant to the skin and eyes. Symptomology subsequent to ingestion by humans include nausea, vomiting, diarrhea, shock, and injury of the heart muscle. In a rat feeding study, animals receiving 25 mg/kg/day developed hindquarter weakness and eventual paralysis. Histopathologic evaluation revealed a spongy degeneration of brain and spinal cord tissue. Likewise, a 13-week dog feeding study resulted in spongiosis of the brain and optic nerve, as well as swelling of the salivary glands (EPA 1996a). The LOAEL in the dog study was 0.75 mg/kg/day (a NOAEL was not determined).

On the basis of the dietary study in dogs, and applying an uncertainty factor of 3000, the oral RfD for hexachlorophene was calculated to be 3E-4 mg/kg/day. A medium level of confidence has been assigned to this RfD.

Carcinogenicity

Insufficient data are available to determine a cancer slope factor. Hexachlorophene has been reported to be an experimental tumorigen and teratogen and a suspected carcinogen (Sax and Lewis, 1984).

A.19 2-HEXANONE (METHYL N-BUTYL KETONE)

Noncancer Toxicity

The acute oral toxicity of 2-hexanone is low, with an oral $LD_{50/30}$ for rats of 2,600 mg/kg (ACGIH 1986). The classic effect of occupational (dermal and inhalation) exposure to 2-hexanone is peripheral neuropathy. The same effect was observed in inhalation experiments with laboratory animals. Studies by the Carnegie Mellon Institute of Research (1977a, 1977b) and Eben et al. (1979) on laboratory rats resulted in an overall LOAEL of 40 mg/kg/day. A provisional chronic oral RfD of 0.04 mg/kg/day was derived based on the application of an uncertainty factor of 10,000 to the LOAEL.

Carcinogenicity

Data were not located regarding the carcinogenicity of 2-hexanone.

A.20 IRON

Noncancer Toxicity

Iron is moderately toxic through ingestion and inhalation of iron dusts and powders. Inhalation may be irritating to the respiratory tract. The inhalation of large amounts of iron dust results in iron pneumoconiosis (arc welders lung) (Sax and Lewis, 1989). Chronic inhalation can produce mottling (spotting) of lungs (siderosis). Ingestion of greater than 50 to 100 mg of iron per day may result in pathological iron deposition in body tissues the symptoms of which are fibrosis of the pancreas, diabetes mellitus, and liver cirrhosis. Eye contact may cause conjunctivitis. The LDLO intraperitoneal for rabbits is 20 mg/kg with no toxic effect observed. The ACGIH TLV for iron oxide fumes is 5 mg/m^3.

Carcinogenicity

IARC, National Toxicology Program (NTP), and Occupational Safety and Health Association (OSHA) do not list iron as a carcinogen although the mining of one particular ore, hematite, may be associated with an increased risk of lung cancer in miners. No other iron ores are identified specifically as a carcinogen.

A.21 LEAD

Pharmacokinetics

Studies in humans indicate that an average of 10 percent of ingested lead is absorbed, but estimates as high as 40 percent were obtained in some individuals (Tsuchiya 1986). Nutritional factors have a profound effect on GI absorption efficiency. Children absorb ingested lead more efficiently than adults; absorption efficiencies up to 53 percent were recorded for children three months to eight years of age. Similar results were obtained for laboratory animals; absorption efficiencies of 5 to 10 percent were obtained for adults and ≥50 percent were obtained for young animals. The deposition rate of inhaled lead averages approximately 30 to 50 percent, depending on particle size, with as much as 60 percent deposition of very small particles (0.03 mm) near highways. All lead deposited in the lungs is eventually absorbed.

Approximately 95 percent of the lead in the blood is located in the erythrocytes (EPA 1990a). Lead in the plasma exchanges with several body compartments, including the internal organs, bone, and several excretory pathways. In humans, lead concentrations in bone increase with age (Tsuchiya, 1986). About 90 percent of the body burden of lead is located in the skeleton. Neonatal blood concentrations are about 85 percent of maternal concentrations (EPA 1990a). Excretion of absorbed lead is principally through the urine, although GI secretion, biliary excretion, and loss through hair, nails, and sweat are also significant.

Noncancer Toxicity

The noncancer toxicity of lead to humans has been well characterized through decades of medical observation and scientific research. The principal effects of acute oral exposure are colic with diffuse paroxysmal abdominal pain (probably due to vagal irritation), anemia, and, in severe cases, acute encephalopathy, particularly in children (Tsuchiya 1986). The primary effects of long-term exposure are neurological and hematological. Limited occupational data indicate that long-term exposure to lead may induce kidney damage. The principal target organs of lead toxicity are the erythrocyte and the nervous system. Some of the effects on the blood, particularly changes in levels of certain blood enzymes, and subtle

neurobehavioral changes in children, appear to occur at levels so low as to be considered nonthreshold effects.

EPA (1995b) presents no inhalation RfC for lead, but referred to the National Ambient Air Quality Standard (NAAQS) for lead, which could be used in lieu of an inhalation RfC. The NAAQSs are based solely on human health considerations and are designed to protect the most sensitive subgroup of the human population. The NAAQS for lead is 1.5 mg/m^3, averaged quarterly (EPA 1995b). The NAAQS is equivalent to 0.00043 mg/kg/day, assuming a body weight of 70 kg and an inhalation rate of 20 m^3/day.

The EPA (1990a) determined that it is inappropriate to derive an RfD for oral exposure to lead for several reasons. First, the use of an RfD assumes that a threshold for toxicity exists, below which adverse effects are not expected to occur; however, the most sensitive effects of lead exposure, impaired neurobehavioral development in children and altered blood enzyme levels associated with anemia, may occur at blood lead concentrations so low as to be considered practically nonthreshold in nature. Second, RfD values are specific for the route of exposure for which they are derived. Lead, however, is ubiquitous, so that exposure occurs from virtually all media and by all pathways simultaneously, making it practically impossible to quantify the contribution to blood lead from any one route of exposure. Finally, the dose-response relationships common to many toxicants, and upon which derivation of an RfD is based, do not hold true for lead. This is because the fate of lead within the body depends, in part, on the amount and rate of previous exposures, the age of the recipient, and the rate of exposure. There is, however, a reasonably good correlation between blood lead concentration and effect. Therefore, blood lead concentration is the appropriate parameter on which to base the regulation of lead.

The EPA Integrated Exposure and Uptake Biokinetic (IEUBK) lead model is an iterated set of equations that estimate blood lead concentration in children aged 0 to 7 years (EPA 1990a; 1994b). The biokinetic part of the model describes the movement of lead between the plasma and several body compartments and estimates the resultant blood lead concentration. The rate of the movement of lead between the plasma and each compartment is a function of the transition or residence time (i.e., the mean time for lead to leave the plasma and enter a given compartment, or the mean residence time for lead in that compartment). Compartments modeled include the erythrocytes, liver, kidneys, all the other soft tissue of the body, cortical bone, and trabecular bone. Excretory pathways and their rates are also modeled. These include the mean time for excretion from the plasma to the urine, from the liver to the bile, and from the other soft tissues to the hair, skin, sweat, etc. The model permits the user to adjust the transition and residence times.

EPA guidance (EPA 1994a) recommends a residential screening level for lead of 400 ppm to be applied at Superfund and RCRA sites. This value is considered by EPA to be protective for direct contact with lead-

contaminated soils in residential settings. The guidance adopts recommendations of the Centers for Disease Control and is to be followed when current or predicted land use is residential.

The residential screening level for lead described in this directive has been calculated with the EPA's new IIEUBK using default parameters (EPA 1994b).

Carcinogenicity

EPA (1995a) classifies lead in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate evidence of cancer in humans and sufficient animal evidence. The human data consist of several epidemiologic occupational studies that yielded confusing results. All of the studies lacked quantitative exposure data and failed to control for smoking and concomitant exposure to other possibly carcinogenic metals. Rat and mouse bioassays showed statistically significant increases in renal tumors following dietary and subcutaneous exposure to several soluble lead salts. Various lead compounds were observed to induce chromosomal alterations in vivo and in vitro, sister chromatid exchange in exposed workers, and cell transformation in Syrian hamster embryo cells; to enhance simian adenovirus induction; and to alter molecular processes that regulate gene expression. EPA (1995a) declined to estimate risk for oral exposure to lead because many factors (e.g., age, general health, nutritional status, existing body burden and duration of exposure) influence the bioavailability of ingested lead, introducing a great deal of uncertainty into any estimate of risk.

A.22 MANGANESE

Noncancer Toxicity

Manganese is nutritionally required in humans for normal growth and health (EPA 1995a) Humans exposed to approximately 0.8 mg manganese/kg/day in drinking water exhibited lethargy, mental disturbances (1/16 committed suicide), and other neurologic effects. The elderly appeared to be more sensitive than children. Oral treatment of laboratory rodents induced biochemical changes in the brain, but rodents did not exhibit the neurological signs exhibited by humans. Occupational exposure to high concentrations in air induced a generally typical spectrum of neurological effects, and increased incidence of pneumonia (ACGIH 1986).

Very recently, a chronic oral water RfD of 0.005 mg/kg/day has been made available for manganese based on a drinking water study (EPA 1995a) and a chronic oral food RfD of 0.14 mg/kg/day (EPA 1995a) was adopted based on a NOAEL of 0.14 mg/kg/day for humans in a dietary study. An inhalation RfD of 0.0143 µg/kg/day was presented for manganese. The subchronic oral RfDs presented by EPA (1995b) was

the same value as the chronic oral RfDs. The EPA (1995a) presented a verified chronic inhalation RfC of 0.00005 mg/m^3 based on an LOAEL for respiratory symptoms and psychomotor disturbances in occupationally exposed humans and an uncertainty factor of 1000. The EPA (1995a) presented the same value as a subchronic inhalation RfC. The inhalation RfC is equivalent to 0.000014 mg/kg/day, assuming humans inhale 20 m^3 of air/day and weigh 70 kg. The CNS and respiratory tract are target organs of inhalation exposure to manganese.

Carcinogenicity

The EPA (1995a) classifies manganese in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). Quantitative cancer risk estimates are not derived for Group D chemicals.

A.23 MERCURY

Mercury occurs in three forms: elemental, organic, and inorganic. Although the toxicity of all forms is mediated by the mercury cation, the extent of absorption and pattern of distribution within the body, which determines the effects observed, depends on the form to which the organism is exposed (Goyer 1991). Bacterial activity in the environment converts inorganic mercury to methyl mercury (Berlin 1986a). It is likely that either inorganic mercury or methyl mercury may be taken up by plants and enter the food chain, and this discussion will focus on inorganic and methyl mercury. Exposure to elemental mercury, which is more likely to occur in an occupational setting, is not discussed herein.

Pharmacokinetics

The GI absorption of inorganic mercury salts is about 2 to 10 percent in humans, and slightly higher in experimental animals (Berlin 1986; Goyer 1991). Inorganic mercury in the blood is roughly equally divided between the plasma and erythrocytes. Distribution is preferentially to the kidney, with somewhat lower concentrations found in the liver, and even lower levels found in the skin, spleen, testes, and brain (Berlin 1986). Inorganic mercury is excreted principally through the feces and urine, with minor pathways including the secretions of exocrine glands and exhalation of elemental mercury vapor.

Methyl mercury is nearly completely (90 to 95 percent) absorbed from the GI tract (Berlin 1986). The concentration of methyl mercury in the erythrocytes is about 10 times that in the plasma. Methyl mercury leaves the blood slowly, showing particular affinity for the brain, particularly in primates. In rats, 1 percent of the body burden of methyl mercury is found in the brain, but in humans, 10 percent of the body burden is found in the brain. Somewhat lower levels are found in the liver and kidney. During pregnancy, methyl

mercury accumulates in the fetal brain, often at levels higher than in the maternal brain. Most tissues except the brain transform methyl mercury to inorganic mercury. Excretion of methyl mercury is principally via the bile, with a half-life of 70 days in humans not suffering from toxicity. Following exposure to methyl mercury, some of the mercury in the bile exists as methyl mercury and some as the inorganic form. The inorganic form is largely passed in the feces, but the methyl mercury is subject to enterohepatic recirculation. Another important excretory pathway for methyl mercury is lactation.

Noncancer Toxicity

Target organs for inorganic or methyl mercury include the kidney, nervous system, fetus, and neonate. Acute oral exposure to high doses of inorganic mercury causes severe damage to the GI mucosa because of the corrosive nature of mercury salts, which may lead to bloody diarrhea, shock, circulatory collapse, and death (Berlin 1986; Goyer 1991). Acute sublethal poisoning induces severe kidney damage. Chronic exposure induces an autoimmune glomerular disease and renal tubular injury. The EPA (1995b) presented a verified RfD of 0.3 mg/mg-day for chronic oral exposure to inorganic mercury, based on kidney effects in rats.

Acute or chronic exposure to methyl mercury leads to neurologic dysfunction (Berlin 1986; Goyer 1991). The region of the nervous system affected is species-dependent. Methyl mercury poisoning in rats induces peripheral nerve damage and kidney effects. In humans, the sensory cortex appears to be the most sensitive. The brain of the fetus and the neonate may be unusually sensitive to methyl mercury; retarded neurologic development was observed in prenatally exposed children whose mothers showed no clinical signs of poisoning. An inhalation RfC of 0.0003 mg/kg/day (uncertainty factor of 30) has been established for inorganic mercury based on neurotoxic effects in humans. This translates into a chronic RfD of 0.000086 mg/kg/day (EPA, 1995b).

Carcinogenicity

The EPA (1995a) classifies inorganic mercury in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans), based on no data regarding cancer in humans, and inadequate animal and supporting data. In an intraperitoneal injection study with metallic mercury in rats, sarcomas developed only in those tissues in direct contact with the test material (Druckrey et al. 1957). A two-year dietary study in rats with mercuric acetate (inorganic mercury) yielded no evidence of carcinogenicity (Fitzhugh et al. 1950). In mice, however, dietary exposure to high doses of mercury chloride for up to 78 weeks induced renal adenomas and adenocarcinomas (Mitsumori et al. 1981). The EPA has not yet evaluated the carcinogenicity of organic mercury. No carcinogenic effect, however, was observed in a two-year feeding study with phenylmercuric acetate in rats (Fitzhugh et al. 1950).

A.24 NICKEL

Noncancer Toxicity

In a subchronic gavage study with nickel chloride in water, clinical signs of toxicity in rats included lethargy, ataxia, irregular breathing, reduced body temperature, salivation, and discolored extremities (EPA 1995a). Inhalation exposure was associated with asthma and pulmonary fibrosis in welders using nickel alloys (ACGIH 1986). Lung effects were observed in laboratory animals exposed by inhalation. The EPA (1995a) presented a verified RfD of 0.02 mg/kg/day for chronic oral exposure to nickel, based on an NOAEL for decreased organ and body weights in a two-year dietary study with nickel in rats and an uncertainty factor of 300. The EPA (1995b) presented the same value as a provisional subchronic oral RfD. The CNS appears to be the target organ for the oral toxicity of nickel. The lung is the target organ for inhalation exposure.

Carcinogenicity

Occupational exposure to nickel was associated with increased risk of nasal, laryngeal and lung cancer (ATSDR 1991b). Inhalation exposure of rats to nickel subsulfide increased the incidence of lung tumors. The EPA (1995a) presents a cancer weight-of-evidence Group A classification (human carcinogen) for nickel, and presents an inhalation unit risk of 0.00024 per mg/m^3 for nickel refinery dust. The unit risk is equivalent to 0.84 per mg/kg/day, assuming humans inhale 20 m^3 of air/day and weigh 70 kg. The quantitative estimate was derived from the human occupational studies.

A.25 POLYAROMATIC HYDROCARBONS

Polynuclear aromatic hydrocarbons (PAHs) are a large class of ubiquitous natural and anthropogenic chemicals, all with similar chemical structures (ATSDR 1990). There are eleven individual PAHs listed among the chemicals of potential concern (COPCs) for Key West.

Pharmacokinetics

Although quantitative absorption data for the PAHs were not located, benzo(a)pyrene was readily absorbed across the GI (Rees et al. 1971) and respiratory epithelia (Kotin et al. 1969; Vainich et al. 1976). The high lipophilicity of other compounds in this class suggests that other PAHs also would be readily absorbed across GI and respiratory epithelia.

Benzo(a)pyrene was distributed widely in the tissues of treated rats and mice, but primarily to tissues high in fat, such as adipose tissue and mammary gland (Kotin et al. 1969; Schlede et al. 1970a). Patterns of tissue distribution of other PAHs would be expected to be similar because of the high lipophilicity of the members of this class.

Studies of the metabolism of benzo(a)pyrene provide information relevant to other PAHs because of the structural similarities of all members of the class. Metabolism involves microsomal mixed function oxidase hydroxylation of one or more of the phenyl rings with the formation of phenols and dihydrodiols, probably via formation of arene oxide intermediates (EPA 1979a). The dihydrodiols may be further oxidized to diol epoxides, which, for certain members of the class, are known to be the ultimate carcinogens (LaVoie et al. 1982). Conjugation with glutathione or glucuronic acid, and reduction to tetrahydrotetrols are important detoxification pathways. Metabolism of naphthalene resulted in the formation of 1,2-naphthoquinone, which induced cataract formation and retinal damage in rats and rabbits.

Excretion of benzo(a)pyrene or dibenzo(a,h)anthracene residues was reported to be rapid, although quantitative data were not located (EPA 1979b). Excretion occurred mainly via the feces, probably largely due to biliary secretion (Schlede et al. 1970a, 1970b). The EPA (1980a) concluded that accumulation in the body tissues of PAHs from chronic low level exposure would be unlikely.

Noncancer Toxicity

Oral noncancer toxicity data are available for acenaphthene, anthracene, fluoranthene, fluorene, and naphthalene. Newborn infants, children, and adults exposed to naphthalene by ingestion, inhalation, or possibly by skin contact developed hemolytic anemia with associated jaundice and occasionally renal disease (EPA 1979c). In a 13-week gavage study in rats, treatment with 50 mg naphthalene/kg, 5 days/week for 13 weeks (35.7 mg/kg/day) induced no effects; higher doses presumably reduced the growth rate (NTP 1980). Application of an uncertainty factor of 1000 yielded a provisional RfD for chronic oral exposure of 0.04 mg/kg/day (EPA 1995b)which has recently been withdrawn. The very mild effect (decreased growth rate) apparently observed at higher doses suggests that the RfD is very conservatively protective.

Acenaphthene appears to be a mild hepatotoxicant, and possibly a nephrotoxicant, in rodents (EPA 1995a). In a comprehensive 90-day toxicity study in mice, gavage treatment with 175 mg/kg/day was an NOAEL; liver weight changes accompanied by hepatocellular hypertrophy and elevated cholesterol levels occurred in mice treated with 350 or 700 mg/kg/day (EPA 1989a). Oral treatment of rats and mice for 32 days with 2,000 mg/kg/day resulted in weight loss and mild liver and kidney lesions (Knobloch et al. 1969). The EPA (1995a) verified a chronic oral RfD for acenaphthene of 0.06 mg/kg/day based on an NOAEL for liver effects

in a subchronic gavage study in mice and an uncertainty factor of 3000. An uncertainty factor of 3000 was used with factors of 10 each for inter- and intraspecies variation and to expand from subchronic to chronic exposure, and a factor of 3 to reflect gaps in the database, namely lack of adequate data in a second species and lack of developmental and reproductive data. Confidence in the database was low because of the data gaps. Confidence in the critical study was low because the effects were considered adaptive, rather than adverse, which implies that the RfD is extremely conservative. The EPA (1995b) presented a provisional subchronic oral RfD of 0.6 based on the same NOAEL and an uncertainty factor of 300. Target organs for acenaphthene include the liver and kidney.

The toxic potency of anthracene appears to be very low. In a chronic study in rats, doses of 5 to 15 mg/rat (16 to 48 mg/kg/day) via the diet had no effect on longevity or gross or histopathologic appearance on unspecified tissues (Schmahl 1955). Gavage treatment of mice with 1000 mg/kg/day for at least 90 days had no effects on a comprehensive range of toxicologic parameters. The NOEL of 1000 mg/kg/day in mice and an uncertainty factor of 3000 (10 each for inter- and intraspecies variation, and 30 for the use of a subchronic study and an incomplete database) yielded a verified RfD for chronic oral exposure of 0.3 mg/kg/day (EPA 1995a). The EPA (1995b) presented a subchronic oral RfD of 3 mg/kg/day based on the same NOEL and an uncertainty factor of 300. The data were inadequate to define target organs for the toxicity of anthracene.

Fluoranthene appears to be toxic to the liver, kidney, and blood. In a comprehensive 13-week gavage study in mice, 125 mg/kg/day was an NOAEL and 250 mg/kg/day was an LOAEL (EPA 1988). The verified chronic oral RfD for fluoranthene is 0.04 mg/kg/day, based on the NOAEL in a comprehensive 13-week gavage study of 125 mg/kg/day in mice and an uncertainty factor of 3000 (EPA 1995a). The uncertainty factor of 3000 includes factors of 10 each for inter- and intraspecies variation, and a factor of 30 to expand from subchronic to chronic exposure and to reflect an incomplete database. A provisional subchronic oral RfD of 0.4 mg/kg/day was derived from the same NOAEL and an uncertainty factor of 300. The liver, kidney, and blood appear to be the target organs for the toxicity of fluoranthene.

The critical effects of oral exposure to fluorene appear to be hemolytic anemia and CNS effects. In mice treated by gavage for 13 weeks, 125 mg/kg/day was an NOAEL and 250 mg/kg/day was an LOAEL (EPA 1989b). A verified chronic oral RfD for fluorene of 0.04 mg/kg/day was based on the NOAEL of 125 mg/kg/day for hemolytic anemia in mice (EPA 1995a). An uncertainty factor of 3000 was used with factors of 10 each for inter- and intraspecies variation and to expand from subchronic to chronic exposure, and a factor of 3 to reflect gaps in the database. The EPA (1995b) presented a provisional subchronic oral RfD of 0.4 mg/kg/day based on the same NOAEL and an uncertainty factor of 300. The target organs of fluorene toxicity are the erythrocyte and the CNS.

Newborn infants, children, and adults exposed to naphthalene by ingestion, inhalation, or possibly by skin contact developed hemolytic anemia with jaundice and, occasionally, renal disease (EPA 1980a). In a 13-week gavage study in rats, treatment with naphthalene reduced the growth rate (EPA 1992a). Application of an uncertainty factor of 1000 to the rat NOEL yielded a provisional RfD for subchronic and chronic oral exposure of 0.04 mg/kg/day (EPA 1992a). The erythrocyte and the kidney appear to be the target organs for the toxicity of naphthalene.

Mild kidney lesions appear to be the critical effects of pyrene. In mice treated by gavage for 13 weeks, 75 mg/kg/day was an NOAEL and 125 mg/kg/day was an LOAEL (EPA 1989c). Even in mice treated with 250 mg/kg/day the lesions were considered minimal to mild. The EPA (1993) verified a chronic oral RfD for pyrene of 0.03 mg/kg/day based on the NOAEL in mice and an uncertainty factor of 3000 (10 each for inter- and intraspecies variation and to expand from subchronic to chronic exposure, and a factor of 3 to reflect gaps in the database). The EPA (1995b) presented a provisional subchronic oral RfD of 0.3 mg/kg/day based on the same NOAEL and an uncertainty factor of 300. The kidney is the target organ for the toxicity of pyrene.

Carcinogenicity

The PAHs are ubiquitous, being released to the environment from anthropogenic as well as from natural sources (ATSDR 1987). Benzo(a)pyrene is the most extensively studied member of the class, inducing tumors in multiple tissues of virtually all laboratory species tested by all routes of exposure. Although epidemiology studies suggested that complex mixtures that contain PAHs (coal tar, soots, coke oven emissions, cigarette smoke) are carcinogenic to humans, the carcinogenicity cannot be attributed to PAHs alone because of the presence of other potentially carcinogenic substances in these mixtures (ATSDR 1987). In addition, recent investigations showed that the PAH fraction of roofing tar, cigarette smoke, and coke oven emissions accounted for only 0.1 to 8 percent of the total mutagenic activity of the unfractionated complex mixture in *Salmonella* (Lewtas 1988). Aromatic amines, nitrogen heterocyclic compounds, highly oxygenated quinones, diones, and nitrooxygenated compounds, none of which would be expected to arise from in vivo metabolism of PAHs, probably accounted for the majority of the mutagenicity of coke oven emissions and cigarette smoke. Furthermore, coal tar, which contains a mixture of many PAHs, has a long history of use in the clinical treatment of a variety of skin disorders in humans (ATSDR 1987).

Because of the lack of human cancer data, assignment of individual PAHs to EPA cancer weight-of-evidence groups was based largely on the results of animal studies with large doses of purified compound. Frequently, unnatural routes of exposure, including implants of the test chemical in beeswax and trioctanoin in the lungs of female Osborne-Mendel rats, intratracheal instillation, and subcutaneous or intraperitoneal injection, were

used. Of the PAHs of concern, no EPA cancer weight-of-evidence group classification was provided for acenaphthene (EPA 1995a). Anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, and naphthalene were classified in Group D (not classifiable as to carcinogenicity to humans), and benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were classified in Group B2 (probable human carcinogens).

The EPA (1995a) verified a slope factor for oral exposure to benzo(a)pyrene of 7.3 per mg/kg/day, based on several dietary studies in mice and rats. Neither verified nor provisional quantitative risk estimates were available for the other PAHs in Group B2. The EPA (1980a) promulgated an ambient water quality criterion for "total carcinogenic PAHs," based on an oral slope factor derived from a study with benzo(a)pyrene, as being sufficiently protective for the class. Largely because of this precedent, the quantitative risk estimates for the other carcinogenic PAHs were based on benzo(a)pyrene when quantitative estimates were needed.

Recent reevaluations of the carcinogenicity and mutagenicity of the Group B2 PAHs suggest that there are large differences between individual PAHs in cancer potency (Krewski et al., 1989). Based on the available cancer and mutagenicity data, and assuming that there is a constant relative potency between different carcinogens across different bioassay systems and that the PAHs under consideration have similar dose-response curves, Thorslund and Charnley (1988) derived relative potency values for several PAHs. A more recent Relative Potency Factor (RPF) scheme for the Group B2 PAHs was based only on the induction of lung epidermoid carcinomas in female Osborne-Mendel rats in the lung-implantation experiments (Clement International 1990). The most defensible RPFs and the associated oral and inhalation slope factors are presented in Table G.3-2 in Appendix G of the Supplemental RCRA Facility Investigation/Remedial Investigation (RFI/RI) Report.

Listed below are individual PAH toxicological profiles, if available.

BENZO(B)FLUORANTHENE

Noncancer Toxicity

Little information is available on benzo(b)fluoranthene. However based on the similarities of chemical structures, most properties should be similar to benzo(a)pyrene.

Carcinogenicity

A Clement's RFP has been developed (Clement International, 1990) for benzo(b)fluoranthene which allows the estimation of Slope Factors (SFs) of 7.3E-01 and 6.1E-01 per mg/kg/day for the oral and inhalation routes respectively. The EPA (1995b) has classified benzo(b)fluoranthene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on lung tumors in mice.

BENZO(G,H,I)PERYLENE

Noncancer Toxicity

Little information is available on benzo(g,h,i)perylene. However based on the similarities of chemical structures, most properties should be similar to benzo(a)pyrene.

Carcinogenicity

The EPA (1995b) has classified benzo(g,h,i)perylene in cancer weight-of-evidence Group D (Not classifiable as to Human Carcinogenicity, inadequate or no evidence).

BENZO(K)FLUORANTHENE

Noncancer Toxicity

Little information is available on benzo(k)fluoranthene. However, based on the similarities of the chemical structures, most properties should be similar to benzo(a)pyrene.

Carcinogenicity

A Clement's RFP has been developed (Clement International, 1990) for benzo(k)fluoranthene which allows the estimation of 7.3E-02 and 6.1E-02 per mg/kg/day for the SF for the oral and inhalation route respectively. The EPA (1995a) has classified benzo(k)fluoranthene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on lung tumors in mice.

CHRYSENE

Noncancer Toxicity

Chrysene is absorbed by the oral route of exposure. Absorption may also occur following dermal exposure. Data are not available to determine whether chrysene is absorbed via the lungs. Absorbed chrysene is distributed to several tissues, i.e. it was found in five tissues in a study reported in 1983. It is accumulated preferentially in the adipose and mammary tissue.

There is no information on other toxic effects of chrysene in human and laboratory animals following inhalation, oral and dermal exposures. (ATSDR 1987, draft).

Carcinogenicity

A Clement's RFP has been developed for chrysene. This allows the estimation of SFs of 7.3E-03 and 6.1E-03 per mg/kg/day for the oral and inhalation routes respectively.

The EPA (1995a) has classified chrysene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on tumors and malignant lymphoma in mice and chromosomal abnormalities in hamsters.

INDENO(1,2,3-CD)PYRENE

Noncancer Toxicity

Little information was found on the toxicity of indeno(1,2,3-cd)pyrene. Because of its structural similarity its properties should resemble benzo(a)pyrene.

Carcinogenicity

A Clement's RFP has been developed for indeno(1,2,3-cd)pyrene. This allows the estimation of SFs of 7.3E-01 and 6.1E-01 per mg/kg/day for the oral and inhalation routes respectively. The EPA (1995a) has classified indeno(1,2,3-cd)pyrene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on tumors in mice following lung implants.

A.26 POLYCHLORINATED BIPHENYLS (AROCHLOR-1260)

Noncancer Toxicity

Epidemiologic studies of women in the United States associated oral polychlorinated biphenyl (PCB) exposure with low birth weight or retarded musculoskeletal or neurobehavioral development of their infants (ATSDR 1991a). Oral studies in animals established the liver as the target organ in all species, and the thyroid as an additional target organ in the rat. Effects observed in monkeys included gastritis, anemia, chloracne-like dermatitis, and immunosuppression. Oral treatment of animals induced developmental effects, including retarded neurobehavioral and learning development in monkeys. An oral RfD of 0.07 µg/kg/day was presented for Arochlor-1016. A chronic RfD of 0.02 µg/kg/day derived from a LOAEL of 0.005 mg/kg/day based on a 5-year study with monkeys was presented for Arochlor-1254 (EPA 1995a) and a subchronic oral RfD of 0.05 µg/kg/day with an uncertainty factor of 100 (EPA 1995b). The target organ was the immune system.

Occupational exposure to PCBs was associated with upper respiratory tract and ocular irritation, loss of appetite, liver enlargement, increased serum concentrations of liver enzymes, skin irritation, rashes and chloracne, and, in heavily exposed female workers, decreased birth weight of their infants (ATSDR 1991a). Concurrent exposure to other chemicals confounded the interpretation of the occupational exposure studies. Laboratory animals exposed by inhalation to Arochlor-1254 vapors exhibited moderate liver degeneration, decreased body weight gain and slight renal tubular degeneration. Neither subchronic nor chronic inhalation RfC values were available.

Target organs for PCBs include the skin, liver, fetus, and neonate.

Carcinogenicity

The EPA (1995b) classifies the PCBs as EPA cancer weight-of-evidence Group B2 substances (probable human carcinogens), based on inadequate data in humans and sufficient data in animals. The human data consist of several epidemiologic occupational and accidental oral exposure studies with serious limitations, including poorly quantified concentrations of PCBs and durations of exposure, and probable exposures to other potential carcinogens.

The animal data consist of several oral studies in rats and mice with various arochlors, kanechlors, or clophens (commercial PCB mixtures manufactured in the United States, Japan and Germany, respectively) that reported increased incidence of liver tumors in both species (EPA 1995a).

The EPA (1995a) presents a verified oral slope factor of 7.7 per mg/kg/day for all PCBs based on liver tumors in rats treated with Arochlor-1260.

A.27 SELENIUM

Noncancer Toxicity

Selenium is a nutritionally essential trace element that is an integral part of the enzyme glutathione peroxidase and other proteins (Högberg and Alexander 1986). The National Research Council (1989) recommended dietary allowances (RDAs) for humans range from 10 to 75 mg/day. Chronic ingestion of 5 mg/day (0.071 mg/kg/day, assuming humans weigh 70 kg) induced selenosis in humans, characterized by abnormal hair and nail formation (Högberg and Alexander 1986). Effects in domestic grazing animals exposed to high levels of selenium included emaciation, lameness, and loss of hair and hooves. Occupational exposure to selenium fume or various selenium compounds was associated with intense ocular and respiratory tract irritation, chemical pneumonia, skin rashes, garlic odor to the breath, metallic taste in the mouth, and various socio-psychological effects (ACGIH 1986). The EPA (1995a) presented a verified RfD of 0.005 mg/kg/day for chronic oral exposure to selenium, based on effects in humans exposed to selenium in high selenium areas. An uncertainty factor of 3 was used. The EPA (1995b) presented the same value as a provisional subchronic oral RfD. The principal target organs for oral exposure to selenium are the skin, including the nails and hair, and, in animals, the hooves and joints. Targets for inhalation or dermal exposure include the skin and mucous membranes of the eyes and respiratory tract, and possibly the CNS.

Carcinogenicity

An impressive body of data indicates that selenium exerts an anticarcinogenic effect (Högberg and Alexander 1986). In laboratory animals, selenium supplementation decreased the incidence of chemical-induced cancers. In humans, the incidence of lymphomas and cancers of the breast, digestive tract, and lung were lower in geographic areas with high soil selenium levels. Occupational data suggest that selenium may protect against lung cancer. Several animal tests with various deficiencies in design and conduct equivocally associated exposure to selenium with cancer induction. In a well controlled oral experiment, selenium sulfide was associated with an increase in the incidence of liver tumors in rats, and with liver and lung tumors in mice. On the basis of this study, EPA (1995a) classified selenium sulfide a cancer weight-of-evidence Group B2 compound (probable human carcinogen), but declined to derive quantitative risk estimates. Selenium and other selenium compounds were classified in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (EPA 1995a). Quantitative risk estimates are not derived for Group D substances.

A.28 SILVER

Pharmacokinetics

The GI absorption of ingested silver in animals was estimated at £10 percent; however, absorption of 18 percent was estimated for one human subject given silver acetate (Fowler and Nordberg 1986). Highest tissue levels are located in the liver; lower levels are located in the lungs, brain, spleen, bone marrow, muscle, and skin (Fowler and Nordberg 1986; Goyer 1991). Excretion is virtually entirely through the bile. The excretion kinetics appear to be species- and organ-dependent. In humans, the apparent half-life for silver in the liver is approximately 50 days. Silver in skin also appeared to have a long half-life (not quantified).

Noncancer Toxicity

Silver compounds have been used in dentistry, medicinally in the treatment of burns, as a local disinfectant, and as a drinking water disinfectant (Fowler and Nordberg 1986). The classical syndrome of toxicity, called argyria, is a blue-gray to nearly black discoloration of areas of the skin or the viscera resulting from deposition of microscopic granules of silver compounds in the affected tissues. Argyria results from occupational (inhalation), parenteral, or oral exposure. The EPA (1995b) derived an RfD of 0.005 mg/kg/day for chronic oral exposure based on a 2 to 9 year human i.v. study, where a total i.v. dose of 1g metallic silver (in the form of 4g silver arsphenamine) resulted in minimal observed effects (argyria) in patients. This total i.v. dose for metallic silver was converted into an oral dose (LOAEL) of 0.014 mg/kg/day. The chronic oral RfD was derived by dividing the LOAEL by an uncertainty factor of 3, which was applied to account for minimal effects in a subpopulation that has exhibited an increased propensity for the development of argyria.

Carcinogenicity

The EPA (1995a) classifies silver in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). The human data consist of no evidence in the literature of cancer despite frequent medical use of silver compounds. The animal data are limited to studies of implanted silver foil or injected metallic silver that provided unconvincing indications of a carcinogenic response relevant to humans.

A.29 THALLIUM

Noncancer Toxicity

Thallium is highly toxic; acute ingestion by humans or laboratory animals induced gastroenteritis, neurological dysfunction, and renal and liver damage (Kazantzis, 1986). Chronic ingestion of more moderate doses characteristically caused alopecia. Thallium was used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with disastrous results. In industrial (inhalation, oral, dermal) exposure, neurologic signs preceded alopecia, suggesting that the nervous system is more sensitive than the hair follicle. The EPA (1994c) presented verified chronic oral RfD values for several thallium compounds (thallium acetate, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate, and thallic oxide) based on increased incidence of alopecia and increased serum levels of liver enzymes indicative of hepatocellular damage in rats treated with thallium sulfate for 90 days. An oral RfD for thallium alone was not located. That for thallium sulfate is 8.00E-05 (EPA 1996a), based on a lack of effects from an oral subchronic study in which rats received 0.25 mg/kg/day. The uncertainty factor was 3000 and the confidence level was low.

Carcinogenicity

Several thallium compounds (thallic oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate) were classified as cancer weight-of-evidence Group D substances (not classifiable as to carcinogenicity to humans) (EPA 1994c). No weight-of-evidence classification was located for thallium alone.

A.30 TIN

Pharmacokinetics

Estimates of the gastrointestinal absorption efficiency of tin in humans and animals range from 0.6 percent to 5 percent (Magos 1986). The data suggest that tin in the +2 valence state is more readily absorbed than tin in the +4 valence state. Species differences in gastrointestinal absorption appear to be slight. Absorption efficiency appears to be somewhat greater when the administered dose is smaller. From these data, it appears that an estimate of 5 percent (0.05) is a reasonable estimate of gastrointestinal absorption efficiency. Data regarding dermal uptake of tin were not located.

Noncancer Toxicity

Industrial (inhalation) exposure to tin dust results in a benign pneumoconiosis called stannosis (Magos 1986). Acute oral exposure causes gastroenteritis (nausea and diarrhea) in humans. Other effects in animals include anemia, interference with calcium metabolism, and liver and kidney lesions. A chronic oral RfD of 0.6 mg/kg-day was based on a NOAEL for liver and kidney lesions of 2000 ppm stannous chloride in the diet in a two-year study in rats (EPA 1995b). An uncertainty factor of 100 was applied. The chronic oral RfD was considered sufficiently protective for subchronic exposure as well.

Carcinogenicity

Data regarding the carcinogenicity of tin were not located in the available literature.

A.31 TRANS-1,4-DICHLORO-2-BUTENE

Health Effects

1,4-Dichloro-2-butene is a poison by ingestion, inhalation and intravenous routes. It is moderately toxic by skin contact. It is a severe skin and eye irritant (Sax and Lewis, 1989)

Carcinogenicity

1,4-Dichloro-2-butene is an experimental teratogen. Some mutagenic data exists. (Sax and Lewis 1989). The EPA (1992a) has reported a Cancer Slope Factor of 9.3E+00 mg/kg/day for the inhalation route of exposure. The EPA (1993) has classified trans-1,4-dichloro-2-butene in cancer weight-of-evidence group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans).

A.32 VANADIUM

Noncancer Toxicity

The oral toxicity of vanadium compounds to humans is very low (Lagerkvist et al. 1986), probably because little vanadium is absorbed from the GI tract. Effects in humans exposed by inhalation include upper and lower respiratory tract irritation. A provisional subchronic and chronic oral RfD of 0.007 mg/kg/day was derived from a NOEL of 5 ppm in rats in a lifetime drinking water study with an uncertainty factor of 100 (EPA

1995b). A target organ could not be identified for oral exposure. The respiratory tract is the target organ for inhalation exposure.

Carcinogenicity

No information was located regarding the carcinogenicity of vanadium.

A.33 ZINC

Pharmacokinetics

Zinc is a nutritionally required trace element. Estimates of the efficiency of GI absorption of zinc in animals range from <10 to 90 percent (Elinder 1986b). Estimates in normal humans range from approximately 20 to 77 percent (Elinder 1986b; Goyer 1991). The net absorption of zinc appears to be homeostatically controlled, but it is unclear whether GI absorption, intestinal secretion, or both are regulated. Distribution of absorbed zinc is primarily to the liver (Goyer 1991), with subsequent redistribution to bone, muscle, and kidney (Elinder 1986b). Highest tissue concentrations are found in the prostate. Excretion appears to be principally through the feces, in part from biliary secretion, but the relative importance of fecal and urinary excretion is species-dependent. The half-life of zinc absorbed from the GI tracts of humans in normal zinc homeostasis is approximately 162 to 500 days.

Noncancer Toxicity

Humans exposed to high concentrations of aerosols of zinc compounds may experience severe pulmonary damage and death (Elinder 1986b). The usual occupational exposure is to freshly formed fumes of zinc, which can induce a reversible syndrome known as metal fume fever. Orally, zinc exhibits a low order of acute toxicity. Animals dosed with 100 times dietary requirement showed no evidence of toxicity (Goyer 1991). In humans, acute poisoning from foods or beverages prepared in galvanized containers is characterized by GI upset (Elinder 1986b). Chronic oral toxicity in animals is associated with poor growth, GI inflammation, arthritis, lameness, and a microcytic, hypochromic anemia (Elinder 1986b), possibly secondary to copper deficiency (Underwood 1977). The EPA (1995b) presented a verified RfD of 0.3 mg/kg/day for chronic oral exposure to zinc, based on anemia in humans.

Carcinogenicity

The EPA (1995a) classifies zinc in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) based on inadequate evidence for carcinogenicity in humans and animals. The human data consist largely of occupational exposure studies not designed to detect a carcinogenic response, and of reports that prostatic zinc concentrations were lower in cancerous than in noncancerous tissue. The animal data consist of several dietary, drinking water, and zinc injection studies, none of which provided convincing data for a carcinogenic response.

PART 2 - A Detailed Explanation of Inhalation of Fugitive Dust Exposure Modeling

APPENDIX A, PART 2
A DETAILED EXPLANATION OF INHALATION OF FUGITIVE DUST EXPOSURE MODELING

Inhalation of Particulates from Soil

To evaluate the estimated levels of site contaminants that would occur in ambient air due to wind erosion at NAS Key West, a three-step modeling process was performed. Respirable, particle-phase emission rates are calculated in the first step. In the second phase, contaminant emission rates on a unit-basis are calculated. The third phase calculates downwind ambient concentrations by using dispersion modeling. These methods are explained in the following text.

Step 1: Estimation of PM_{10} Emissions From Wind Erosion

Emission rates for respirable particle-phase contaminants by wind erosion have been developed by Cowherd and others (1985). Airborne respirable particulate matter (PM_{10}) are defined as having an aerodynamic diameter less than or equal to 10 µm. A conservative estimate of the PM_{10} emission factor (E_{10}) for contaminated surface soils with "unlimited" erosion potential was developed using an emission factor derived by Gillette (1981). The following equation is used:

$$E_{10} + (1\times10^{-5}) * (1 - V) * (\frac{[u]}{Ut})^3 * F(x)$$

where:	E_{10}	=	PM_{10} emission factor (g/m^2 - s)
	1E-05	=	empirical constant (g/m^2 - s)
	V	=	fraction of the contaminated surface area with continuous vegetative cover
	U	=	mean annual wind speed (m/s)
	Ut	=	threshold value of wind speed at 7 m (m/s)
	F(x)	=	function to estimate unlimited erosion (plotted in Cowherd, et. al 1985)
	x	=	dimensionless ratio = 0.886 x Ut/U

and: Ut = $Ut = U^* * (\frac{1}{0.4}) * LN(\frac{z}{z_o})$

where:

Ut	=	wind speed at height z (m/s)
z	=	height above surface (cm)
z_0	=	roughness height (cm)
U*	=	friction velocity (m/s)

For values of x greater than 2:

$$F(x) = 0.18 * (8x^3 + 12x) * e^{-X^2}$$

Step 2: Estimation of Contaminant Emission Rates

Contaminant-specific emission rates are calculated from the PM_{10} emission rates, the mass fraction of contaminant in PM_{10} emissions, and the contaminated surface area. These factors are used to calculate contaminant emission rates (Q_{10}) by using the following equation:

$$Q_{10} = f * E_{10} * A * 1$$

where:

Q10	=	contaminant emission rate as PM_{10} (µg/s)
f	=	mass fraction of contaminant in PM_{10} emissions (mg contaminant/kg PM_{10})
E_{10}	=	PM_{10} emission rate (g PM_{10}/m^2-s)
A	=	contaminated surface area (m^2)
1	=	conversion factor (1,000 µg contaminant/mg contaminant x kg PM_{10}/ 1,000 g PM_{10})

Step 3: Airborne Contaminant Concentration

The box model for air dispersion has been selected to predict contaminant air concentrations bases on PM_{10} emission rate. This is the most appropriate model to use when receptors are less than 100 meters from the edge of a source area. This is a conservative model which overpredicts concentrations by approximately four to six; therefore, it provides concentrations protective of human health. The model assumes mixing of

emissions with the ambient air is complete. The box encloses the entire source area. The mixing height is determined by the following equation presented by Pasquill (1975) for neutral stability:

$$x = 6.25 * z_o * [(H/z_o) * \ln(H/z_o) - 1.58 * (H/z_o) + 1.58]$$

where: x = downwind distance from the leading edge of the source area to the receptor (m)
H = downwind mixing height (m)
z_0 = roughness height (m)

The roughness height has been selected at 0.02 meters based on determination by Cowherd and others (1985). Downwind distance to receptors is measured to the closest exposure points to potentially exposed populations. For purposes of this evaluation, this distance has been conservatively assumed as 1 meter (the receptor is at the source). The ambient 24-hour contaminant concentration (C_{10}) is estimated by the bos model equation:

$$C_{10} = \frac{(Q_{10} * a)}{([u] * H * w}$$

where: C_{10} = concentration of contaminant at distance X (μg/m^3)
Q_{10} = particle-phase emission rate from wind erosion (μg/s)
a = fraction of 24 hours during which emissions occur
U = average wind speed (m/s)
H = downwind mixing height (m)
W = width of area perpendicular to wind (m)
C_{10}/1,000 = CA in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report

PART 3 - A Detailed Explanation of Dermal Exposure to Water and Soil

APPENDIX A, PART 3

A DETAILED EXPLANATION OF DERMAL EXPOSURE TO WATER AND SOIL

Water

Dermal exposure to water was evaluated using the following equations (EPA, 1992c):

Inorganics

For inorganics (steady state approach), the dose absorbed per unit area per event is:

$$DA_{event} = PC_{event} * C_w * CF_1 * CF_2$$

$$PC_{event} = K_{pw} * t_{event}$$

where:

PC_{event}	=	Diffusion depth per event (cm/event)
K_{pw}	=	Permeability coefficient from water (cm/hr)
t_{event}	=	Duration of event (hr/event)
C_w	=	Concentration of contaminant in water (mg/L)
CF_1	=	Conversion factor ($L/10^3\ cm^3$)
CF_2	=	Conversion factor ($mg/10^3\ \mu g$)
DA_{event}	=	Dose absorbed per unit area per event (mg/cm^2-event)

Organics

For organics (the unsteady state approach), the dose absorbed per unit area per event is:

$$DA_{event} = PC_{event} * C_w * CF_3 * CF_4$$

$$PC_{event} = 2 * Kp * \sqrt{\frac{6 * \tau * t_{event}}{\pi}}$$

where: $t < t^*$

and $DA_{event} = PC_{event} * CW * CF_5 * CF_6$

$$PC_{event} = Kp * ((t_{event} / (1+B)) + 2\tau * ((1+3B) / (1+B))$$

where: $t > t^*$

where:

Kp	=	Permeability coefficient from water (cm/hr)
CW	=	Concentration of contaminant in water (µg/L)
t	=	lsc2/6 Dsc (hr)
l_{sc}	=	Thickness of stratum corneum (10 µm)
D_{sc}	=	Stratum corneum diffusion diffusion coefficient (cm^2/hr)
t_{event}	=	Duration of a single event (hr/event)
p	=	Pi (dimensionless)
t*	=	Time to reach steady state (hr)
B	=	Octanol water partition coefficient divided by 104 (dimensionless)
CF_3	=	Units conversion factor (1 mg/10^3 µg)
CF_4	=	Units conversion factor (1 liter/10^3 cm^3)
CF_5	=	Units conversion factor (1 mg/10^3 µg)
CF_6	=	Units conversion factor (1 liter/10^3 cm^3)

Dermally Absorbed Dose (DAD)

After DA_{event} is calculated, the dermally absorbed dose (DAD) for use in risk calculations can be derived by using the following:

For adults:

$$DAD_{adult} = \frac{DA_{event} * EV * EF * ED * SA}{BW * AT}$$

For children:

To account for changing surface areas and body weight, the DAD is calculated as follows:

$$DAD_{child} = \frac{DA_{event} * EV * EF}{AT} * \sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

where: EV = Event frequency (events/day)

EF = Exposure frequency (days/year)

AT = Averaging time (days). For non-carcinogenic effects, AT = ED, for carcinogenic effects, AT = 70 years or 25,550 days.

SA_i = Surface area exposed at age i (cm^2)

ED_i = Exposure duration at age i (years)

BW_i = Bodyweight at age i (kg)

Values of:

$$\sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

The age adjusted, bodyweight-normalized surface areas exposed while wading of a resident child and a adolescent trespasser are 766.7 cm^2-year/kg and 1136.3 cm^2-year/kg, respectively. For wading, it is assumed that the entire surface area of the feet, lower legs, and hands is exposed to the surface water during the entire exposure event. This assumption is for shallow water situations. Averaging surface areas over the 6 childhood years yields the following: hands represent 5.5 percent of total body surface area, lower leg represents 12.8 percent of total body surface area, and the feet represent 7 percent of total body surface area. Therefore, the feet, lower legs and hands represent approximately 25 percent of total body surface area for children ages 1 through 6 (Table G.3-12 of Appendix G of the Supplemental RFI/RI Report). This value is the same value which EPA identifies as the per cent of total body surface area which is available for soil contact (EPA 1992c). This value, 25 percent of total body surface area is used here to represent surface area available for waders of all ages.

Soil

Dermal exposure to soil was evaluated using the following equations (EPA, 1992c):

The calculation of the estimated dermally absorbed dose per unit area per event is:

$$DA_{event} = CS * AF * ABS * CF$$

where: CS = Contaminant concentration in soil/sediment (mg/kg)
AF = Adherence factor of soil to skin (mg/cm^2-event)
ABS = Absorption fraction (dimensionless)
CF = Conversion factor (10^{-6} kg/mg)

Dermally Absorbed Dose - Adults

For adults, the dermally absorbed dose for use in quantitative risk assessments is as follows:

$$DA_{adult} = \frac{DA_{event} * EF * ED * SA}{BW * AT}$$

Dermally Absorbed Dose - Children

For children, to account for changing surface areas and bodyweights, the dermally absorbed dose is calculated as follows:

$$DA_{child} = \frac{DA_{event} * EF}{AT} * \sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

where: EF = Exposure frequency (events/year)
AT = Averaging time (days). For noncarcinogenic effects AT - ED, and for carcinogenic effects AT - 70 years or 25,550 days.
SA_i = Surface area exposed at age i (cm^2)
ED_i = Exposure duration at age i (years)
BW_i = Bodyweight at age i (kg)

For the typical case, EPA recommends SA for head and hands only. For the "reasonable worst case," the EPA recommends the SA of the head, hands, forearms, and lower legs. EPA simplifies these assumptions by saying that 25 percent of the total body surface area would be available for soil contact. For adults, using 50th and 95th percentile whole body SA values, the default SA values are 5000 cm^2 and 5800. For children,

the default values for each age group would be equal to 25 percent of the 50th percentile and 95th percentile whole body SA values.

Values of:

$$\sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

The age adjusted, bodyweight-normalized surface areas exposed to soil of a resident child and a trespasser child are 766.7 cm^2-year/kg and 1136.3 cm^2-year/kg, respectively.

PART 4 - Risk Assessment Example Calculations

APPENDIX A, PART 4

RISK ASSESSMENT EXAMPLE CALCULATIONS

Surface Soil Exposure

Three potential exposure routes are associated with theoretical surface soil direct contact at the NAS Key West SWMUs. These exposure routes include ingestion, dermal contact, and inhalation of fugitive dust. Example calculations for each of these routes of exposure are presented in the following text.

Ingestion

Incidental surface soil ingestion exposure (cancer risk) for beryllium at SWMU 1 is estimated for an occupational worker from the following equation (EPA, 1989d):

$$IEX(mg/kg)/day = \frac{CS * IR_{soil} * FI * CF * EF * ED}{BW * AT}$$

where:	CS	=	0.19 mg/kg	=	Beryllium representative concentration in surface soil at SWMU 1
	IR_{soil}	=	50 mg soil/day	=	Soil ingestion rate
	FI	=	1.0	=	Fraction ingested from contaminated source
	EF	=	250 days/yr	=	Exposure frequency
	ED	=	25 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	=	9125 days	=	Averaging time, non-carcinogens (365 days/yr x 25 yr)
	CF	=	1E-6 kg soil/mg soil	=	Conversion factor
	IEX_{car}	=	3.32E-8 mg/kg/day	=	Ingestion exposure (beryllium in surface soil at SWMU 1)
	IEX_{noncar}	=	9.30E-8 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental ingestion of beryllium in surface soil is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	=	3.32E-8 (mg/kg)/day	=	Ingestion exposure (beryllium in surface soil at SWMU 1)
	SF	=	4.3 $(mg/kg/day)^{-1}$	=	Carcinogenic slope factor (upper 95 percent confidence limit of a dose-response curve)
	CA	=	1.40E-7	=	Incremental (upper bound) risk of developing cancer

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar}/Rfd$$

where:	IEX_{noncar}	=	9.30E-8 mg/kg/day	=	Ingestion exposure
	Rfd	=	5E-3 mg/kg	=	Reference dose dermal
	NC	=	1.82E-5	=	Non-carcinogenic risk

Dermal Contact

Incidental surface soil dermal contact exposure (cancer risk) for beryllium at SWMU 1 is estimated for an occupational worker from the following equation (EPA 1989d; EPA 1992c):

$$DEX(mg/kg)/day = \frac{CS * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

where:	CS	=	0.19 mg/kg	=	Beryllium representative concentration in surface soil at SWMU 1
	SA	=	2,300 cm^2/day	=	Skin surface area available for contact
	AF	=	1.0 mg/cm^2	=	Soil-to-skin adherence factor
	ABS	=	0.1% = 0.001	=	Fraction from contaminated source for beryllium
	EF	=	250 days/yr	=	Exposure frequency

ED	=	25 yrs	=	Exposure duration
CF	=	1E-06 kg soil/mg soil	=	Conversion factor
BW	=	70 kg	=	Body weight
AT_{car}	=	25,550 days	=	Averaging time, carcinogens (365 days/yr x 70 yrs)
AT_{noncar}	=	9,125 days	=	Averaging time, non-carcinogens (365 days/yr x 25 yr)
DEX_{car}	=	1.53E-9 mg/kg/day	=	Dermal exposure dose (beryllium in surface soil at SWMU 1)
DEX_{noncar}	=	4.28E-9 mg/kg/day	=	Non-carcinogenic dermal exposure dose

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental dermal contact with beryllium in surface soil is estimated as follows:

$$CA = DEX * SF$$

where:	DEX	=	1.53E-9 mg/kg/day	=	Dermal exposure (beryllium in surface soil at SWMU 1)
	SF	=	2.15E+1 $(mg/kg/day)^{-1}$	=	Dermal slope factor (4.3 oral slope factor/0.2 GI absorption factor)
	CA	=	3.21E-8	=	Incremental (upper bound) risk of developing cancer

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report.

$$NC = DEX_{noncar}/(Rfd * GI)$$

where:	DEX_{noncar}	=	4.28E-9 mg/kg/day	=	Noncarcinogenic dermal exposure dose
	Rfd	=	5E-3 mg/kg	=	Reference dose dermal
	GI	=	0.2	=	Gastrointestinal absorption factor
	NC	=	4.28E-6	=	Non-carcinogenic risk

Inhalation

Incidental surface soil inhalation of fugitive dust emission exposure (cancer risk) for beryllium at SWMU 1 is estimated for an occupational worker from the following equations (EPA 1989d; Cowherd, et al. 1985):

$$INHX(mg/kg)/day = \frac{CA * IR_{air} * ET * EF * ED}{BW * AT}$$

$$E_{10} = (1x10^{-5}) * (1-V) * (\frac{[u]}{Ut})^3 * F(x)$$

$$Ut = U^* * (\frac{1}{0.4}) * LN(\frac{z}{z_O})$$

$$Q_{10} = f * E_{10} * A$$

$$C_{10} = \frac{(Q_{10} * a)}{([u] * H * w)}$$

Exposure to fugitive dust emissions can be estimated by first estimating the rate of distribution and beryllium emission from SWMU 1 and then relating this to the exposure rate for the receptors.

Estimation of PM_{10} Emissions are as follows:

E_{10}

where:	V	=	0.6	=	Fraction of vegetative cover
	[u]	=	3.9 m/s	=	Mean annual wind speed (Tampa, Fla.) (Table 4-1, Cowherd, et al. 1985)
	Ut	=	9.23 m/s	=	Threshold value of wind speed at 7 m

z	=	7 m	=	Height above surface (Cowherd et. al 1985)
z_0	=	0.02 m	=	Roughness height for the area, medium buildings (Figure 3-6, Cowherd, et al. 1985)
U*	=	0.63 m/s	=	Friction velocity for assumed particle size 0.25 mm (Figure 3-4, Cowherd, et al. 1985)
F(x)	=	0.2	=	Function (calculated or from Figure 4-3, Cowherd et al. 1985)
E10	=	6.04E-8 g/(m^2s)	=	Particulates less than 10 microns (PM_{10}) average annual emission rate

Estimation of Contaminant Emission Rates are as follows:

Q_{10}

where:	f	=	1	=	Fraction of PM_{10} with contaminant (mg contaminant/kg soil)
	E10	=	6.04E-8 g/(m^2s)	=	Particulates less than 10 microns (PM_{10}) average annual emission rate
	A	=	33,600 m^2	=	Source area
	Q_{10}	=	2.03E-3 µg/sec	=	Contaminant emission rate

To estimate the annual average air concentration to receptors near the site, a screening air dispersion model was used as described in Cowherd, et al.

Airborne Contaminant Concentrations were estimated as follows:

C_{10}

where:	Q_{10}	=	2.03E-3 µg/sec	=	Contaminant emission rate
	a	=	1	=	Fraction of 24 hours during which activity occurs
	[µ]	=	3.9 m/s	=	Wind speed
	H	=	0.276 m	=	Downwind mixing height, based on described value of X
				=	Downwind distance from leading edge of area source to receptor; derived value of X from equation: $X= 6.25 \times (z0) \times [(H/z_0) \times \ln(H/z_0) - 1.58 \times (H/z_0) + 1.58]$
	z_0	=	02 m	=	Roughness height

w	=	140 m/s	=	Width of area perpendicular to wind
C_{10}	=	1.34E-5 (µg/m^3)	=	Airborne contaminant concentration

The EPA (1989a) inhalation equation was estimated as follows:

INHX

where:	CA	=	1.34E-8 µg/m^3	=	C_{10}/1,000, airborne Contaminant concentration
	IR_{air}	=	0.833 m^3/hour	=	Soil inhalation rate
	FI	=	1.0	=	Fraction ingested from contaminated source
	ET	=	8 hours/day	=	Exposure Time
	EF	=	250 days/yr	=	Exposure frequency
	ED	=	25 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time, carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	=	9,125 days	=	Averaging time, non-carcinogens (365 days/yr x 25 yr)
	$INHX_{car}$	=	3.12E-10 mg/kg/day	=	Inhalation exposure (beryllium in surface soil at SWMU 1)
	$INHX_{noncar}$	=	8.74E-10	=	Noncarcinogenic inhalation exposure

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental inhalation of beryllium in fugitive dust is estimated as follows:

$$CA = INHX * SF$$

where:	INHX	=	3.12E-10 mg/kg/day	=	Inhalation exposure
	SF	=	8.4 (mg/kg/day)-1	=	Inhalation slope factor
	CA	=	2.64E-9	=	Incremental (upper bound) risk of developing cancer

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report. Cadmium was used to calculate the noncarcinogenic risk because beryllium does not have an inhalation reference dose.

$NC = INHX_{noncar} / RfD$

where:	$INHX_{noncar}$	=	8.74E-10 mg/kg/day	=	Noncarcinogenic inhalation exposure
	RfD	=	5.71E-5 mg/kg/day	=	Reference dose-inhalation
	NC	=	1.54E-5	=	Noncarcinogenic risk for cadmium

Subsurface Soil Exposure

The assumptions for incidental ingestion of, dermal contact with, and inhalation of fugitive dust emissions for COPCs in subsurface soil are the same as the assumptions and equations for surface soil presented in the previous section, except the potential receptor is an excavation worker (assumptions for this exposure scenario are presented in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report).

Sediment Exposure

Two potential exposure routes are associated with theoretical sediment direct contact at the NAS Key West SWMUs. These exposure routes include ingestion and dermal contact. Example calculations for each of these routes of exposure are presented in the following text.

Ingestion

Incidental sediment ingestion exposure (cancer risk) for beryllium at SWMU 1 is estimated for an adult trespasser from the following equation (EPA, 1989d):

$$IEX(mg/kg)/day = \frac{CS * IR_{sediment} * FI * CF * EF * ED}{BW * AT}$$

where:	CS	=	0.28 mg/kg	=	Beryllium representative concentration in sediment at SWMU 1
	IR_{sed}	=	100 mg soil/day	=	Sediment ingestion rate
	FI	=	1.0	=	Fraction ingested from contaminated source
	CF	=	1E-6 kg soil/mg soil	=	Conversion factor
	EF	=	45 days/yr	=	Exposure frequency
	ED	=	19 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight

AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
AT_{noncar}	=	6,935 days	=	Averaging time, noncarcinogens (365 days/yr x 19 yr)
IEX_{car}	=	1.33E-8 mg/kg/day	=	Ingestion exposure (beryllium in sediment at SWMU 1)
IEX_{noncar}	=	4.93E-8 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The cancer risk for an adult trespasser from incidental ingestion of beryllium in SWMU 1 sediment is estimated as follows:

$$CA = IEX * SF$$

where:	IEX	=	1.33E-8 mg/kg/day	=	Ingestion exposure (beryllium in sediment at SWMU 1)
	SF	=	4.3 $(mg/kg/day)^{-1}$	=	Carcinogenic slope factor (upper 95 percent confidence limit of a dose-response curve)
	CA	=	5.72E-8	=	Incremental (upper bound) risk of developing cancer

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar}/Rfd$$

where:	IEX_{noncar}	=	4.93E-8 mg/kg/day	=	Noncarcinogenic ingestion exposure
	Rfd	=	5E-3 mg/kg	=	Reference dose dermal
	NC	=	9.86E-6	=	Noncarcinogenic risk

Dermal Contact

Dermal exposure to beryllium from SWMU 1 sediment is estimated for an adult trespasser from the following equation (EPA, 1989d; EPA, 1992c):

$$DEX(mg/kg)/day = \frac{CS * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

where:	C	=	0.28 mg/kg	=	Beryllium representative concentration in sediment at SWMU 1
	AF	=	1.0 mg/cm2	=	Soil-to-skin adherence factor
	ABS	=	0.1% = 0.001	=	Absorption fraction from contaminated source for beryllium
	CF	=	1E-06 kg soil/mg soil	=	Conversion factor
	SA	=	5750 cm2/day	=	Skin surface area available for contact
	EF	=	45 days/yr	=	Exposure frequency
	ED	=	19 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time, carcinogen (365 days/yr x 70 yrs)
	At_{noncar}	=	6,935 days	=	Averaging time, noncarcinogens (365 days/yr x 19 yr)
	DEX_{car}	=	7.70E-10 mg/kg/day	=	Dermal exposure dose (beryllium in sediment at SWMU 1)
	DEX_{noncar}	=	2.84E-9 mg/kg/day	=	Non-carcinogenic dermal exposure dose

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The lifetime cancer risk for an adult trespasser from dermal contact with beryllium in sediment at SWMU 1 is calculated as follows:

$$CA = DEX * SF$$

where:	DEX	=	7.70E-10 mg/kg/day	=	Dermal exposure (beryllium in sediment at SWMU 1)
	SF	=	2.15E+1 $(mg/kg/day)^{-1}$	=	Dermal slope factor (4.3 oral slope factor/0.2 GI absorption factor)
	CA	=	1.66E-8	=	Incremental (upper bound) risk of developing cancer

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar}/(Rfd \times GI)$$

where:	IEX_{noncar}	=	2.84E-9 mg/kg/day	=	Non-carcinogenic ingestion exposure
	Rfd	=	5E-3 mg/kg	=	Dermal reference dose
	GI	=	0.2	=	Gastrointestinal absorption factor
	NC	=	2.84E-6	=	Non-carcinogenic risk

Surface Water Exposure

Two potential exposure routes are associated with theoretical surface water direct contact at the NAS Key West SWMUs. These exposure routes include ingestion and dermal contact. Example calculations for each of these routes of exposure are presented in the following text.

Incidental surface water ingestion exposure (cancer risk) for beryllium at SWMU 1 is estimated for an adult trespasser from the following equation (EPA 1989d):

$$IEX = \frac{CW * IR_{SW} * CF * EF * ED}{BW * AT}$$

where:	CW	=	1.20 µg/L	=	Beryllium concentration in surface water SWMU 1
	IR_{sw}	=	0.13 L/day	=	Ingestion rate
	CF	=	1E-3 mg/µg	=	Conversion factor
	EF	=	45 days/yr	=	Exposure frequency
	ED	=	19 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
	At_{noncar}	=	6,935 days	=	Averaging time, non-carcinogens (365 days/yr x 19 yr)
	IEX_{car}	=	7.46E-8 mg/kg/day	=	Ingestion exposure dose (mg/kg/day)
	IEX_{noncar}	=	2.74xE-7 mg/kg/day	=	Non-carcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The lifetime cancer risk for an adult trespasser from ingestion of beryllium in surface water at SWMU 1 is estimated as follows:

$$CA = DEX * SF$$

where:	IEX	=	7.46E-8 mg/kg/day	=	Ingestion exposure for child for 6 years
	SF	=	4.3 $(mg/kg/day)^{-1}$	=	Carcinogenic slope factor (upper 95 percent confidence limit of a dose-response curve)
	CA	=	3.21E-7	=	Incremental (upper bound) risk of developing cancer

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar}/Rfd$$

where:	IEX_{noncar}	=	2.74E-7 mg/kg/day	=	Non-carcinogenic ingestion exposure
	Rfd	=	5E-3 mg/kg	=	Reference dose dermal
	NC	=	5.50E-5	=	Non-carcinogenic risk

Dermal Contact

Dermal exposure to beryllium in SWMU 1 surface water during wading was evaluated using the following equations (EPA, 1992c):

$$DEX = \frac{Kp * ET * CW * CF_1 * CF_2 * EV * EF * ED * SA}{BW * AT}$$

where:	Kp	=	1E-3 cm/hr	=	Permeability coefficient from water
	CW	=	1.2 µg/L	=	Beryllium concentration in surface water
	CF_1	=	(1 liter/10^3 cm^3)	=	Conversion Factor
	CF_2	=	(1 mg/10^3 µg)	=	Conversion Factor
	EV	=	1 event/day	=	Event frequency
	EF	=	45 days/yr	=	Exposure frequency
	ED	=	19 yrs	=	Exposure duration
	SA	=	5750 cm^2	=	Skin surface area exposed
	ET	=	2 hours/event	=	Exposure time
	BW	=	70 kg	=	Body weight
	At_{car}	=	25,550 days	=	Averaging time, carcinogen (365 days/yr x 70 yrs)

At_{noncar}	=	6,935 days	=	Averaging time, non-carcinogens (365 days/yr x 19 yr)
DEX_{car}	=	6.60E-9 mg/kg/day	=	Dermally absorbed beryllium dose
DEX_{noncar}	=	2.43E-8 mg/kg/day	=	Non-carcinogenic dermal exposure dose

As discussed in Section 3.2.4 of Appendix G of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The cancer risk for an adult trespasser from dermal contact with beryllium in surface water at SWMU 1 is estimated as follows:

$$CA = DEX * SF$$

where:	DEX	=	6.60E-9 mg/kg/day	=	Dermally absorbed beryllium dose
	SF	=	2.15E+1 $(mg/kg/day)^{-1}$	=	Slope factor (4.3 oral slope factor/0.2 GI absorption factor)
	CA	=	1.42E-7	=	Incremental cancer risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix G of the Supplemental RFI/RI Report.

$$NC = DEX_{noncar} / (Rfd \times GI)$$

where:	DEX_{noncar}	=	2.43E-8 mg/kg/day	=	Non-carcinogenic ingestion exposure
	Rfd	=	5E-3 mg/kg	=	Dermal reference dose
	GI	=	0.2	=	Gastrointestinal absorption factor
	NC	=	2.43E-5	=	Non-carcinogenic risk

PART 5 - IEUBK (V.0.99) Lead Modeling Results

NARRATIVE FOR

IEUBK MODEL RESULTS

The following sections of Appendix A Part 5 contain site-specific histograms that present the estimated percentage of children (age 0 to 6 years) with a blood-lead level above 10 µg/dL based on conditions present at each applicable SWMU and background (for comparison purposes). The histograms are output from the IEUBK Model (v. 0.99). Also included are site-specific input parameters selected for each run of the IEUBK Model. SWMUs 1,2, 9, and background are included.

HISTOGRAMS FOR

SWMU 1 - GROUNDWATER AND SURFACE SOIL DATA

IEUBK MODEL RESULTS

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 74.40 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	740.0	740.0
1-2	740.0	740.0
2-3	740.0	740.0
3-4	740.0	740.0
4-5	740.0	740.0
5-6	740.0	740.0
6-7	740.0	740.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

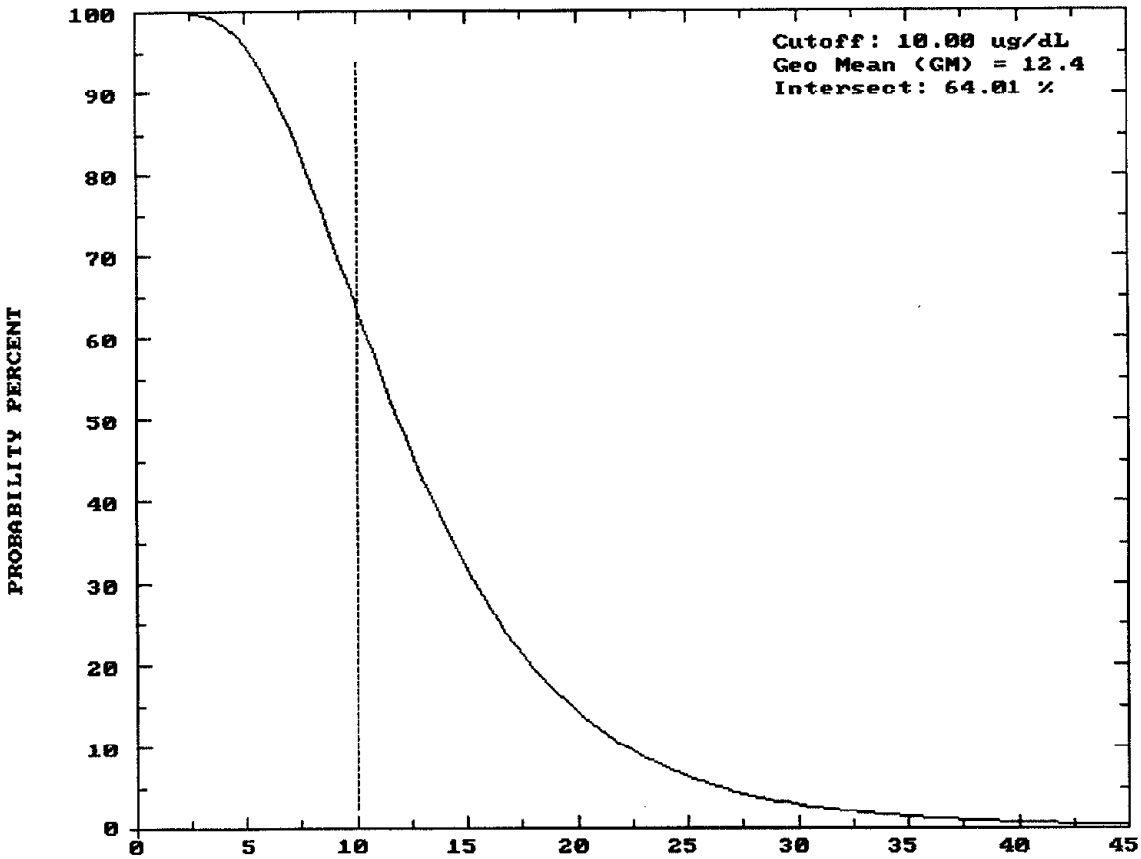
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	11.7	22.37	14.50
1-2:	14.6	36.80	21.41
2-3:	14.1	38.95	22.17
3-4:	13.8	40.51	22.95
4-5:	12.4	37.11	18.01
5-6:	11.4	37.24	16.59
-7:	10.5	37.45	15.91

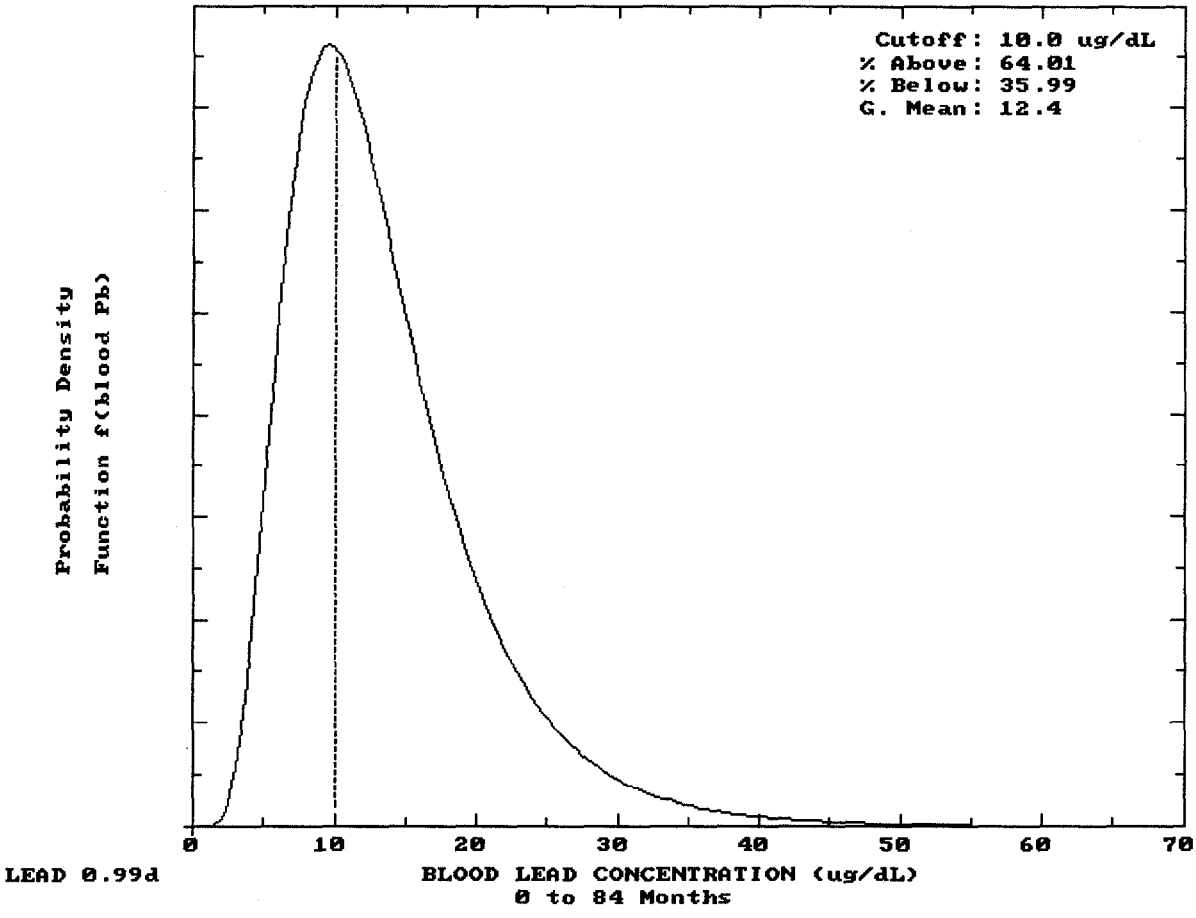
YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.13	5.72	0.00	0.02
1-2:	2.06	13.29	0.00	0.03
2-3:	2.40	14.31	0.00	0.06
3-4:	2.39	15.10	0.00	0.07
4-5:	2.44	16.59	0.00	0.07
5-6:	2.63	17.92	0.00	0.09
6-7:	2.95	18.50	0.00	0.09



LEAD 0.99d

BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 64.01
% Below: 35.99
G. Mean: 12.4
Probability Density
Function f(blood Pb)
0
10
20
30
40
50
60
70
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 22.35 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	111.2	111.2
1-2	111.2	111.2
2-3	111.2	111.2
3-4	111.2	111.2
4-5	111.2	111.2
5-6	111.2	111.2
6-7	111.2	111.2

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

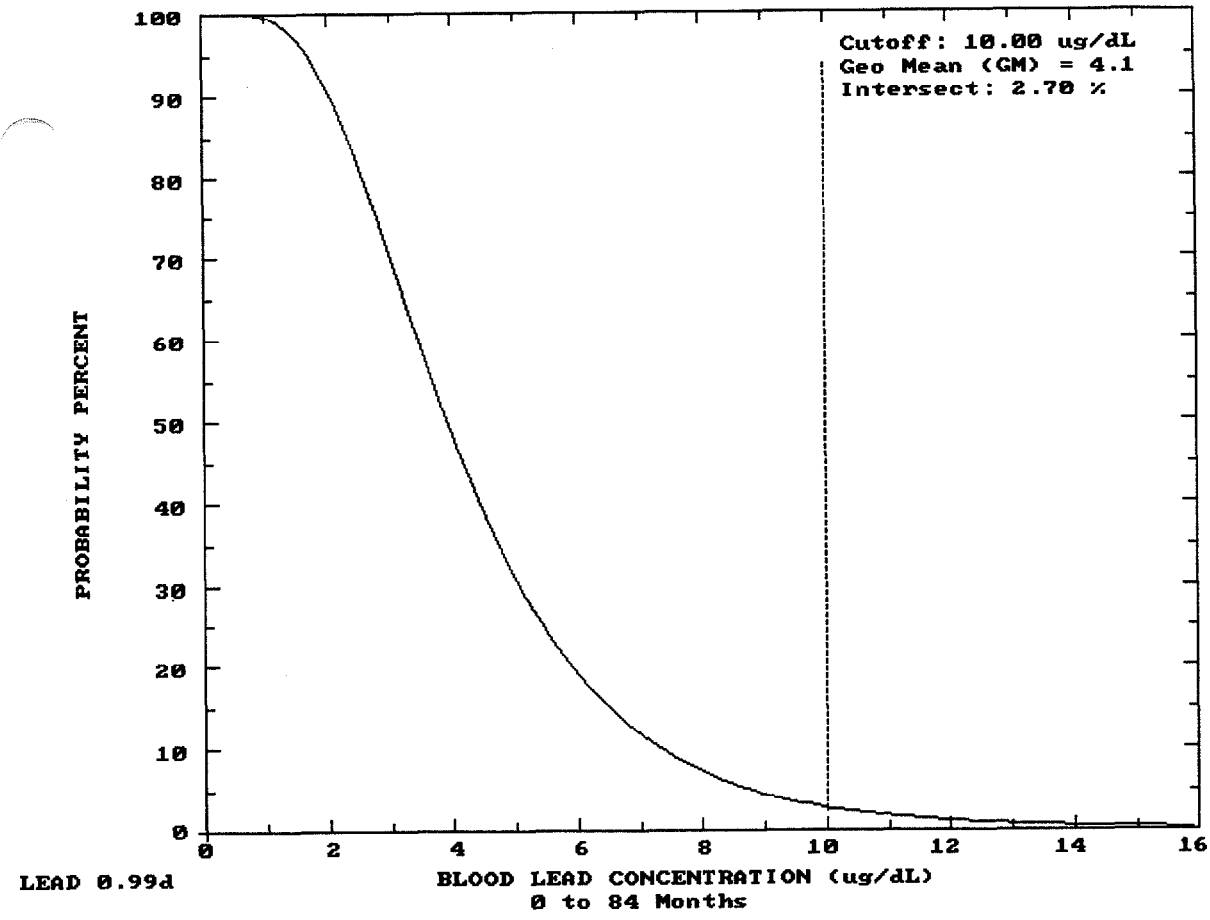
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

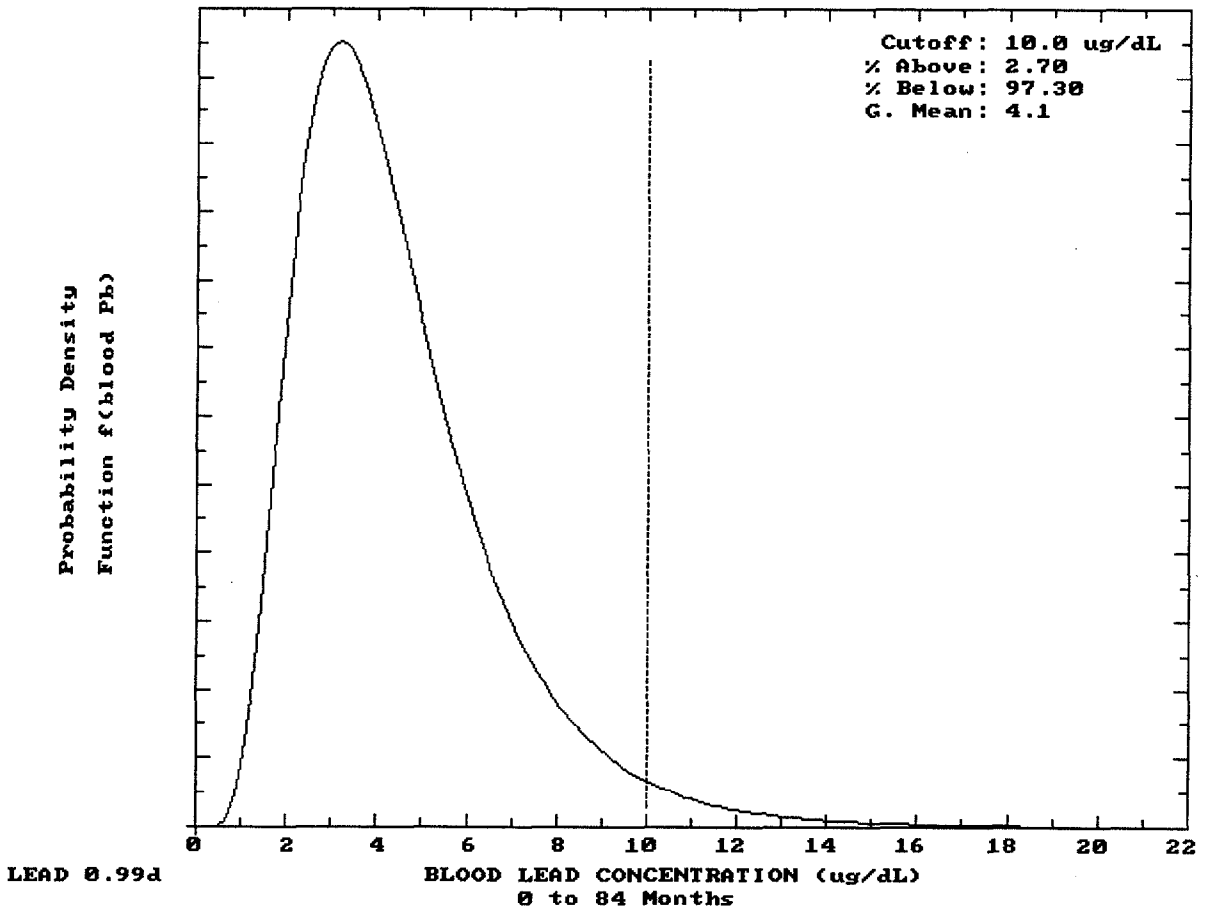
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	3.9	7.24	2.61
1-2:	4.8	11.74	4.06
2-3:	4.6	12.42	4.11
3-4:	4.4	12.57	4.16
4-5:	4.0	11.78	3.13
5-6:	3.7	12.03	2.83
-7:	3.5	12.33	2.69

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.55	2.06	0.00	0.02
1-2:	2.61	5.04	0.00	0.03
2-3:	2.96	5.30	0.00	0.06
3-4:	2.88	5.47	0.00	0.07
4-5:	2.82	5.76	0.00	0.07
5-6:	2.99	6.12	0.00	0.09
6-7:	3.31	6.24	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 4.1
Intersect: 2.70 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 2.70
% Below: 97.30
G. Mean: 4.1
Probability Density
Function f(blood Pb)
0
2
4
6
8
10
12
14
16
18
20
22
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HISTOGRAMS FOR

SWMU 2 - GROUNDWATER AND SURFACE SOIL DATA

IEUBK MODEL RESULTS

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 2.20 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	55.4	55.4
1-2	55.4	55.4
2-3	55.4	55.4
3-4	55.4	55.4
4-5	55.4	55.4
5-6	55.4	55.4
6-7	55.4	55.4

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

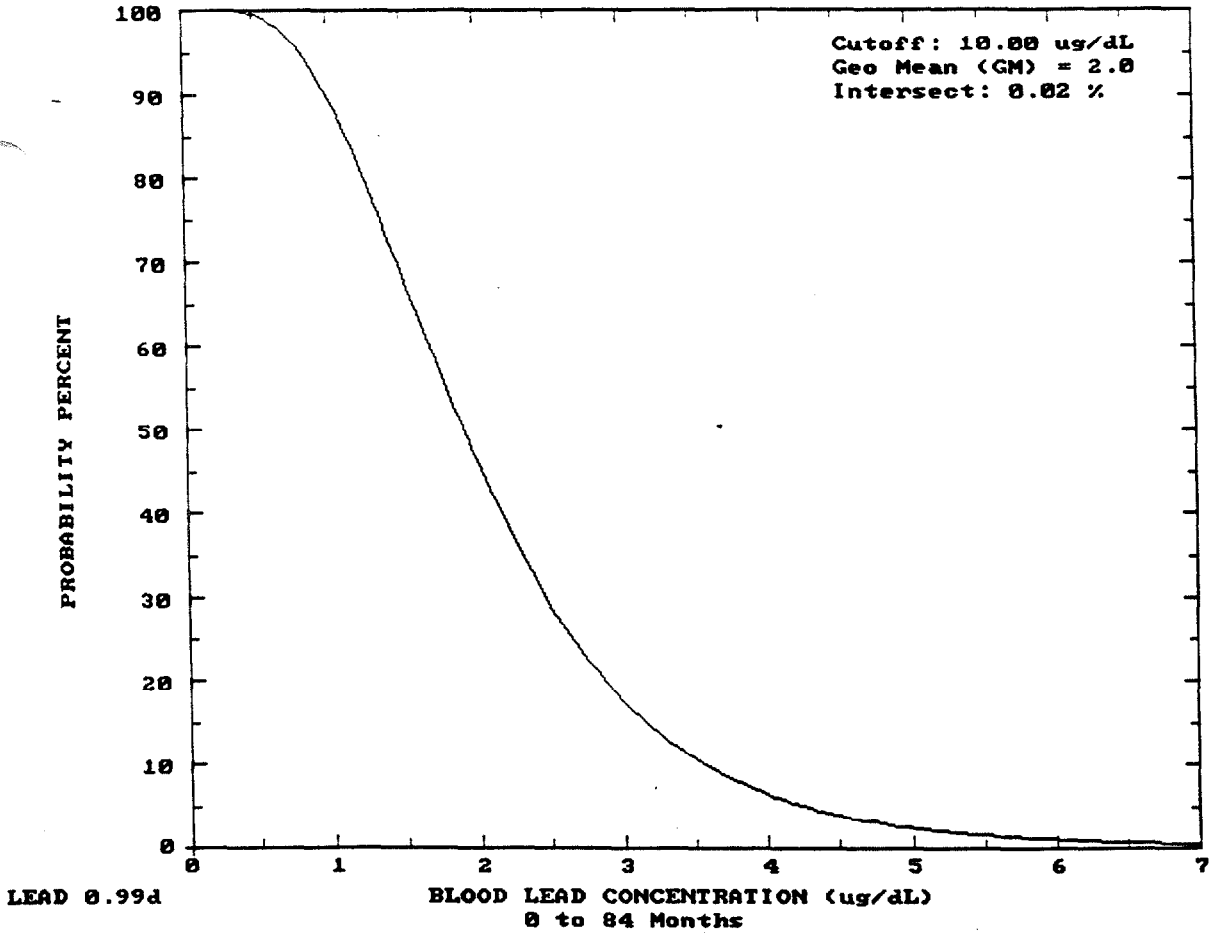
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

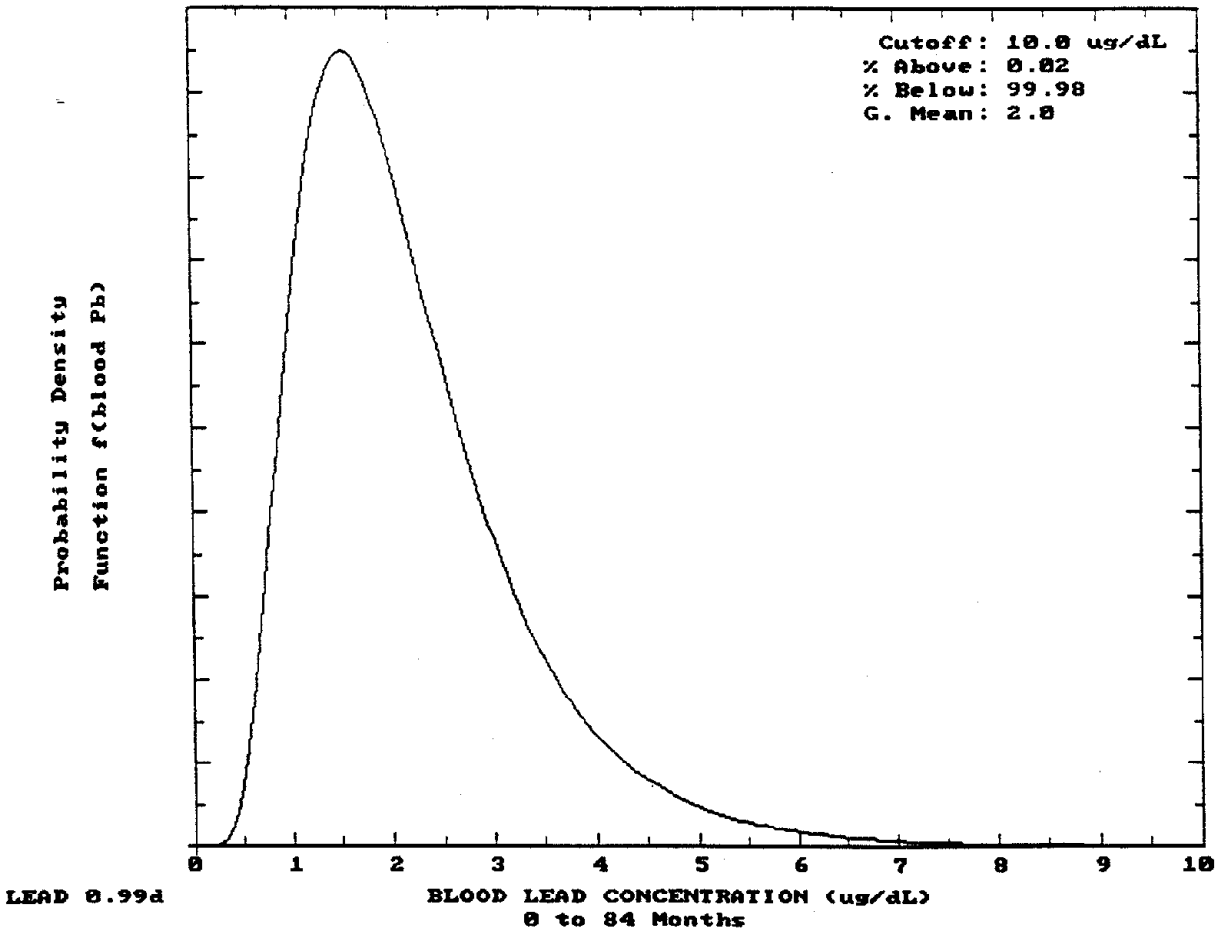
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	2.3	4.21	1.35
1-2:	2.3	5.46	2.14
2-3:	2.2	5.87	2.15
3-4:	2.1	5.80	2.16
4-5:	1.8	5.19	1.62
5-6:	1.6	5.27	1.46
6-7:	1.6	5.52	1.38

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.64	0.21	0.00	0.02
1-2:	2.76	0.52	0.00	0.03
2-3:	3.11	0.55	0.00	0.06
-4:	3.01	0.56	0.00	0.07
4-5:	2.92	0.59	0.00	0.07
5-6:	3.09	0.62	0.00	0.09
6-7:	3.42	0.63	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 2.0
Intersect: 0.02 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 0.02
% Below: 99.98
G. Mean: 2.0
Probability Density
Function f(blood Pb)
0
1
2
3
4
5
6
7
8
9
10
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 2.50 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	15.9	15.9
1-2	15.9	15.9
2-3	15.9	15.9
3-4	15.9	15.9
4-5	15.9	15.9
5-6	15.9	15.9
6-7	15.9	15.9

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

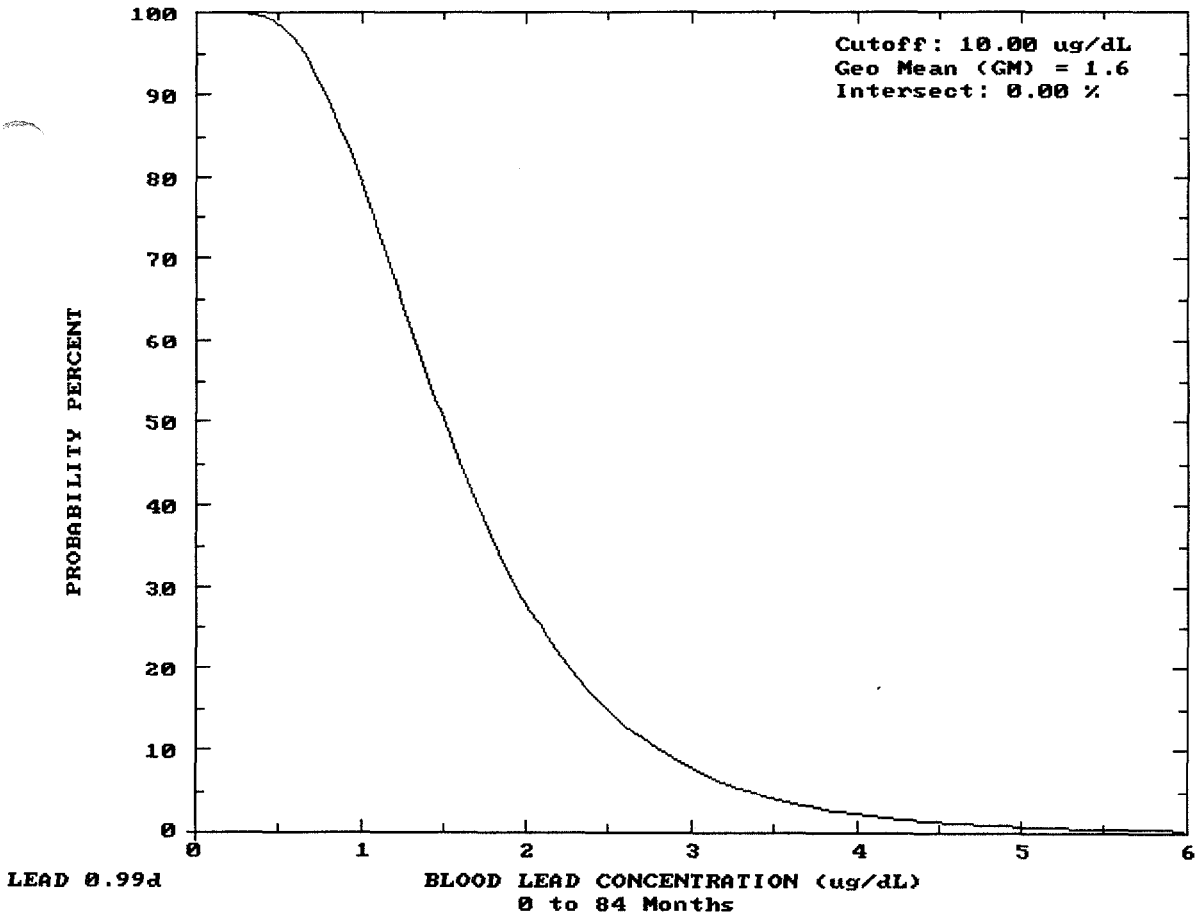
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

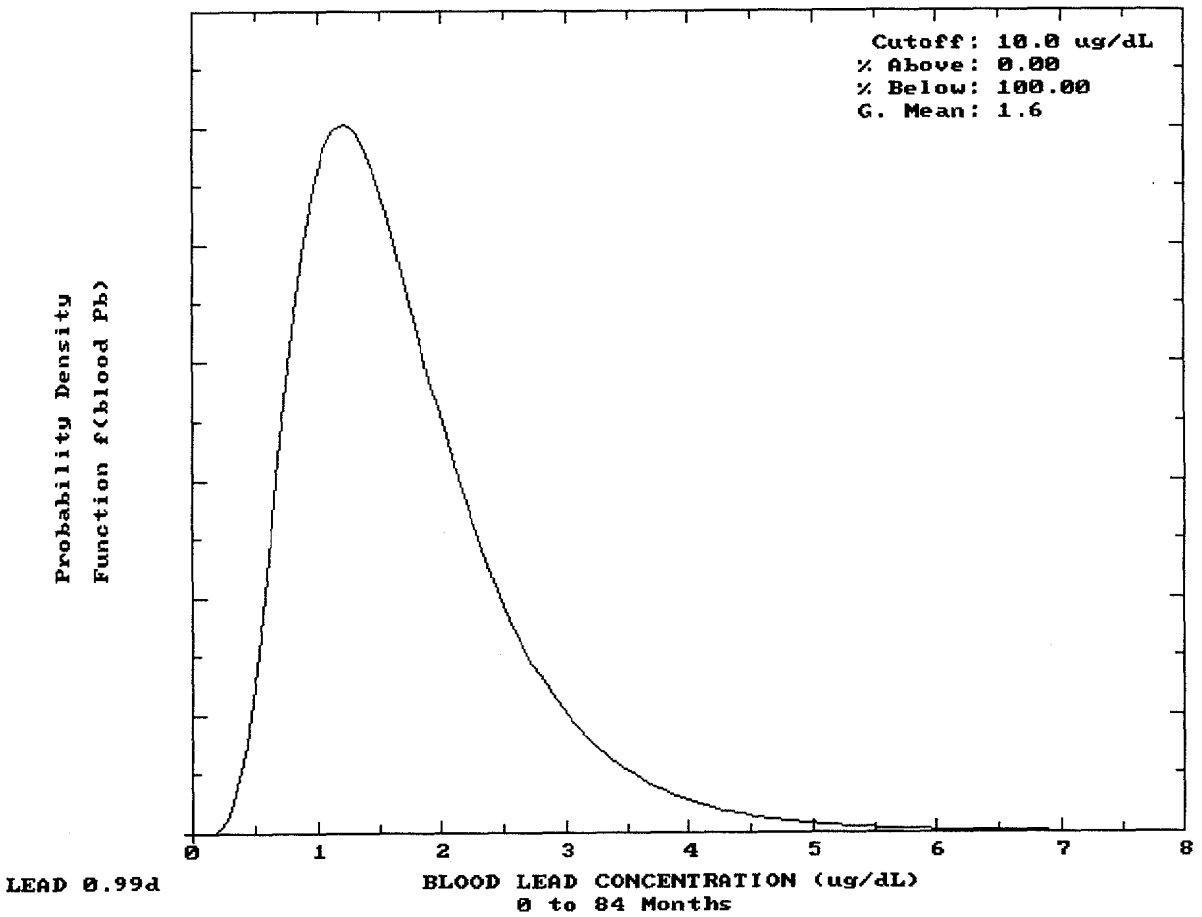
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	1.8	3.32	0.39
1-2:	1.7	4.05	0.62
2-3:	1.6	4.46	0.62
3-4:	1.6	4.38	0.63
4-5:	1.4	4.15	0.47
5-6:	1.3	4.33	0.42
-7:	1.3	4.64	0.40

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.66	0.24	0.00	0.02
1-2:	2.79	0.60	0.00	0.03
2-3:	3.14	0.63	0.00	0.06
3-4:	3.04	0.64	0.00	0.07
4-5:	2.94	0.67	0.00	0.07
5-6:	3.11	0.71	0.00	0.09
6-7:	3.43	0.72	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 1.6
Intersect: 0.00 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 0.00
% Below: 100.00
G. Mean: 1.6
Probability Density
Function f(blood Pb)
0
1
2
3
4
5
6
7
8
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HISTOGRAMS FOR

SWMU 9 - GROUNDWATER AND SURFACE SOIL DATA

IEUBK MODEL RESULTS

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 2.10 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	265.0	265.0
1-2	265.0	265.0
2-3	265.0	265.0
3-4	265.0	265.0
4-5	265.0	265.0
5-6	265.0	265.0
6-7	265.0	265.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

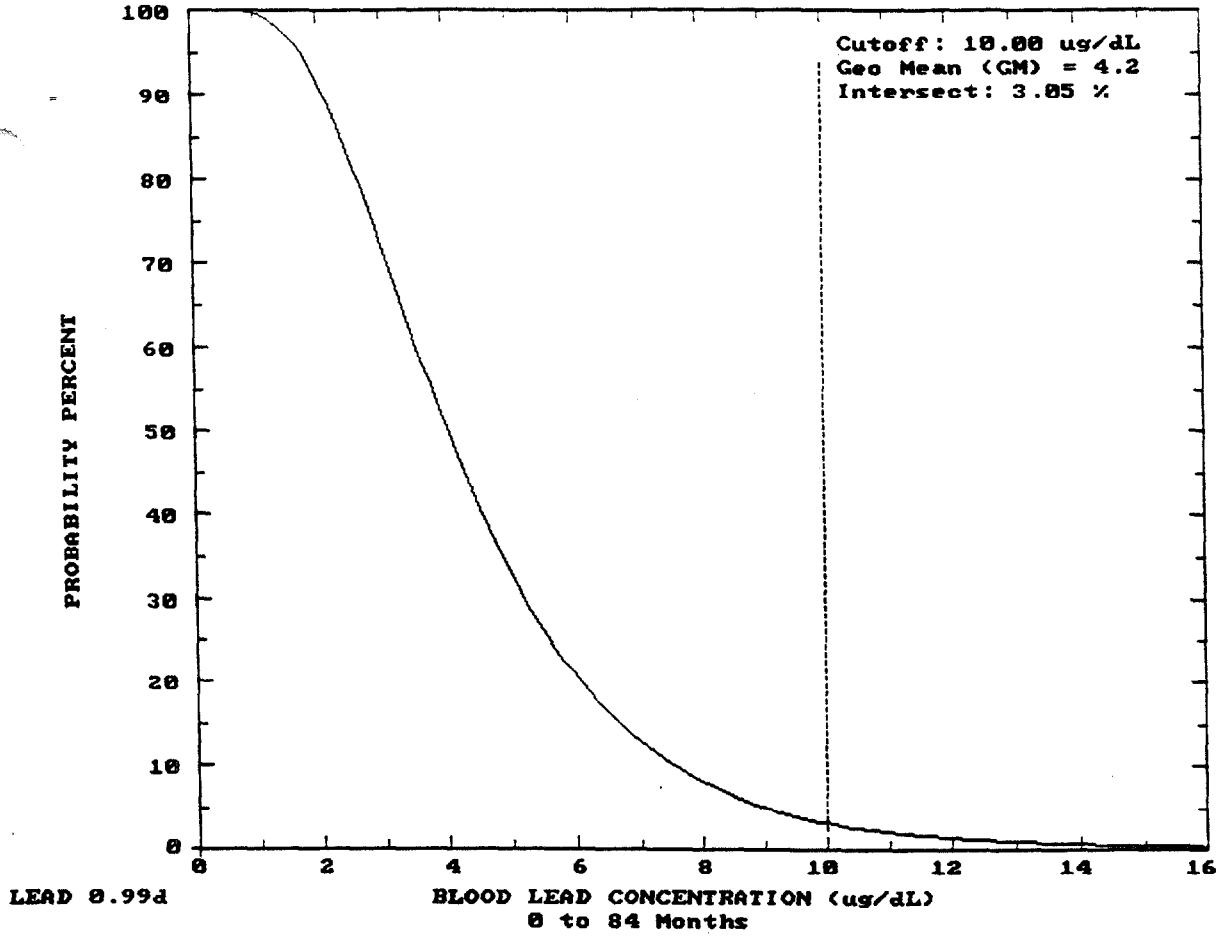
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

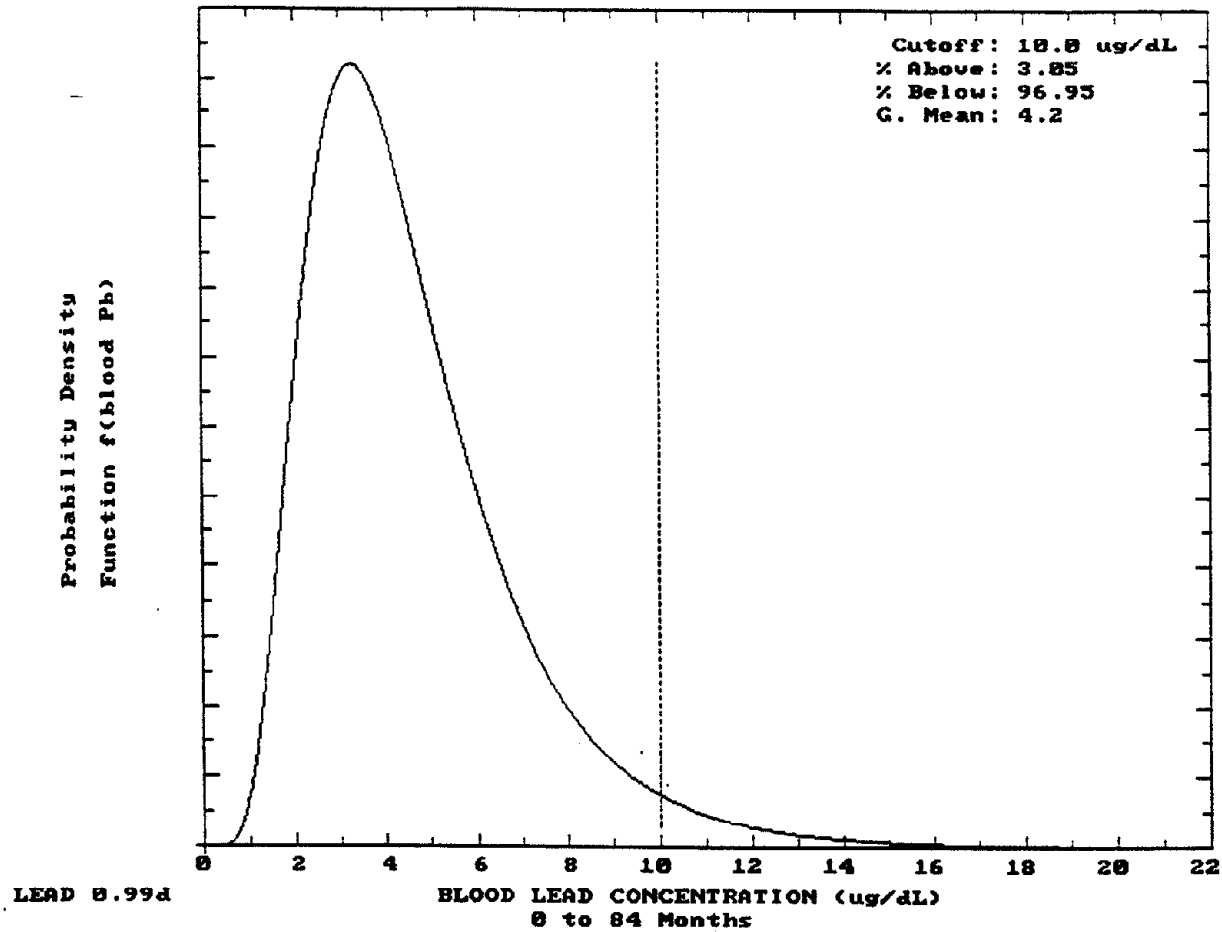
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.8	8.82	6.11
1-2:	5.3	12.68	9.60
2-3:	4.9	13.22	9.72
3-4:	4.7	13.31	9.86
4-5:	3.9	10.93	7.49
5-6:	3.3	10.49	6.80
6-7:	3.0	10.48	6.45

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.50	0.19	0.00	0.02
1-2:	2.58	0.47	0.00	0.03
2-3:	2.94	0.49	0.00	0.06
-4:	2.87	0.51	0.00	0.07
4-5:	2.83	0.54	0.00	0.07
5-6:	3.01	0.58	0.00	0.09
6-7:	3.34	0.59	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 4.2
Intersect: 3.05 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 3.85
% Below: 96.95
G. Mean: 4.2
Probability Density
Function f(blood Pb)
0
2
4
6
8
10
12
14
16
18
20
22
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 2.10 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	75.6	75.6
1-2	75.6	75.6
2-3	75.6	75.6
3-4	75.6	75.6
4-5	75.6	75.6
5-6	75.6	75.6
6-7	75.6	75.6

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

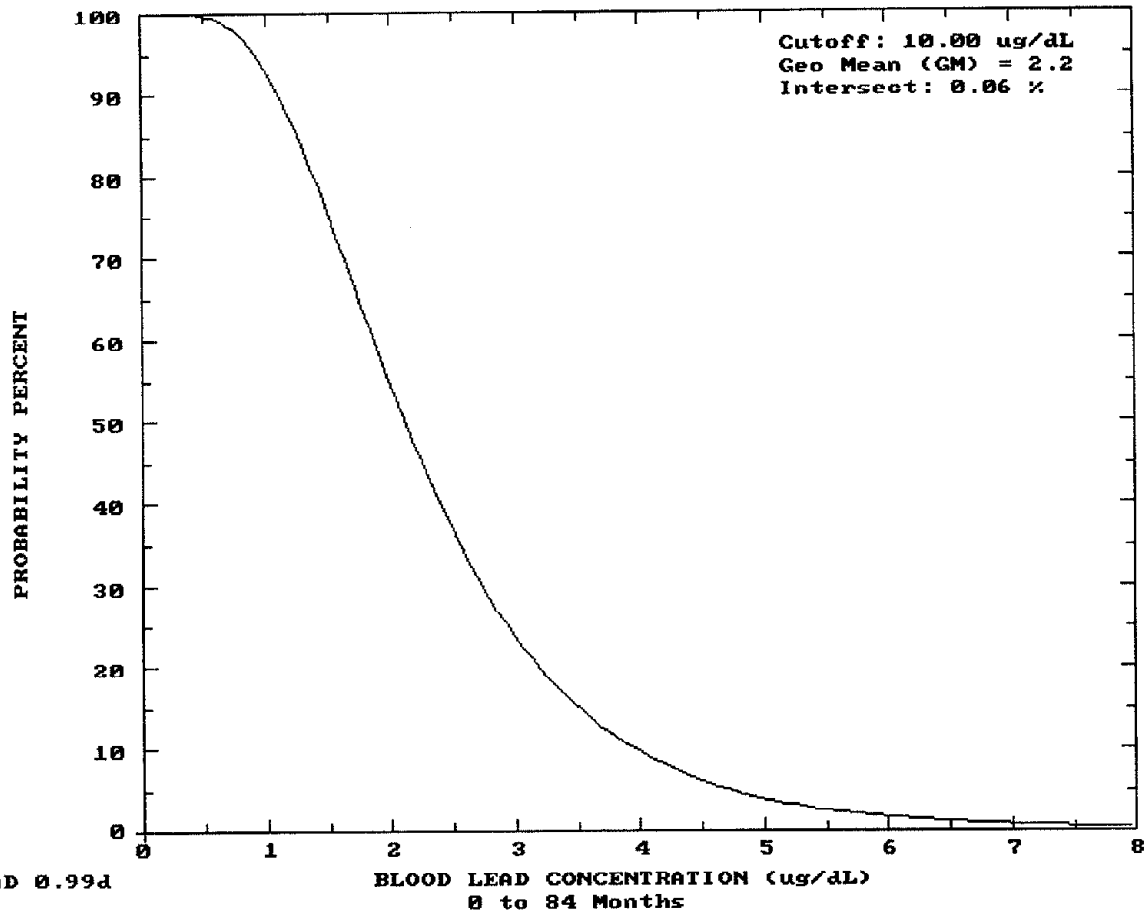
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

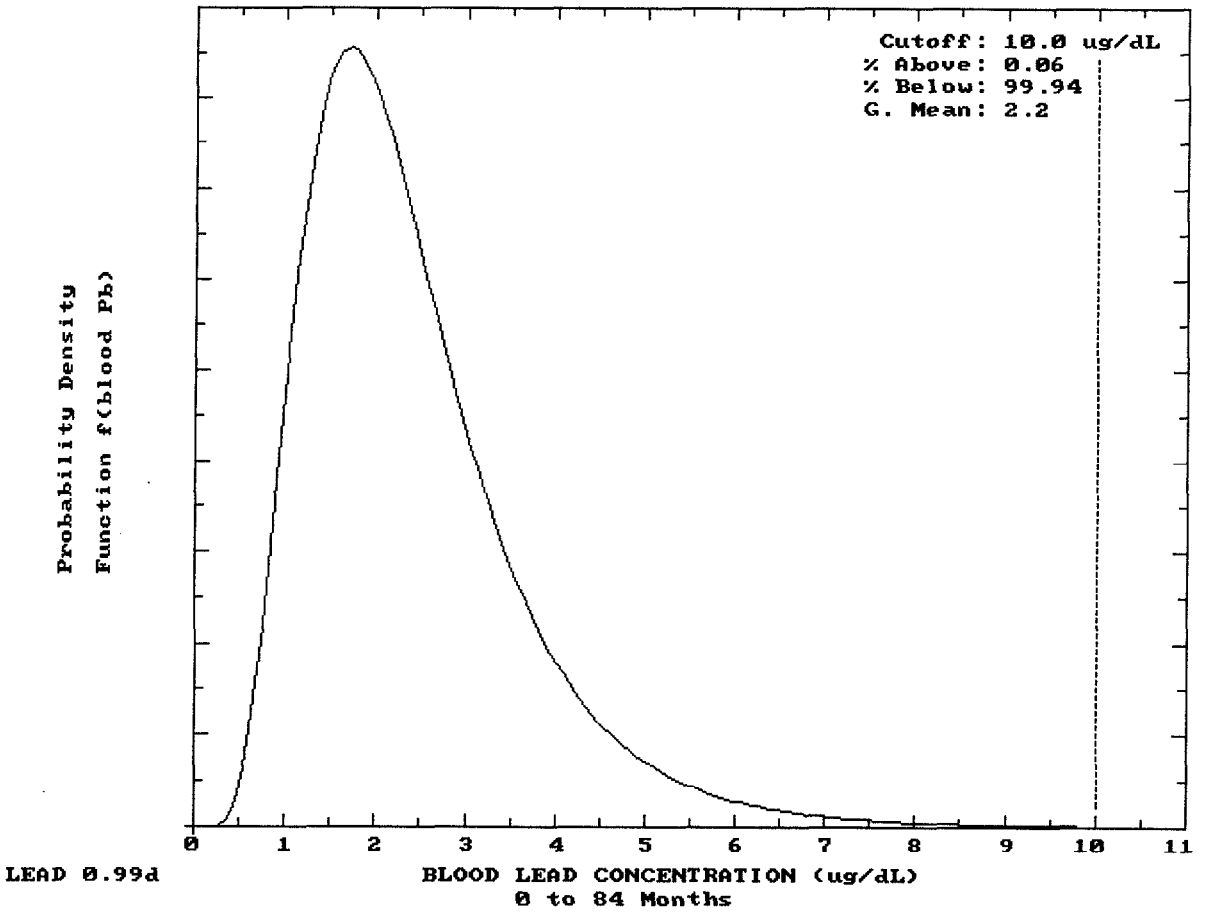
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	2.6	4.67	1.83
1-2:	2.6	6.17	2.90
2-3:	2.4	6.59	2.92
3-4:	2.3	6.53	2.94
4-5:	2.0	5.74	2.20
5-6:	1.8	5.76	1.99
6-7:	1.7	5.98	1.88

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.62	0.20	0.00	0.02
1-2:	2.74	0.50	0.00	0.03
2-3:	3.09	0.52	0.00	0.06
3-4:	2.99	0.53	0.00	0.07
4-5:	2.91	0.56	0.00	0.07
5-6:	3.08	0.59	0.00	0.09
6-7:	3.41	0.60	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 2.2
Intersect: 0.06 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d


Cutoff: 10.0 ug/dL
% Above: 0.06
% Below: 99.94
G. Mean: 2.2
Probability Density
Function f(blood Pb)
0
1
2
3
4
5
6
7
8
9
10
11
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HISTOGRAMS FOR

BACKGROUND - GROUNDWATER AND SURFACE SOIL DATA

LEAD MODEL Version 0.99d

AIR-CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 1.19 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	16.8	16.8
1-2	16.8	16.8
2-3	16.8	16.8
3-4	16.8	16.8
4-5	16.8	16.8
5-6	16.8	16.8
6-7	16.8	16.8

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

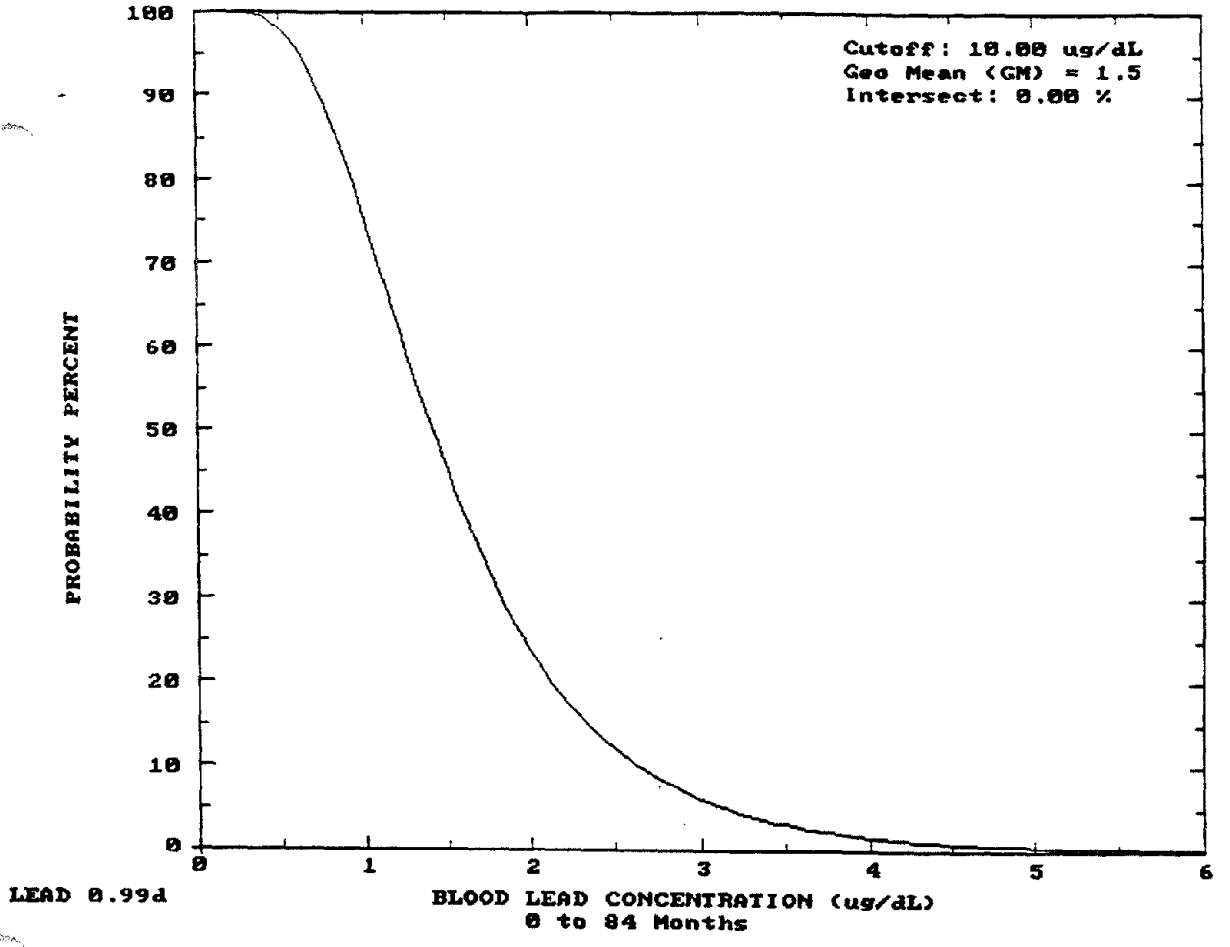
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

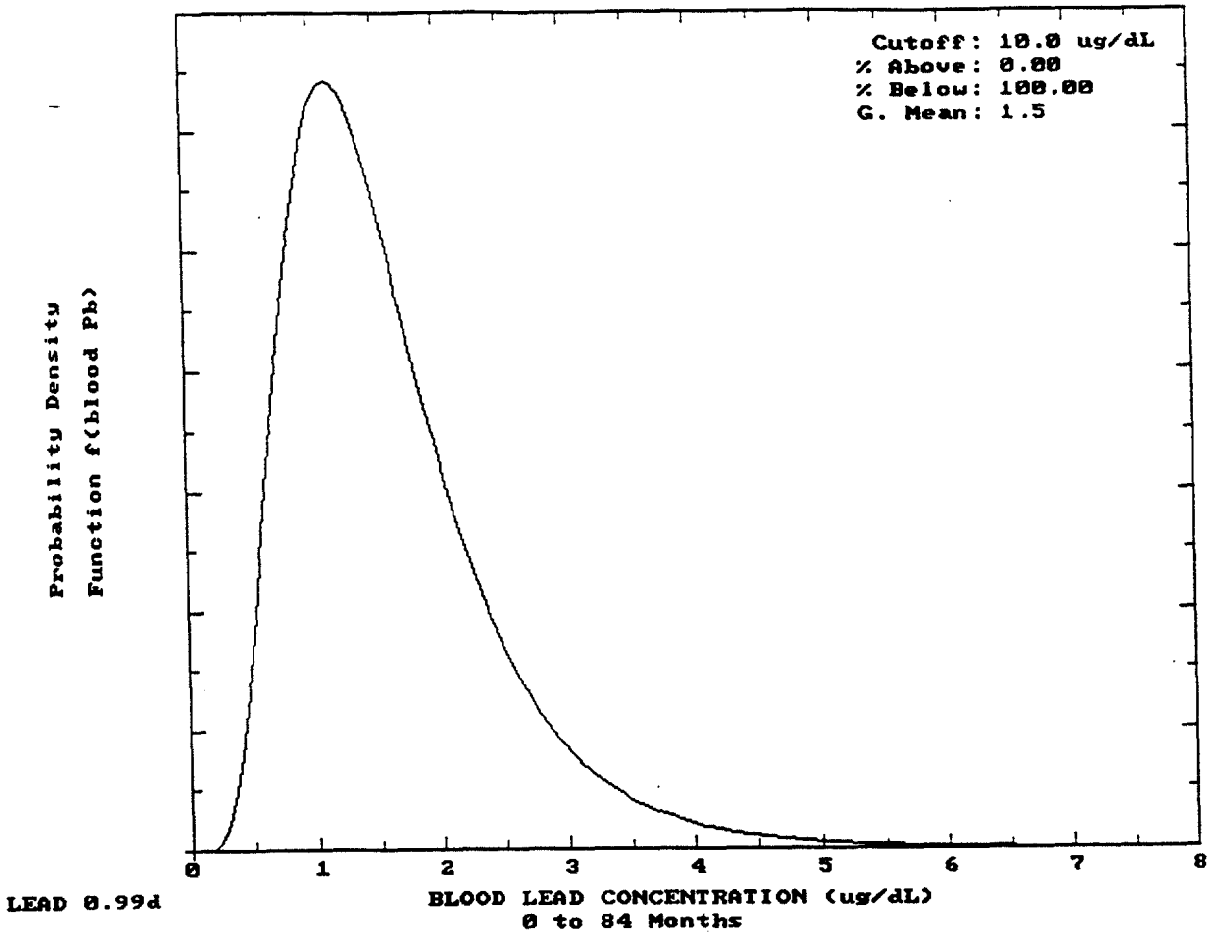
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	1.8	3.22	0.41
1-2:	1.6	3.78	0.66
2-3:	1.5	4.17	0.66
3-4:	1.4	4.08	0.66
4-5:	1.3	3.83	0.49
5-6:	1.2	3.99	0.45
6-7:	1.2	4.29	0.42

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptak (ug/day)

0.5-1:	2.67	0.11	0.00	0.02
1-2:	2.80	0.29	0.00	0.03
2-3:	3.15	0.30	0.00	0.06
3-4:	3.04	0.31	0.00	0.07
4-5:	2.94	0.32	0.00	0.07
5-6:	3.11	0.34	0.00	0.09
6-7:	3.44	0.34	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 1.5
Intersect: 0.00 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 0.00
% Below: 100.00
G. Mean: 1.5
Probability Density
Function f(blood Pb)
0
1
2
3
4
5
6
7
8
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d

APPENDIX A - PART 6

REPLACEMENT PAGES

SWMU 1 - CHEMICAL SPECIFIC RISKS
SUBSURFACE SOIL

NO COPCS WERE SELECTED FOR SUBSURFACE SOILS - SWMU 1

SWMU 1 - CHEMICAL SPECIFIC RISKS
SUBSURFACE SOIL

1 - SD	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA INGESTION	SEDIMENT NON CARC RISK CHILD RESIDENT VIA INGESTION	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA DERMAL	SEDIMENT NON CARC RISK CHILD RESIDENT VIA DERMAL	SEDIMENT CANCER RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT CANCER RISK TRESPASSER ADOLESCENT VIA INGESTION	SEDIMENT NON CARC RISK TRESPASSER ADOLESCENT VIA INGESTION	SEDIMENT CANCER RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT CANCER RISK TRESPASSER ADOLESCENT VIA DERMAL	SEDIMENT NON CARC RISK TRESPASSER ADOLESCENT VIA DERMAL
ARSENIC	1.0E-05	1.8E-01	3.9E-05	2.8E-01	1.1E-06	8.9E-03	1.1E-06	1.6E-02	1.0E-05	8.2E-02	7.3E-06	1.0E-01
BERYLLIUM	5.4E-07	2.0E-04	6.5E-08	9.8E-06	5.8E-08	9.9E-06	5.8E-08	1.7E-05	1.7E-08	2.8E-06	1.2E-08	3.6E-06
COPPER		3.9E-02		1.9E-03		1.9E-03		3.3E-03		5.4E-04		6.8E-04
BENZO(A)PYRENE	3.6E-05				3.8E-06		3.9E-06					
BENZO(B)FLUORANTHENE	4.5E-07				4.8E-08		4.8E-08					
CHRYSENE	4.6E-08				4.9E-09		5.0E-09					
DIBENZ(A,H)ANTHRACENE	2.0E-06				2.1E-07		2.2E-07					
HEXACHLOROPHENE		9.9E-02		1.9E-01		4.8E-03		8.3E-03		5.5E-02		6.9E-02
INDENO(1,2,3-CD)PYRENE	1.5E-06				1.6E-07		1.6E-07					
total	5.1E-05	3.2E-01	3.9E-05	4.7E-01	5.4E-06	1.6E-02	5.5E-06	2.7E-02	1.0E-05	1.4E-01	7.3E-06	1.7E-01

SWMU 1 - CHEMICAL SPECIFIC RISKS
SURFACE WATER

1 - SW	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER CANCER RISK TRESSPASSER ADOLESCENT VIA INGESTION	SURFACE WATER NON CARC RISK TRESSPASSER ADOLESCENT VIA INGESTION	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER CANCER RISK TRESSPASSER ADOLESCENT VIA DERMAL	SURFACE WATER NON CARC RISK TRESSPASSER ADOLESCENT VIA DERMAL
BERYLLIUM	2.0E-06	5.7E-04	8.5E-08	3.7E-05	3.2E-07	5.5E-05	3.2E-07	9.6E-05	2.3E-08	4.0E-06	8.6E-09	2.5E-06
CADMIUM		6.5E-02		4.2E-03		6.3E-03		1.1E-02		4.6E-04		2.9E-04
COPPER		1.6E-02		1.0E-03		1.6E-03		2.7E-03		1.1E-04		7.2E-05
MERCURY		6.6E-02		4.3E-03		6.4E-03		1.1E-02		4.7E-04		3.0E-04
CHLOROBENZILATE	5.1E-08	5.9E-05			8.4E-09	5.7E-06	8.5E-09	1.0E-05				
KEPONE	6.8E-07				1.1E-07		1.1E-07					
total	2.7E-06	1.5E-01	8.5E-08	9.6E-03	4.4E-07	1.4E-02	4.5E-07	2.5E-02	2.3E-08	1.0E-03	8.6E-09	6.6E-04

SWMU 2 - CHEMICAL SPECIFIC RISKS
SURFACE SOIL

2 - SS	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA INHALATION	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA INHALATION	SURFACE SOIL CANCER RISK TRESPASSER ADULT VIA INGESTION	SURFACE SOIL NON CARC RISK TRESPASSER ADULT VIA INGESTION	SURFACE SOIL CANCER RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE SOIL NON CARC RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE SOIL CANCER RISK TRESPASSER ADULT VIA DERMAL	SURFACE SOIL NON CARC RISK TRESPASSER ADULT VIA DERMAL	SURFACE SOIL CANCER RISK TRESPASSER ADOLESCENT VIA DERMAL
ANTIMONY		1.5E-01		7.2E-03				1.1E-03		2.4E-03		3.2E-04	
BERYLLIUM	1.5E-06	5.9E-04	1.9E-07	2.8E-05	1.5E-08		2.5E-08	4.3E-06	3.2E-08	9.5E-06	7.2E-09	1.2E-06	6.6E-09
4,4'-DDD	1.2E-07		5.7E-07				1.9E-09		2.4E-09		2.2E-08		2.0E-08
4,4'-DDE	2.9E-07		1.4E-06				4.7E-09		6.0E-09		5.4E-08		4.9E-08
4,4'-DDT	2.0E-07	9.6E-03	9.6E-07	1.8E-02	6.2E-10		3.3E-09	7.1E-05	4.1E-09	1.5E-04	3.7E-08	8.1E-04	3.4E-08
total	2.2E-06	1.6E-01	3.1E-06	2.6E-02	1.6E-08		3.5E-08	1.2E-03	4.4E-08	2.6E-03	1.2E-07	1.1E-03	1.1E-07

2 - SS	SURFACE SOIL NON CARC RISK TRESPASSER ADOLESCENT VIA DERMAL	SURFACE SOIL CANCER RISK TRESPASSER ADULT VIA INHALATION	SURFACE SOIL NON CARC RISK TRESPASSER ADULT VIA INHALATION	SURFACE SOIL CANCER RISK TRESPASSER ADOLESCENT VIA INHALATION	SURFACE SOIL NON CARC RISK TRESPASSER ADOLESCENT VIA INHALATION	SURFACE SOIL CANCER RISK MAINT. WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA INGESTION	SURFACE SOIL CANCER RISK MAINT. WORKER VIA DERMAL	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA DERMAL	SURFACE SOIL CANCER RISK MAINT. WORKER VIA INHALATION	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA INHALATION	SURFACE SOIL CANCER RISK SITE WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK SITE WORKER VIA INGESTION
ANTIMONY	5.0E-04						6.5E-04		1.6E-04				5.7E-03
BERYLLIUM	2.0E-06	9.6E-11		1.2E-10		2.0E-08	2.5E-06	4.8E-09	6.2E-07	1.3E-10		1.7E-07	2.3E-05
4,4'-DDD						1.5E-09		1.5E-08				1.3E-08	
4,4'-DDE						3.7E-09		3.6E-08				3.2E-08	
4,4'-DDT	1.3E-03	3.9E-12		4.9E-12		2.5E-09	4.2E-05	2.5E-08	4.1E-04	5.1E-12		2.2E-08	3.7E-04
total	1.8E-03	1.0E-10		1.3E-10		2.7E-08	7.0E-04	8.0E-08	5.7E-04	1.3E-10		2.4E-07	6.1E-03

2 - SS	SURFACE SOIL CANCER RISK SITE WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK SITE WORKER VIA DERMAL	SURFACE SOIL CANCER RISK SITE WORKER VIA INHALATION	SURFACE SOIL NON CARC RISK SITE WORKER VIA INHALATION
ANTIMONY		1.3E-03		
BERYLLIUM	4.0E-08	5.2E-06	2.6E-09	
4,4'-DDD	1.2E-07			
4,4'-DDE	3.0E-07			
4,4'-DDT	2.1E-07	3.4E-03	1.1E-10	
total	6.6E-07	4.7E-03	2.7E-09	

SWMU 2 - CHEMICAL SPECIFIC RISKS
SUBSURFACE SOIL

NO COPCS WERE SELECTED FOR SUBSURFACE SOILS - SWMU 2

SWMU 2 - CHEMICAL SPECIFIC RISKS
SEDIMENT

2 - SD	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA INGESTION	SEDIMENT NON CARC RISK CHILD RESIDENT VIA INGESTION	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA DERMAL	SEDIMENT NON CARC RISK CHILD RESIDENT VIA DERMAL	SEDIMENT CANCER RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT CANCER RISK TRESSPASSER CHILD VIA INGESTION	SEDIMENT NON CARC RISK TRESSPASSER CHILD VIA INGESTION	SEDIMENT CANCER RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT CANCER RISK TRESSPASSER CHILD VIA DERMAL	SEDIMENT NON CARC RISK TRESSPASSER CHILD VIA DERMAL
IRON		3.2E-02		1.5E-03		1.5E-03		2.7E-03		4.4E-04		5.6E-04
4,4'-DDD	1.8E-06		8.8E-06		2.0E-07		2.0E-07		2.3E-06		1.7E-06	
4,4'-DDE	7.1E-07		3.4E-06		7.5E-08		7.6E-08		8.7E-07		6.3E-07	
4,4'-DDT	2.3E-06	1.1E-01	1.1E-05	2.1E-01	2.4E-07	5.2E-03	2.4E-07	9.1E-03	2.8E-06	6.0E-02	2.0E-06	7.5E-02
total	4.8E-06	1.4E-01	2.3E-05	2.1E-01	5.1E-07	6.8E-03	5.2E-07	1.2E-02	5.9E-06	6.0E-02	4.3E-06	7.6E-02

SWMU 2 - CHEMICAL SPECIFIC RISKS
SURFACE WATER

2 - SW	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER CANCER RISK TRESSPASSER ADOLESCENT VIA INGESTION	SURFACE WATER NON CARC RISK TRESSPASSER ADOLESCENT VIA INGESTION	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER CANCER RISK TRESSPASSER ADOLESCENT VIA DERMAL	SURFACE WATER NON CARC RISK TRESSPASSER ADOLESCENT VIA DERMAL
ANTIMONY		7.7E-02		5.0E-03		7.4E-03		1.3E-02		5.4E-04		3.4E-04
4,4'-DDD	1.3E-07		8.9E-06		2.2E-08		2.2E-08		2.4E-06		1.5E-06	
4,4'-DDT	4.2E-08	1.6E-03	5.7E-06	9.9E-02	7.0E-09	1.5E-04	7.1E-09	2.6E-04	1.5E-06	3.3E-02	9.6E-07	3.6E-02
ALDRIN	7.1E-07	8.7E-03	3.8E-07	2.2E-03	1.2E-07	8.4E-04	1.2E-07	1.5E-03	1.0E-07	7.3E-04	6.4E-08	8.0E-04
BETA-BHC	1.0E-07				1.7E-08		1.7E-08					
HEPTACHLOR	9.9E-08	2.8E-04	3.9E-07	5.1E-04	1.6E-08	2.7E-05	1.6E-08	4.7E-05	1.0E-07	1.7E-04	6.6E-08	1.9E-04
total	1.1E-06	8.8E-02	1.5E-05	1.1E-01	1.8E-07	8.5E-03	1.8E-07	1.5E-02	4.1E-06	3.4E-02	2.6E-06	3.7E-02

SWMU 3 - CHEMICAL SPECIFIC RISKS
SURFACE SOIL

NO COPCS WERE SELECTED FOR SURFACE SOILS - SWMU 3

SWMU 3 - CHEMICAL SPECIFIC RISKS
SUBSURFACE SOIL

NO COPCS WERE SELECTED FOR SUBSURFACE SOILS - SWMU 3

SWMU 3 - CHEMICAL SPECIFIC RISKS
SEDIMENT

3- SD	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA INGESTION	SEDIMENT NON CARC RISK CHILD RESIDENT VIA INGESTION	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA DERMAL	SEDIMENT NON CARC RISK CHILD RESIDENT VIA DERMAL	SEDIMENT CANCER RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT CANCER RISK TRESPASSER ADOLESCENT VIA INGESTION	SEDIMENT NON CARC RISK TRESPASSER ADOLESCENT VIA INGESTION	SEDIMENT CANCER RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT CANCER RISK TRESPASSER ADOLESCENT VIA DERMAL	SEDIMENT NON CARC RISK TRESPASSER ADOLESCENT VIA DERMAL
ARSENIC	3.4E-06	6.2E-02	1.3E-05	9.5E-02	3.7E-07	3.0E-03	3.7E-07	5.2E-03	3.4E-06	2.8E-02	2.4E-06	3.5E-02
IRON		4.3E-02		2.0E-03		2.1E-03		3.6E-03		5.9E-04		7.4E-04
total	3.4E-06	1.0E-01	1.3E-05	9.7E-02	3.7E-07	5.0E-03	3.7E-07	8.8E-03	3.4E-06	2.8E-02	2.4E-06	3.5E-02

SWMU 3 - CHEMICAL SPECIFIC RISKS
SURFACE WATER

3 - SW	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER CANCER RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE WATER NON CARC RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER CANCER RISK TRESPASSER ADOLESCENT VIA DERMAL	SURFACE WATER NON CARC RISK TRESPASSER ADOLESCENT VIA DERMAL
ANTIMONY		6.6E-01		3.4E-01		6.4E-02		1.1E-01		2.8E-02		3.5E-02
total		6.6E-01		3.4E-01		6.4E-02		1.1E-01		2.8E-02		3.5E-02

SWMU 9 - CHEMICAL SPECIFIC RISKS
SURFACE SOIL

9 - SS	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA INHALATION	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA INHALATION	SURFACE SOIL CANCER RISK TRESSPASSER ADULT VIA INGESTION	SURFACE SOIL NON CARC RISK TRESSPASSER ADULT VIA INGESTION	SURFACE SOIL CANCER RISK TRESSPASSER ADOLESCENT VIA INGESTION	SURFACE SOIL NON CARC RISK TRESSPASSER ADOLESCENT VIA INGESTION	SURFACE SOIL CANCER RISK TRESSPASSER ADULT VIA DERMAL	SURFACE SOIL NON CARC RISK TRESSPASSER ADULT VIA DERMAL	SURFACE SOIL CANCER RISK TRESSPASSER ADOLESCENT VIA DERMAL
CADMIUM		1.8E-01		8.8E-02	1.2E-08	2.0E-04		1.3E-03		2.9E-03		3.9E-03	
IRON		1.3E-01		6.2E-03				9.6E-04		2.1E-03		2.8E-04	
MANGANESE		1.7E-01		8.1E-03		8.0E-04		1.2E-03		2.7E-03		3.6E-04	
total		4.8E-01		1.0E-01	1.2E-08	1.0E-03		3.5E-03		7.8E-03		4.5E-03	

9 - SS	SURFACE SOIL NON CARC RISK TRESSPASSER ADOLESCENT VIA DERMAL	SURFACE SOIL CANCER RISK TRESSPASSER ADULT VIA INHALATION	SURFACE SOIL NON CARC RISK TRESSPASSER ADULT VIA INHALATION	SURFACE SOIL CANCER RISK TRESSPASSER ADOLESCENT VIA INHALATION	SURFACE SOIL NON CARC RISK TRESSPASSER ADOLESCENT VIA INHALATION	SURFACE SOIL CANCER RISK MAINT. WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA INGESTION	SURFACE SOIL CANCER RISK MAINT. WORKER VIA DERMAL	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA DERMAL	SURFACE SOIL CANCER RISK MAINT. WORKER VIA INHALATION	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA INHALATION	SURFACE SOIL CANCER RISK SITE WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK SITE WORKER VIA INGESTION
CADMIUM	6.1E-03	7.2E-11	7.4E-07	9.1E-11	1.6E-06		7.9E-04		1.9E-03	9.5E-11	7.4E-07		7.0E-03
IRON	4.3E-04						5.7E-04		1.4E-04				5.0E-03
MANGANESE	5.6E-04		2.9E-06		6.5E-06		7.4E-04		1.8E-04		2.9E-06		6.5E-03
total	7.1E-03	7.2E-11	3.7E-06	9.1E-11	8.1E-06		2.1E-03		2.2E-03	9.5E-11	3.7E-06		1.8E-02

9 - SS	SURFACE SOIL CANCER RISK SITE WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK SITE WORKER VIA DERMAL	SURFACE SOIL CANCER RISK SITE WORKER VIA INHALATION	SURFACE SOIL NON CARC RISK SITE WORKER VIA INHALATION
CADMIUM		1.6E-02	2.0E-09	1.5E-05
IRON		1.1E-03		
MANGANESE		1.5E-03		6.1E-05
total		1.9E-02	2.0E-09	7.7E-05

SWMU 9 - CHEMICAL SPECIFIC RISKS
SUBSURFACE SOIL

NO COPCS WERE SELECTED FOR SUBSURFACE SOILS - SWMU 9

SWMU 9 - CHEMICAL SPECIFIC RISKS
SEDIMENT

9 - SD	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA INGESTION	SEDIMENT NON CARC RISK CHILD RESIDENT VIA INGESTION	SEDIMENT CANCER RISK LIFETIME RESIDENT VIA DERMAL	SEDIMENT NON CARC RISK CHILD RESIDENT VIA DERMAL	SEDIMENT CANCER RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA INGESTION	SEDIMENT CANCER RISK TRESSPASSER CHILD VIA INGESTION	SEDIMENT NON CARC RISK TRESSPASSER CHILD VIA INGESTION	SEDIMENT CANCER RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT NON CARC RISK TRESPASSER ADULT VIA DERMAL	SEDIMENT CANCER RISK TRESSPASSER CHILD VIA DERMAL	SEDIMENT NON CARC RISK TRESSPASSER CHILD VIA DERMAL
ARSENIC	1.2E-05	2.2E-01	4.6E-05	3.3E-01	1.3E-06	1.0E-02	1.3E-06	1.8E-02	1.2E-05	9.6E-02	8.5E-06	1.2E-01
IRON		3.3E-02		1.6E-03		1.6E-03		2.8E-03		4.5E-04		5.7E-04
total	1.2E-05	2.5E-01	4.6E-05	3.3E-01	1.3E-06	1.2E-02	1.3E-06	2.1E-02	1.2E-05	9.7E-02	8.5E-06	1.2E-01

SWMU 9 - CHEMICAL SPECIFIC RISKS
SURFACE WATER

9 - SW	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE WATER CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE WATER NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA INGESTION	SURFACE WATER CANCER RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE WATER NON CARC RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE WATER CANCER RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER NON CARC RISK TRESPASSER ADULT VIA DERMAL	SURFACE WATER CANCER RISK TRESPASSER ADOLESCENT VIA DERMAL	SURFACE WATER NON CARC RISK TRESPASSER ADOLESCENT VIA DERMAL
THALLIUM		3.0E-01		1.5E-01		2.9E-02		5.1E-02		1.3E-02		1.6E-02
total		3.0E-01		1.5E-01		2.9E-02		5.1E-02		1.3E-02		1.6E-02

SWMU 1 - CHEMICAL SPECIFIC RISKS
SURFACE SOIL

1 -SS	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA INGESTION	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA INGESTION	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA DERMAL	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA DERMAL	SURFACE SOIL CANCER RISK LIFETIME RESIDENT VIA INHALATION	SURFACE SOIL NON CARC RISK CHILD RESIDENT VIA INHALATION	SURFACE SOIL CANCER RISK TRESPASSER ADULT VIA INGESTION	SURFACE SOIL NON CARC RISK TRESPASSER ADULT VIA INGESTION	SURFACE SOIL CANCER RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE SOIL NON CARC RISK TRESPASSER ADOLESCENT VIA INGESTION	SURFACE SOIL CANCER RISK TRESPASSER ADULT VIA DERMAL	SURFACE SOIL NON CARC RISK TRESPASSER ADULT VIA DERMAL	SURFACE SOIL CANCER RISK TRESPASSER ADOLESCENT VIA DERMAL
ALUMINUM		9.1E-02		4.4E-03				6.7E-04		1.5E-03		1.9E-04	
ANTIMONY		4.7E-01		2.3E-02				3.5E-03		7.6E-03		9.9E-04	
ARSENIC	1.3E-05	2.4E-01	5.1E-05	3.7E-01	2.8E-11		2.2E-07	1.8E-03	2.7E-07	3.9E-03	2.0E-06	1.6E-02	1.8E-06
BERYLLIUM	1.2E-06	4.7E-04	1.5E-07	2.2E-05	1.2E-12		2.0E-08	3.4E-06	2.5E-08	7.5E-06	5.8E-09	9.9E-07	5.2E-09
CADMIUM		2.9E-01		1.4E-01	1.5E-11	4.2E-07		2.1E-03		4.6E-03		6.0E-03	
CHROMIUM		2.8E-01		1.3E-02	9.8E-10			2.0E-03		4.4E-03		5.8E-04	
COPPER		1.3E-01		6.2E-03				9.6E-04		2.1E-03		2.7E-04	
IRON		1.2E+00		5.8E-02				8.9E-03		2.0E-02		2.6E-03	
MANGANESE		2.6E-01		1.2E-02		4.4E-05		1.9E-03		4.2E-03		5.5E-04	
MERCURY		2.6E-01		1.3E-02		2.4E-07		1.9E-03		4.2E-03		5.6E-04	
4,4'-DDD	5.3E-07		2.5E-06				8.6E-09		1.1E-08		9.9E-08		9.0E-08
4,4'-DDE	9.2E-07		4.4E-06				1.5E-08		1.9E-08		1.7E-07		1.6E-07
4,4'-DDT	2.5E-06	1.2E-01	1.2E-05	2.3E-01	2.1E-12		4.1E-08	8.8E-04	5.2E-08	1.9E-03	4.7E-07	1.0E-02	4.3E-07
AROCLOR-1260	1.1E-05		3.1E-05				1.8E-07		2.2E-07		1.2E-06		1.1E-06
BENZ(A)ANTHRACENE	3.9E-06				2.9E-12		6.4E-08		8.1E-08				
BENZO(A)PYRENE	2.5E-05				1.9E-11		4.1E-07		5.2E-07				
BENZO(B)FLUORANTHENE	5.9E-06				4.5E-12		9.7E-08		1.2E-07				
BENZO(K)FLUORANTHENE	4.7E-08				3.5E-14		7.6E-10		9.7E-10				
CHRYSENE	5.6E-08				4.2E-14		9.1E-10		1.2E-09				
DIBENZ(A,H)ANTHRACENE	6.9E-06				5.2E-12		1.1E-07		1.4E-07				
INDENO(1,2,3-CD)PYRENE	1.8E-06				1.4E-12		3.0E-08		3.7E-08				
total	7.3E-05	3.3E+00	1.0E-04	8.6E-01	1.1E-09	4.5E-05	1.2E-06	2.5E-02	1.5E-06	5.4E-02	3.9E-06	3.8E-02	3.6E-06

1-SS	SURFACE SOIL NON CARC RISK TRESPASSER ADOLESCENT VIA DERMAL	SURFACE SOIL CANCER RISK TRESPASSER ADULT VIA INHALATION	SURFACE SOIL NON CARC RISK TRESPASSER ADULT VIA INHALATION	SURFACE SOIL CANCER RISK TRESPASSER ADOLESCENT VIA INHALATION	SURFACE SOIL NON CARC RISK TRESPASSER ADOLESCENT VIA INHALATION	SURFACE SOIL CANCER RISK MAINT. WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA INGESTION	SURFACE SOIL CANCER RISK MAINT. WORKER VIA DERMAL	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA DERMAL	SURFACE SOIL CANCER RISK MAINT. WORKER VIA INHALATION	SURFACE SOIL NON CARC RISK MAINT. WORKER VIA INHALATION	SURFACE SOIL CANCER RISK SITE WORKER VIA INGESTION	SURFACE SOIL NON CARC RISK SITE WORKER VIA INGESTION
ALUMINUM	3.0E-04						4.0E-04		9.6E-05				3.5E-03
ANTIMONY	1.6E-03						2.0E-03		5.0E-04				1.8E-02
ARSENIC	2.5E-02	1.7E-13		1.2E-13		1.7E-07	1.0E-03	1.3E-06	8.1E-03	2.3E-13		1.5E-06	9.2E-03
BERYLLIUM	1.6E-06	7.4E-15		5.4E-15		1.6E-08	2.0E-06	3.8E-09	4.9E-07	9.7E-15		1.4E-07	1.8E-05
CADMIUM	9.5E-03	9.5E-14	1.5E-09	6.9E-14	1.9E-09		1.2E-03		3.0E-03	1.3E-13	1.5E-09		1.1E-02
CHROMIUM	9.2E-04	6.1E-12		4.4E-12			1.2E-03		2.9E-04	8.1E-12			1.1E-02
COPPER	4.3E-04						5.6E-04		1.4E-04				5.0E-03
IRON	4.0E-03						5.3E-03		1.3E-03				4.6E-02
MANGANESE	8.6E-04		1.6E-07		2.0E-07		1.1E-03		2.7E-04		1.6E-07		9.9E-03
MERCURY	8.8E-04		8.8E-10		1.1E-09		1.1E-03		2.8E-04		8.8E-10		1.0E-02
4,4'-DDD						6.7E-09		6.5E-08				5.9E-08	
4,4'-DDE						1.2E-08		1.1E-07				1.0E-07	
4,4'-DDT	1.6E-02	1.3E-14		9.4E-15		3.2E-08	5.2E-04	3.1E-07	5.1E-03	1.7E-14		2.8E-07	4.6E-03
AROCLOR-1260						1.4E-07		8.0E-07				1.2E-06	
BENZ(A)ANTHRACENE		1.8E-14		1.3E-14		4.9E-08				2.4E-14		4.4E-07	
BENZO(A)PYRENE		1.2E-13		8.5E-14		3.2E-07				1.5E-13		2.8E-06	
BENZO(B)FLUORANTHENE		2.8E-14		2.0E-14		7.5E-08				3.7E-14		6.6E-07	
BENZO(K)FLUORANTHENE		2.2E-16		1.6E-16		5.9E-10				2.9E-16		5.2E-09	
CHRYSENE		2.6E-16		1.9E-16		7.1E-10				3.5E-16		6.3E-09	
DIBENZ(A,H)ANTHRACENE		3.2E-14		2.3E-14		8.7E-08				4.3E-14		7.7E-07	
INDENO(1,2,3-CD)PYRENE		8.5E-15		6.2E-15		2.3E-08				1.1E-14		2.0E-07	
total	6.0E-02	6.6E-12	1.7E-07	4.8E-12	2.1E-07	9.2E-07	1.5E-02	2.6E-06	1.9E-02	8.7E-12	1.7E-07	8.1E-06	1.3E-01

1-SS	SURFACE SOIL CANCER RISK SITE WORKER VIA DERMAL	SURFACE SOIL NON CARC RISK SITE WORKER VIA DERMAL	SURFACE SOIL CANCER RISK SITE WORKER VIA INHALATION	SURFACE SOIL NON CARC RISK SITE WORKER VIA INHALATION
ALUMINUM		8.0E-04		
ANTIMONY		4.1E-03		
ARSENIC	1.1E-05	6.8E-02	4.7E-12	
BERYLLIUM	3.2E-08	4.1E-06	2.0E-13	
CADMIUM		2.5E-02	2.6E-12	3.2E-08
CHROMIUM		2.4E-03	1.7E-10	
COPPER		1.1E-03		
IRON		1.1E-02		
MANGANESE		2.3E-03		3.4E-06
MERCURY		2.3E-03		1.8E-08
4,4'-DDD	5.4E-07			
4,4'-DDE	9.5E-07			
4,4'-DDT	2.6E-06	4.2E-02	3.6E-13	
AROCLOR-1260	6.7E-06			
BENZ(A)ANTHRACENE			5.0E-13	
BENZO(A)PYRENE			3.2E-12	
BENZO(B)FLUORANTHENE			7.6E-13	
BENZO(K)FLUORANTHENE			6.0E-15	
CHRYSENE			7.2E-15	
DIBENZ(A,H)ANTHRACENE			8.9E-13	
INDENO(1,2,3-CD)PYRENE			2.3E-13	
total	2.2E-05	1.6E-01	1.8E-10	3.5E-06

APPENDIX B

ECOLOGICAL SAMPLING TECHNICAL MEMORANDUM

ECOLOGICAL SAMPLING TECHNICAL MEMORANDUM

NAVAL AIR STATION KEY WEST

PHASE II RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION

BY BROWN & ROOT ENVIRONMENTAL

KEVIN J. WALTER, P.E.
PROJECT MANAGER
NAS KEY WEST (CTO 0007)

1.0 INTRODUCTION

This technical memorandum is written to amplify the ecological sampling at four solid waste management units (SWMUs) at Naval Air Station (NAS) Key West as described in the final Work Plan for Phase II RFI/RI by ABB Environmental Services, Inc. dated December 6, 1995. The SWMUs covered herein include:

SWMU 1	Open Disposal Area
SWMU 2	DDT Mixing Area
SWMU 3	Fire Fighting Training Area
SWMU 9	Jet Engine Test Cell

In the following Chapters 2, 3, 4, and 5, each of these four sites will be discussed. Each SWMU-specific chapter contains sections on:

- site history;
- need for further ecological assessment;
- further sampling needs - biological sampling for toxicity testing and tissues analysis, and non-biological sampling.

Lastly, Chapter 6 covers sampling procedures and protocols common to all SWMUs.

The contents of all available ecological background documents were reviewed prior to the preparation of this technical memorandum with emphasis on two documents: 1) Ecological Survey of U.S. Navy Property in the Lower Florida Keys, Monroe County, Florida, August 1994, prepared by the Florida Natural Areas Inventory; and 2) Final Report of RFI/RI (Phase I) for NAS Key West, June 9, 1994, by IT Corporation. Additionally, on November 14-16, 1995, B&RE biologists conducted a community survey overview of all four SWMUs, and searched for potential ecological receptors and visible evidence of ecological stress.

In addition to ecological sampling of the four SWMUs, three facility-wide (Boca Chica) background sampling areas will also be investigated to represent Boca Chica as a whole. At each site background soil, sediment and surface water will be sampled. Also at each site biological sampling will be conducted of all types conducted at each SWMU. These background sites will form the basis for background comparison to all SWMU-specific sampling for both biological and non-biological/chemical samples. The background sites are, therefore, very critical. One of the background sites will be selected far removed from any SWMU, however, in close proximity to the runways of the NAS. This site will reflect any facility-wide contamination that may ubiquitous due to historic military/commercial operations. The two other background sites will be selected on Boca Chica but as far removed from airfield operations and military/civilian development as possible to represent pristine Boca Chica conditions as well as possible.

2.0 SWMU 1 - OPEN DISPOSAL AREA

Site History

SWMU 1 is located in the southeastern portion of Boca Chica Key. The site consists of a former open disposal and burning area bounded by access roads to the north and west and mangroves to the south and east. Mangroves to the east lead to Geiger Creek and mangroves to the south lead to a paved road near the ocean. SWMU 1 was used for open burning and disposal of general refuse and wastes generated from aircraft maintenance activities. The site is estimated to have received 2,600 tons of waste per year from 1942 through the mid-1960s, including solvents, hydraulic fluid, and waste oils. The waste area proper is flat with exposed soil and debris, and little vegetation. Rainwater frequently inundates this area; tidal flooding may occasionally reach the area. Therefore, this area may be considered to normally contain brackish water of less than 25 parts per thousand salinity.

Several previous studies have investigated media contamination at SWMU 1. Initial groundwater investigations were performed at the site by Geraghty and Miller in 1987. Several VOCs, PAHs, and some metals were detected in groundwater samples. IT also conducted a preliminary RI at this site. Only metals were detected in surface water. VOCs were detected in sediment but were not above project-specific action levels; aldrin and heptachlor were also detected in sediments. Several pesticides and PCBs were detected in soils, as well as some VOCs. Dichloroethene was detected in groundwater.

More extensive investigations were performed as part of the RFI/RI (Phase I) sampling effort by IT. One surface water sample contained chrysene and pyrene, as well as copper, lead, mercury, and zinc above background concentrations. Sediment samples included pesticides, PAHs, VOCs, and metals, including lead, in concentrations greater than background, as did soil samples. Groundwater samples contained both organic and inorganic contaminants, although concentrations did not greatly exceed background. Bechtel Environmental, Inc. also conducted soil and sediment sampling to determine the extent of lead contamination for an Interim Removal Action at this site. Several samples contained lead in sediments at concentrations above the sediment quality cleanup criteria of 30.2 ppm. As a result, an extensive excavation of soil and sediment at this site is planned for early 1996.

In addition, IT conducted a baseline ecological assessment at SWMU 1. The assessment concluded that several contaminants of concern (COCs) were present in surface water and soil at concentrations that pose a potential risk to ecological receptors. Piscivores appear to be at greatest risk from PAHs and pesticides bioaccumulated in food items, while fish are at greatest risk from pesticides in water. Complete exposure pathways exist for these receptors. Ingestion of contaminants from contaminated vegetation was determined to be minimal. IT concluded that ecological receptors were at "high" risk at this area from site contaminants. Since contaminants may be migrating via surface waters, offsite receptors may also be at potential risk.

Need for Further Ecological Risk Assessment

Conditions at this site appear to pose possible risks to ecological receptors. Several organic and inorganic contaminants are present in surface water, sediment, and soil at concentrations that may cause adverse effects to aquatic and terrestrial populations. The baseline assessment performed by IT did not fully characterize ecological risk at this site. The possibility of deleterious effects to ecological receptors has not been fully elucidated. No biological samples were taken as part of the baseline ecological assessment and the full extent of surface water, sediment, and soil contamination has not been adequately characterized, with the exception of lead. Therefore, the need for a more thorough investigation of possible ecological risks at this site exists.

Further Sampling Needs

Biological Sampling

Toxicity Testing

Laboratory toxicity testing will be conducted to measure the toxicity to ecological receptors of contaminants in soil, sediment, and surface water at SWMU 1. Sediment and surface water samples will be taken from locations outside the area proposed to be excavated as part of interim removal. Toxicity testing will be done with sediments and sediment pore water only since sediment contamination and risks to benthic organisms are the primary concerns. In cases where the volume of pore-water collected is insufficient to perform a specified test due to site-specific conditions, overlying surface water collected concurrently with sediment samples will be used as a surrogate medium. The samples will be shipped to an approved testing laboratory for screening-level toxicity tests. The amphipod crustacean *Hyalella azteca* will be used for 10-day sediment tests, while the silversides fish (*Menidia sp.*) will be used for 96-hour aquatic toxicity tests. These species have been chosen assuming salinity of less than 25 parts per thousand. Results will be compared to results of tests conducted with the same species using background samples. Testing procedures will follow ASTM Standards on Aquatic Toxicology and Hazard Evaluation.

Soil samples will be collected for terrestrial toxicity tests. Samples will be collected from locations outside the area proposed to be excavated as part of interim removal. The samples will be shipped to an approved testing laboratory for 14-day screening-level toxicity tests using earthworms (*Eisenia foetida*). Results will be compared to results of tests conducted with the same species using background samples.

Tissue Analysis

Several shallow (<12 inches) ponded areas are present at SWMU 1. Wading birds were seen foraging and small fish were observed in this area during a site reconnaissance by Brown and Root Environmental in November 1995. IT also concluded that piscivores may be at risk. Therefore, fish samples will be collected from these areas to determine body burdens of contaminants in aquatic receptors and possible food chain transfer.

Due to the shallow water at SWMU 1, only minnow-sized fish exist at this site. No studies of fish species present have been conducted to date. Species present probably consist of killifish (*Cyprinodontidae*), and *Gambusia* spp. Attempts will be made to collect several fish samples from this site. However, very few fish were seen during the November 1995 visit; thus, the number of fish samples from this site may be limited by availability.

Fish will be collected using seines, dip nets, and funnel traps. Appropriate permits will be obtained. All samples will be collected, frozen, and shipped to the analytical laboratory in accordance with established chain-of-custody procedures. Samples will be analyzed for the chemicals identified as "chemicals of potential concern" in the earlier RFI/RI report (IT, 1994).

There is a possibility that key silversides (*Menidia conchorom*) and mangrove rivulus (*Rivulus marmoratus*) occur at SWMU 1. The Florida Game and Fresh Water Fish Commission lists the key silversides as threatened and the mangrove rivulus as a species of special concern. If any individuals of either of these species are captured, they will be immediately released.

To investigate bioaccumulation of contaminants by soil-dwelling organisms, earthworms will be reared in soil samples for an additional 14 days beyond the 14-day toxicity test described above. Following the 28-day study duration, earthworm samples will be subjected to chemical analysis.

Non-Biological Sampling

Groundwater, surface water, sediment, and soil and will be conducted as per the final work plan and the sampling and analyses plan submitted by ABB Environmental Services (December, 1995).

3.0 SWMU 2 - DDT MIXING AREA

Site History

SWMU 2 is located south of an active taxiway on Boca Chica Key, and adjacent to the north side of a man-made drainage ditch that is connected to a large ponded area in a former borrow pit to the east of the SWMU. Water flow in the ditch and borrow pit pond is tidally influenced and variable, however generally flows west. DDT operations were conducted from the 1940's to the early 1970's in and near Building 915 (demolished in 1982) located approximately 30 feet north of the drainage ditch. The area near the demolished building is sparsely covered by grasses. The water-filled ditch is lined with mangroves.

A previous study of soil contamination at SWMU 2 (Geraghty and Miller, 1987) found chlorinated hydrocarbon pesticides in soil throughout the site. The pesticides included DDT and its metabolites DDD and DDE, as well as hexachlorocyclohexanes. IT (1994) conducted a preliminary RI at this site. High concentrations of chlorinated hydrocarbon pesticides were found in soil, sediment, surface water, and ground water from SWMU 2. A few VOCs were also present.

More extensive investigations were performed as part of the RFI/RI (Phase I) sampling effort. Soil, ground water, surface water and sediment contaminants consisted primarily of pesticides, but various metals and VOCs were also present in some samples at concentrations greater than background values. Bechtel Environmental, Inc. also conducted soil and sediment sampling to determine the extent of lead and DDT contamination for an Interim Removal Action at this site. Several samples contained lead, DDT, DDD or DDE in soil and sediments at concentrations above the soil and sediment quality cleanup criteria. As a result, an extensive excavation of soil and sediment at this site is planned for early 1996.

IT conducted a baseline ecological assessment at SWMU 2. The assessment concluded that several COCs were present in surface water and soil at concentrations that pose a potential risk to ecological receptors. Piscivores appear to be at greatest risk from pesticides bioaccumulated in food items, while fish are at greatest risk from pesticides in water. Complete exposure pathways exist for these receptors. Ingestion of contaminants from vegetation was determined to be minimal. IT concluded that ecological receptors were at "high to moderate" risk in this area from site contaminants. Since contaminants may be migrating offsite via the ditch, offsite receptors may also be at risk.

Need for Further Ecological Risk Assessment

Conditions at this site appear to pose risks to ecological receptors. Several organic and inorganic contaminants are present in surface water, sediment, and soil at concentrations that may cause adverse effects to aquatic and terrestrial species. Extensive excavation of soil is scheduled to occur at this site. However, the extent of excavation of sediment from the drainage ditch is dependent on on-going dredging/dewatering pilot testing. Since the possibility of deleterious effects to ecological receptors via sediment and surface water contamination has not been fully elucidated, and since no biological samples were taken as part of the baseline ecological assessment, the full extent of surface water and sediment contamination has not been adequately characterized. Therefore, the need for a more thorough investigation of possible ecological risks at this site exists.

Additional Ecological Sampling

Biological Sampling

Toxicity Testing

Laboratory toxicity testing will be conducted to measure the toxicity to ecological receptors of contaminants in sediment and surface water at SWMU 2. Six sediment and surface water samples will be taken from the ditch adjacent to the site, and will also be taken from the borrow pit pond. Toxicity testing will be done with sediments and sediment pore water only since sediment contamination and risks to benthic organisms are the primary concerns. In cases where the volume of pore-water collected is insufficient to perform a specified test due to site-specific conditions, overlying surface water collected concurrently with sediment samples will be used as a surrogate medium. The samples will be shipped to an approved testing laboratory for screening-

level toxicity tests. Mysid shrimp will be used for 10-day sediment tests, while the silversides fish (*Menidia sp.*), oyster, and sea urchin will be used for 96-hour aquatic toxicity tests. Results will be compared to results of tests conducted with the same species using background samples. Testing procedures will follow ASTM Standards on Aquatic Toxicology and Hazard Evaluation. Soil samples will not be collected for terrestrial toxicity tests since extensive excavation of soil is already planned at this site.

Tissue Analysis

Bechtel has reported that numerous fish were observed in the ditch adjacent to the site. Hence, fish samples will be collected from the ditch to determine body burdens of contaminants in aquatic receptors and possible food chain transfer. No studies of fish species present in the ditch have been conducted to date. However, based on an examination of the ditch habitat, possible species available for collection include mullet (*Mugilidae*), mojarra (*Gerreidae*), tarpon (*Megalops atlanticus*), killifish (*Cyprinodontidae*), and *Gambusia* spp. Attempts will be made to collect samples of a top predator species (e.g., tarpon), samples of a benthic species (e.g., mullet or mojarra) and samples of a prey species (e.g., killifish or *Gambusia*) from the ditch. Attempts will also be made to collect fish (several samples per trophic level described above) from the borrow pit at the east end of the ditch.

Fish will be collected using seines, dip nets, gillnets, and funnel traps. Appropriate permits will be obtained. All samples will be collected, frozen, and shipped to the analytical laboratory in accordance with established chain-of-custody procedures. Samples will be analyzed for the chemicals identified as "chemicals of potential concern" in the earlier RFI/RI report (IT, 1994).

There is a possibility that key silversides (*Menidia conchorom*) and mangrove rivulus (*Rivulus marmoratus*) occur in the ditch and/or borrow pit. The Florida Game and Fresh Water Fish Commission lists the key silversides as threatened and the mangrove rivulus as a species of special concern. If any individuals of either of these species are captured, they will be immediately released.

Non-biological Sampling

Extensive excavation of soil is scheduled to occur at this site. Therefore, media sampling will consist of surface water, ground water, and sediment. Sampling will be conducted as per the work plan and the sampling and analyses plan submitted by ABB Environmental Services in December, 1995.

4.0 SWMU 3 - FIRE FIGHTING TRAINING AREA

Site History

SWMU 3 is a former fire-fighting training area located adjacent to a blimp pad in the southeastern portion of Boca Chica Key. Two unlined circular pits are currently discernible at the site. The pits were previously used 5 to 10 times per year for training sessions, during which flammable liquids (jet fuel, waste oils, hydraulic fluids) were poured onto mock aircraft within the pits and ignited. The pits are surrounded by a gravel apron. A nearby lagoon is located to the west and northwest of the pits. Mangroves grow along the shoreline of the lagoon.

During a Preliminary RI conducted by IT, no contaminants were present in soil above established action levels. Several metals were detected in groundwater. Cadmium, chromium, and manganese were detected in concentrations slightly above action levels in groundwater, but the frequencies of detection were low. Some VOCs were also present in groundwater samples, but only in one well. No pesticides were detected in any groundwater samples.

Results from the RFI/RI (Phase I) conducted by IT showed that soils were contaminated with some pesticides (e.g. DDT at 25 mg/kg), VOCs, and PAHs. The VOCs and PAHs were consistent with petroleum fuels that were burned at the site. Zinc was the only inorganic contaminant detected at concentrations significantly above background. Surface water samples contained no organic contaminants of concern, but copper, lead, barium, and thallium were detected in concentrations greater than background. Sediments contained some organic contaminants in one sample, although these constituents were not believed to have originated from SWMU 3. Inorganic contaminants above background concentrations in sediments included lead, chromium, mercury, barium, and tin. These metals were not detected in on-site samples. One of the major recommendations from the RFI/RI for this site was a focused feasibility study to remediate the free product found under the northern burn pit.

IT also conducted a screening level ecological assessment of the site. The assessment concluded that the site as a whole poses low to moderate risk to ecological receptors. Soil contamination was relatively localized on and near the burn pits, and the areas immediately adjacent to the pits are concrete or gravel with little or no vegetation. Also, the highly compacted soils at SWMU 3 limit the amount of hydraulic erosion and vertical contaminant migration. VOCs were detected in groundwater from this site, but not at a downgradient well, suggesting a localized plume. The assessment concluded that the greatest risk to ecological receptors is to aquatic organisms in contact with contaminated surface water and sediments.

As part of an interim removal action sampling program, Bechtel Environmental, Inc. found BTEX at only a few locations outside the northern burn pit berm, and no PAHs outside the berm. BTEX and PAHs were detected inside the berm. No BTEX compounds were detected in any samples above the FDEP cleanup goal of 200 ppm. This study, along with the RFI/RI, established a boundary for soil contaminated with petroleum. Bechtel Environmental then executed the interim

removal in mid 1995, which consisted of removing all soil in the northern burn pit down to the water table. Only small amounts of free product were evident on groundwater (Akers, pers. comm.).

Need for Further Ecological Risk Assessment

Contaminant concentrations in soil and groundwater at SWMU 3 appear to be relatively low and confined. Contaminant migration is negligible due to highly compacted soils and lack of net water table migration. Nonetheless, fairly high concentrations of some contaminants were found in the lagoon surface water and sediment. Additionally, although only two burn pits are currently discernible at the site, historical photographs show that at least four pits were once in use at the site. An aerial photograph dated 11/25/85 shows four burn pits, with what appears to be petroleum product staining on the surface of one pit extending into the nearby lagoon. Based on this historical evidence, further sampling is recommended at SWMU 3 and is discussed below.

Further Sampling Needs

Biological Sampling

Toxicity Testing

Laboratory toxicity testing will be conducted to measure the toxicity to ecological receptors of contaminants in sediment and surface water at SWMU 3. Sediment and surface water samples are proposed from locations in the lagoon near the burn pits. Toxicity testing will be done with sediments and sediment pore water only since sediment contamination and risks to benthic organisms are the primary concerns. In cases where the volume of pore-water collected is insufficient to perform a specified test due to site-specific conditions, overlying surface water collected concurrently with sediment samples will be used as a surrogate medium. The samples will be shipped to an approved testing laboratory for screening-level toxicity tests. Mysid shrimp (*Mysidopsis sp.*) will be used for 10-day bulk sediment tests, while the silversides fish (*Menidia sp.*), oyster (*Crassostrea sp.*), and sea urchin (*Stronglocentrotus sp.*) will be used for 96-hour aquatic toxicity tests. Results will be compared to results of tests conducted with the same species using background samples. Testing procedures will follow ASTM Standards on Aquatic Toxicology and Hazard Evaluation.

Tissue Analysis

The lagoon near SWMU 3 is approximately 20 acres in extent. While no fish studies of the lagoon have been conducted, fish of various species are expected to occur there, and wading birds are known to forage in the lagoon. Therefore, fish samples will be collected from this area to determine body burdens of contaminants in aquatic receptors and possible food chain transfer. Attempts will be made to collect samples of a top predator species (e.g., tarpon), samples of a benthic species (e.g., mullet or mojarra) and samples of a prey species (e.g., killifish or *Gambusia*) from the lagoon. Fish will be collected using seines, dip nets, funnel traps, and gill net. Appropriate permits will be obtained. All samples will be collected, frozen, and shipped to the

analytical laboratory in accordance with established chain-of-custody procedures. Samples will be analyzed for the chemicals identified as "chemicals of potential concern" in the earlier RFI/RI report (IT, 1994).

There is a possibility that key silversides (*Menidia conchorom*) and mangrove rivulus (*Rivulus marmoratus*) occur at SWMU 3. The Florida Game and Fresh Water Fish Commission lists the key silversides as threatened and the mangrove rivulus as a species of special concern. If any individuals of either of these species are captured, they will be immediately released.

Non-biological Sampling

Groundwater, surface water, and sediment will be conducted as per the work plan and the sampling and analyses plan submitted by ABB Environmental Services (1995).

5.0 SWMU 9 - JET ENGINE TEST CELL

Site History

SWMU 9 is located in the northeastern portion of Boca Chica Key. The site consists of a facility that is used to test recently repaired jet engines. The site consists of the engine test cell, fuel storage tanks, an office, and a maintenance shed. The site is bordered on the south by an asphalt road that parallels an active runway, on the north by a saltwater inlet, and on the east and west by open grassy areas. ABB Environmental Services initially conducted a petroleum contamination assessment in response to a 700 gallon spill of JP-5 jet fuel that occurred in 1989, in which most of the fuel was recovered shortly after the spill. During their assessment they also tried to delineate soil contamination around the site from other possible historical discharges of chemicals, including a lubrication oil spill in 1992. Although petroleum constituents were found in the upper 1 foot of soil at several locations using an organic vapor analyzer in the field, ABB Environmental Services determined that this contamination was probably due to shallow groundwater contamination rather than soil contamination. ABB Environmental Services also detected the presence of several chlorinated solvents, such as DCE and TCE, in groundwater samples. The exact source of these contaminants was not determined.

As a result of these findings, ABB Environmental Services proposed further media sampling at SWMU 9 as part of the Phase II RFI/RI. Most of the proposed sampling centered around determining the extent of groundwater contamination as well as possible migration to the nearby saltwater inlet and subsequent surface water and sediment contamination.

During the summer of 1995, Bechtel Environmental, Inc. conducted extensive groundwater sampling at the site, as well as a pilot pump test using a carbon filtration system (Bechtel Tech Memo TM-321-001). Two wells were found to contain free product, and two wells had DCE contamination above regulatory criteria, while some other contaminants were also detected at various locations. However, most of these contaminant concentrations were below regulatory

guidelines. The extent of groundwater contaminant plumes was also further determined. Bechtel also concluded that the pump and treat pilot test was successful, indicating that this type of interim remedial action was feasible.

Upon further review of this sampling study, Bechtel determined that the solvent plume was smaller than previously estimated. Furthermore, Bechtel ascertained that the plume was not reaching the lagoon, due to possible natural degradation and the nature of groundwater flow under the site. As a result, Bechtel sent an addendum to TM-321-001 to the Navy suggesting that the interim remedy at SWMU 9 be "natural attenuation."

Need for Further Ecological Risk Assessment

Although the 1995 Bechtel study further evaluated the nature and extent of groundwater contamination at SWMU 9, several questions remain unresolved. To begin with, groundwater flow under the site has not been fully investigated. Groundwater may flow towards the inlet during some seasons, and if so, this is dominant contamination migration pathway. If this is the case site contaminants may have already reached the inlet, or may do so in the future. No surface water or sediment sampling has been performed in the inlet to date to confirm the presence or absence of contaminant migration from SWMU 9, nor has any biological sampling or toxicity testing been attempted. In addition, although ecological risk assessments have been performed at several SWMUs on NAS Key West, no similar studies have been conducted at SWMU 9. In light of this, the need for further ecological sampling and risk assessment is warranted at this site.

Further Sampling Needs

Biological Sampling

Toxicity Testing

As stated above, no ecological sampling of any type has been performed in the inlet adjacent to the Jet Engine Test Cell. Possible contamination of inlet sediments has not been investigated. As a result, toxicity testing will be done with sediments and sediment pore water collected from the inlet to determine whether contaminants which have migrated to open water may potentially be impacting the benthic community. In cases where the volume of pore-water collected is insufficient to perform a specified test due to site-specific conditions, overlying surface water collected concurrently with sediment surplus will be used as a surrogate medium. The Mysid shrimp, *Mysidopsis sp.*, will be employed as a sediment toxicity test species. Another species initially proposed in the Phase II SAP, the amphipod *Ampelisca abdita*, will not be used as per FDEP objections, since the species is highly tolerant of many contaminants and may not exhibit chronic toxicity. Hence, the chronic sea urchin toxicity test, using *Stronylocentrotus sp.*, will be used as a surrogate. The oyster, *Crassostrea sp.*, will also be employed as a sediment toxicity test species, as mangrove oysters have been observed in the inlet (see rationale below). These organisms are all appropriate for tests with salinities > 25 ppt, which the inlet possesses. Sediment samples for use in toxicity testing will be collected concurrently with samples collected

for contaminant analysis, as described below. Results will be compared to results of tests conducted with the same species using background samples. Testing procedures will follow ASTM Standards on Aquatic Toxicology and Hazard Evaluation.

Tissue Analysis

To this point no organisms have been collected at SWMU 9 to determine tissue contaminant concentrations in native aquatic organisms. Fish at this location would not be appropriate to collect for tissue analysis due to the open nature of the inlet and the transient nature of fish in this area. Also, it does not appear that any benthic species are present in the inlet that are suitable or feasible for collection and subsequent tissue analysis. However, mangrove oysters were observed on mangrove roots in the inlet close to the Jet Engine Test Cell during a November 1995 site reconnaissance by Brown and Root Environmental. If these organisms are present in significant numbers during sampling, they will be collected, along with any other bivalves present, for tissue contaminant analysis. Samples will be analyzed for the chemicals identified as "chemicals of potential concern" in the earlier RFI/RI (Phase I) report (IT, 1994).

Non-Biological Sampling

Additional non-biological sampling is also necessary at SWMU 9. As previously stated, the flow of groundwater has not been fully defined, and although Bechtel has done extensive work delineating groundwater plumes, free product was found in some of their wells. The extent of free product under the site is in need of additional investigation. Therefore, as stated in the Phase II SAP, four new shallow monitoring wells will be installed and along with four existing wells, groundwater sampling will be done at eight locations (Phase II SAP Figure 3-20). Surface water and sediment will also be sampled at five locations along the shoreline of the inlet north of the site (Phase II SAP Figure 3-19). Soil sampling at this site to date has also been inadequate to fully characterize the extent of soil contamination. Five surface and five subsurface soil samples will be taken around the site to verify the vertical extent of soil contamination (Phase II SAP Figure 3-18). Samples in all media will be analyzed for VOCs, SVOCs, pesticides, PCBs, TAL metals, and cyanide.

6.0 SAMPLING PROCEDURES AND PROTOCOLS

General Aquatic Survey

As previously noted, fish will be collected in available habitats at SWMUs 1, 2, and 3, and shellfish will be collected at SWMU 9, and both taken at appropriate reference sites to provide qualitative information on species distribution and abundance, and for quantitative analysis of contaminants in tissue. General field observations of habitat conditions (water depth, bottom type, cover type and extent, channel/basin morphology) and diurnal field measurements of physical/chemical water quality parameters (pH, conductivity/salinity, dissolved oxygen, and

water temperature) using portable field instrumentation will be made at each site at least once during the sampling period (1-3 days) to better assess habitat conditions and assist in interpretation of fish and shellfish sampling results.

Fish will be collected using active or passive gear, as suitable to local site conditions. Fish will be removed from passive gear at frequencies appropriate to minimize fish mortality or deterioration. Upon collection at each sampling location, fish will be identified to species and enumerated. In this process, priority will be given to segregating and returning to the source water as soon as possible any special status species (e.g., key silverside, mangrove rivulus) noted in the collection to minimize potential for mortality. Individuals of species potentially targeted for tissue analysis will be segregated by species/sample in plastic bags and placed on wet ice immediately for later processing, as noted below. Estimates or actual measurements of maximum total length will be obtained for individuals of remaining (nontarget) species as appropriate to provide indication of general health of resident populations (e.g., presence of multiple size classes, evidence of stunting, etc.). Healthy fish will be returned to the source waterbody; expired or disabled fish will be disposed of in accordance with provisions in the scientific collecting permit issued for this work.

Shellfish will be collected with active methods, such as by hand, with substrate rakes, or in the case of mangrove oysters, knives. Individuals will be taken from all species present on all substrates. Only live organisms will be taken. They will be documented, wrapped in aluminum foil, sealed in plastic bags and shipped to the laboratory within 24 hours. Samples may be placed on ice and frozen prior to shipment.

General field observations; sampling/measurement parameters and methods (e.g., gear type, methods, calibration data, sampling times, responsible crew member) and resulting sampling/measurement data (e.g., physical/chemical measurements; fish and shellfish species composition, abundance, lengths, weights) will be recorded in ink on standard aquatic field survey data sheets. A formal field notebook will be maintained to document field activities, including any problems and deviations from plans and procedures, with appropriate references to standard data sheets, for all field sample collection and processing activities (i.e., general aquatic survey and tissue sample collection/preparation).

Fish Tissue Sample Collection and Preparation

Sample collection and preparation for fish and shellfish tissue analysis will be conducted in accordance with Florida Department of Environmental Protection (FDEP) standard operating procedures (FDEP 1992) and relevant guidance (e.g., EPA 1981, 1993) to the extent appropriate for whole fish and shellfish analysis for ecological risk assessments. Any deviation from FDEP SOPs will be discussed and resolved with FDEP prior to sampling. Essential elements of this protocol are as follows:

Sample Composition - Fish potentially useful as samples for tissue analysis will be segregated by species and size class, placed in plastic bags, temporarily labeled, and placed on wet ice upon collection. Each sample will consist of a single species and may consist of one or more individuals, depending on sampling success and minimum sample weight requirements for

analysis. A minimum of 200 grams per sample is established as an initial target (EPA 1993); final minimum weight requirements will be established in consultation with the selected analytical laboratory. Shellfish useful as samples will be segregated by species and size class, and processed as previously described. The laboratory will be consulted prior to field collection to identify the proper number and weight of shellfish needed for analysis.

Preservation of Sample Integrity - All reasonable efforts will be made to preserve fish sample integrity in collecting, processing, preserving, and packaging samples for shipping by preventing loss of contaminants from collected fish samples and by preventing contamination of these samples from other sources. Specific measures will include (1) segregation of individual fish or fish in a size class potentially comprising separate samples in plastic bags upon collection; (2) decontaminating sampling equipment that could potentially come in contact with samples (e.g., measuring boards, balances) using Liquinox, Alconox, or comparable detergent and rinsates as required by FDEP SOPs prior to initiating sampling, between sampling sites, and between processing of individual samples; (3) wearing disposable gloves for processing and changing gloves as necessary to minimize cross contamination as noted above for decontamination; and (4) packaging samples or sample components separately for shipment. Care will be taken during collection not to breach individual shellfish shells with sampling equipment, such as rakes or knives. Live individuals will be taken; these include animals whose shell cannot be manually pried open. In addition, twice as many specimens as the laboratory requires will be collected if possible, since many specimens will open during transit. Proper decontamination procedures and cross-contamination avoidance methods will be employed during shellfish collection, as per EPA guidance (EPA, 1993).

Sample Processing, Packaging and Shipping - Tentatively designated fish samples (consisting of appropriately segregated, bagged, and tagged specimens placed on wet ice upon collection) will be processed and packaged for shipment as soon as possible after collection. Individual specimens will be measured for wet weight and maximum total length. Length ranges and total weight only may be recorded for composite samples of enumerated small forage fish specimens. Data will be recorded on standard field data sheets. Sample specimens will then be wrapped in extra heavy duty aluminum foil (spines will be clipped before wrapping to prevent puncture of packaging). If deemed acceptable based on discussions with FDEP and the analytical laboratory, composite samples consisting of numerous small specimens may be wrapped as unit samples. A standard sample identification tag will be completed and taped to each foil package, which will in turn be sealed in a plastic bag and either frozen for later shipment or packed in ice for immediate shipment. Frozen samples will be packed (e.g., in dry ice) to ensure they do not thaw prior to receipt by the analytical laboratory; arrangements will be made to ensure that fresh samples shipped in wet ice will be received by the analytical laboratory within 24 hours of collection. Each sample package (e.g., ice chest) for shipment will be sealed and will be accompanied by a properly completed chain-of-custody form. As previously stated, all live shellfish specimens from one location will be wrapped securely in aluminum foil and placed in labeled plastic bags. Wet weights and lengths will be taken in the field for each specimen. Determination of sex for each individual may be done at the laboratory, and the laboratory will be consulted prior to field collection to ascertain the proper number of individuals and/or weights needed for each species for each sample. All relevant sample data specified by EPA (1993) will be recorded on standard

field data sheets. Samples will be packed on wet ice and shipped to the laboratory within 24 hours of collection. Each sample will be accompanied by the properly completed chain-of-custody form.

References

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Florida Department of Environmental Protection (FDEP). 1992. Standard Operating Procedures for Laboratory Operations and Sample Collection Activities, DEP - QA-001/92. Florida Department of Environmental Protection, Tallahassee.

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APPENDIX C

FISH COLLECTION REPORT TO FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Brown & Root Environmental

900 Trail Ridge Road
Aiken, SC 29803

(803) 649-7963
FAX: (803) 649-4808

AIK-OES-96-5297
March 21, 1996

Steve Adams
Florida Department of Environmental Protection
3900 Commonwealth Boulevard
Tallahassee, FL 32399

REFERENCE: NAS Key West Project HK 7046 (CTO 007)

SUBJECT: Fish Collection Report

Dear Steve:

The following end of project report is submitted in accordance with Chapter 62R-1, F.A.C., and is a summary of the activities conducted under the terms and conditions of FDEP Special Permit # 96S-011, issued to me on January 12, 1996.

Fish were collected during January 17-26, 1996, at six locations on Boca Chica Key at Naval Air Station Key West, Florida. These locations consisted of three sites where contamination of aquatic resources is being investigated, as well as three background (i.e., reference) sites. All sites were either landlocked or connected to marine waters by drainage ditches or canals; none of the sites were in open water of the Gulf of Mexico or the ocean. Fish were collected using gill nets at depths of 0 to 10 feet, and minnow traps and beach seines at depths of 0 to 4 feet.

Fish collected by gill net consisted of 4 tarpon, 10 striped mullet, 9 ladyfish, 9 yellowfin mojarra, 3 gray snapper, 4 pinfish, 1 bluestriped grunt, and 1 sea robin. Individual lengths and weights of these fish are provided in Table 1.

Minnow traps and beach seines were used to collect a variety of small fish. Individual lengths and weights of these minnow-sized fish were not determined. Instead, minnows were pooled by species to create samples of 30-35 grams each. Lengths of the smallest and largest fish in each sample were measured (Table 2).

All specimens were frozen and shipped to Environmental Science and Engineering, Inc., in Gainesville, Florida, for laboratory analyses of contaminants potentially present in the fish tissue. The analytical data are needed to conduct ecological risk assessments at sites where terrestrial and aquatic resources may be at high risk due to contamination from past military-related activities. The results of the risk assessments will be used to determine remediation goals at Naval Air Station Key West.

Thank you for your assistance in obtaining the FDEP permit. If you have any questions, please do not hesitate to call me at 803-649-7963.

Sincerely,

Michael L. Whitten
Senior Scientist

MLW:jm

Enclosures: Tables 1 and 2 Fish Collected January 17-26, 1996

cc w/enclosure:
K. Donnelly, B&RE-Pittsburgh
K. Walter, B&RE-Aiken
D. Patrick, NAVFACENGCOM
R. Demes, NAS Key West
File 7046 (CTO 007)

cc w/o enclosure:
File 1.1.1

Table 1. Fish Collected by Gill Nets During January 17-26, 1996, at Naval Air Station Key West (Boca Chica Key), Monroe County, Florida. (Page 1 of 2).

Species	Total Length (mm)	Weight (g)
Tarpon (*Megalops atlanticus*)	570	1200
	595	1550
	517	970
	580	1250
Striped mullet (*Mugil cephalus*)	511	1500
	545	1400
	505	1350
	325	334
	336	340
	380	508
	343	390
	505	1300
	530	1480
	538	1250
Ladyfish (*Elops saurus*)	535	720
	532	658
	525	634
	495	522
	487	516
	465	488
	477	478
	470	560
	485	500
Yellowfin mojarra (*Gerres cinereus*)	235	167
	235	182
	260	222
	257	223
	223	146
	338	500
	380	606
	370	594
	381	570
Pinfish (*Lagodon rhomboides*)	247	224
	225	178
	261	240
	250	228

Fish Collected by Gill Nets During January 17-26, 1996, at Naval Air Station Key West (Boca Chica Key), Monroe County, Florida. (Page 2 of 2).

Species	Total Length (mm)	Weight (g)
Gray snapper (*Lutjanus griseus*)	315	414
	365	698
	277	300
Sea robin (*Prionotus sp.*)	246	204
Bluestriped grunt (*Haemulon sciurus*)	257	256

Table 2. Fish Collected by Seines and Minnow Traps During January 17-26, 1996, at Naval Air Station Key West (Boca Chica Key), Monroe County, Florida.

Species	Total Length[1] (mm)	Weight[2](g)
Sheepshead minnow (*Cyprinodon variegatus*)	26-57	461
Gulf killifish (*Fundulus grandis*)	77-110	493
Marsh killifish (*Fundulus confluentus*)	37-105	97
Sailfin molly (*Poecilia latipinna*)	25-63	1344
Yellowfin mojarra (*Gerres cinereus*)	30-65	43
Tomtate (*Haemulon aurolineatum*)	50-83	58
Fat sleeper (*Dormitator maculatus*)	93-122	75
Crested goby (*Lophogobius cyprinoides*)	36-92	141
American eel (*Anguilla rostrata*)[3]	385	99

[1] Individual lengths and weights of small fish were not always determined. Lengths provided here indicate the range of the smallest to the largest fish.

[2] Aggregate weight of fish collected.

[3] One eel collected in minnow trap.

APPENDIX D

ECOLOGICAL TOXICITY PROFILES

Acetone

Acetone is a colorless volatile liquid that is a normal microcomponent in blood and urine. It has widespread use as a solvent and is used in the manufacture of paints, varnishes, lacquers, pharmaceuticals, sealants, and adhesives. It has been found in cigarette smoke at 1100 ppm and in gasoline exhaust at 2.3 to 14.0 ppm (Verschueren, 1983).

The 96 hr LC_{50} for bluegill sunfish exposed to acetone in water was 8300 mg/l; the 2 hr LC_{50} for fingerling trout was 6100 mg/l. A "single oral lethal dose" in rabbits was 10 ml/kg (Verschueren, 1983).

Acetonitrile

Acetonitrile is a colorless, volatile liquid. It is used as a solvent and in the manufacture of synthetic pharmaceuticals. Little toxicity data exists for acetonitrile. Verschueren (1983) reports acute oral LD_{50}s in rats range from 1.7 to 8.5 g/kg. In guinea pigs, the acute oral LD_{50} is 0.18 g/kg.

Acetophenone

Acetophenone is colorless liquid with a characteristic sweet almond odor. Natural sources inlcude oil of castoreum and labdanum resin, buds of balsam poplar, and the heavy oil fraction of coal tar. Acetophenone is also a product of the organic chemical industry and the coal processing industry. It is used in perfume manufacturing and as a solvent for synthesis of pharmaceuticals, rubber, chemicals, dyestuffs, and corrosion inhibitors. It is also used as a tobacco flavorant.

The 96 hr LC_{50} for fathead minnows exposed to acetophenone in water was 155 mg/L (Verschueren, 1983). No deaths were recorded for rats exposed to a saturated vapor for 8 hours, and rats administered a repeated oral dose of 102 mg acetophenone/kg/day for 30 days produced no effect (Verschueren, 1983).

Aldrin/Dieldrin

Aldrin and dieldrin have been among the most widely used and distributed chlorinated hydrocarbon insecticides in the United States. Once released in to the environment, aldrin readily transforms into dieldrin (USEPA, 1980a). Based on concerns related to human health toxicity, USEPA banned aldrin and dieldrin from most uses in 1974; production was terminated in 1987. However, as a result of the relatively long half-life of dieldrin, it continues to be detected nationwide (USEPA, 1994a). Like other organochlorine pesticides, dieldrin is lipophilic and is ultimately stored primarily in fat and tissues with lipid components. Mammalian sex and species differences have been reported in the metabolism and tissue distribution of dieldrin; males appear to metabolize and excrete dieldrin more rapidly than females (USEPA, 1994a).

Aquatic toxicity tests have demonstrated that dieldrin in concentrations as low as 1.1 to 9.9 μg/L were acutely toxic to sensitive fish species (e.g., rainbow trout). Goldfish represent more resistant species; 96 hr LC_{50} = 41 μg/L. Saltwater species are even more sensitive to dieldrin; concentrations as low as 0.28 to 50 μg/L were acutely toxic to saltwater invertebrates. All saltwater fish species were sensitive to acute exposures to either aldrin or dieldrin (USEPA, 1980a). Avian oral LD_{50}s reported by Hudson et al. (1984) for aldrin range from 6.59 mg/kg in bobwhite quail to 520 mg/kg in mallards. Avian oral LD_{50}s for dieldrin range from 8.78 mg/kg in California quail to 381 mg/kg in mallards (Hudson et al., 1984).

Aluminum

Although present in food in varying amounts, aluminum is not an essential element for mammals. The aluminum content of plants typically depends on the soil aluminum concentration and ranges from 10 to 30 mg/kg fresh weight; studies have indicated that this element stimulates the growth of several pasture plant species (Hackett, 1962). As summarized in Venugopal and Luckey (1978), aluminum is not readily absorbed through the skin and gastrointestinal absorption of ingested aluminum is poor due to the transformation of aluminum salts into insoluble aluminum phosphate. The lack of accumulation of aluminum in animals with age or of any increase in tissue levels of aluminum following fairly high dietary intake, suggests that mammals posses a homeostatic mechanism for this element. For most terrestrial organisms, aluminum compounds are generally not harmful and are considered to be toxicologically inert, except in cases of high experimental doses or prolonged inhalation (Venugopal and Luckey, 1978).

Data on the toxicity of aluminum to aquatic organisms is somewhat limited. USEPA (1988a) stated that freshwater organisms should not be adversely affected if aluminum concentrations do not exceed 87 μg/L when pH is between 6.5 and 9.0. Some studies have shown that the acute toxicity of aluminum increases with pH, whereas other studies found the opposite to be true (USEPA, 1988a). The occurrence of pH effects in fish depends on aluminum and calcium concentrations in the water. Laboratory studies have established that low pH is toxic to fish, that aluminum concentrations found in acidified waters (particularly inorganic monomeric aluminum) are toxic, and that calcium is ameliorative (Suter, 1993).

Sublethal effects were also reviewed by USEPA (1988a). It was found that 169 μg/L at a pH of 6.5 to 6.6 caused a 24 percent reduction in the growth of young brook trout (*Salvelinus fontinalis*). Cleveland et al. (1991) determined that brook trout accumulated significantly higher aluminum residues at pH 5.3 than at pH 6.1 or pH 7.2. They also determined that elimination of aluminum during depuration was more rapid at pH 5.3 than at pH 6.1 or pH 7.2. Data reported in USEPA (1988a) indicated this metal does not bioconcentrate; bioconcentration factors range from 50 to 231 for brook trout (geometric mean value = 82).

Antimony

Antimony is frequently associated with nonferrous ore deposits and is commonly encountered in industrial environments, including smelters. It is considered a nonessential metal and is easily taken up by plants if present in a soluble form (Kabata-Pendias and Pendias, 1992). Plants growing in soils contaminated by industrial emissions may be expected to contain elevated tissues concentrations of this metal. However, there are no reports of plant toxicity resulting from uptake of antimony (Kabata-Pendias and Pendias, 1992). Antimony has been shown to produce liver damage in rabbits at 5.5 mg/kg in diet (NRC, 1980).

Arsenic

Arsenic is a relatively common element; its industrial uses primarily center on the manufacture of pesticides, wood preservatives, and growth stimulants for plants and animals (USFWS, 1988a). The chemistry of arsenic in water is complex, and is a function of chemical, biological, and geochemical reactions that interact to control the concentration, oxidation state, and the form of arsenic in water (USEPA, 1984a). Arsenic exists in four oxidation states, both as inorganic and organic forms. Its bioavailability and toxicity are significantly influenced by the physical and chemical forms of arsenic tested, route of exposure, dose, and species of animal tested (USFWS, 1988a). Inorganic forms are generally regarded as being more toxic than organic forms, and trivalent forms are more toxic than pentavalent species (USFWS, 1988a; USEPA 1984a). Tests conducted to date indicate that this contaminant does not readily bioconcentrate (USEPA, 1984a).

Arsenic is a constituent of most plants, but little is known about its biochemical role. In general,

arsenic availability to plants is highest in coarse-textured soils having little colloidal material and little ion exchange capacity, and lowest in fine textured soils high in clay, organic material, iron, calcium, and phosphate (USFWS, 1988a). Reports suggest that plants absorb arsenic passively via the roots with water and that this metal is readily taken up by various plant species (Thoresby and Thornton, 1979). Apparently arsenic is translocated in plants since its concentration in grain also has been reported (Kabata-Pendias and Pendias, 1992). Except for locations where arsenic content is high, (e.g., around smelters) arsenic is distributed throughout the plant body in non-toxic amounts (USFWS, 1988a).

Median lethal dietary concentrations for wildlife range from 99.8 mg/kg in cowbirds (*Molothrus ater*) to > 5,000 mg/kg in mallards (*Anas platyrhynchos*) (NAS, 1977). Very little information exists regarding sublethal effects on birds. Chronic arsenic poisoning in mammals is rare, because detoxication and excretion are rapid. Chronic toxicity has been associated with reduced growth, weakness, dermatitis, liver damage and decreased resistance to infection. These effects have been recorded in various mammals at dietary levels of 5-50 mg/kg (USFWS, 1988a).

Barium

The concentration of barium in natural waters is controlled by the solubility of barite ($BaSO_4$), a fairly common mineral. Other factors influencing barium solubility in natural waters include metal oxides or hydroxides (Hem, 1970). Sulfates also govern the solubility of barium in soil as do carbonates, and it is strongly adsorbed to clays. Although commonly reported in plant tissues, it is apparently a nonessential component (Kabata-Pendias and Pendias, 1992). While barium is readily taken up by plants in acidic soil, few reports exist regarding its toxicity to plants. Chaundry et al. (1977) reported 1 to 2 percent barium (dry weight) in plants as highly toxic while 220 mg/kg (ash-free dry weight) has been reported to be moderately toxic (Shacklette et al., 1978). Calcium, magnesium, and sulfur appear to act antagonistically with barium and may serve to reduce its toxicity (Kabata-Pendias and Pendias, 1992).

Beryllium

The major source of beryllium in the environment is the combustion of fossil fuels (Tepper, 1972). Beryllium enters the waterways through weathering of rocks and soils, atmospheric fallout, and discharges from industrial and municipal operations (USEPA, 1980b). Most common beryllium compounds are readily soluble in water. In aqueous solution, beryllium does not exist as actual Be^{+2} ions, but as hydrated complexes. Like a number of other metals, water hardness significantly affects the toxicity of this metal. Only a limited number of aquatic species have been tested, but the results of these tests suggest that freshwater invertebrates exhibit similar sensitivities to this metal. Acute and chronic toxicities of beryllium to aquatic species occur as low as 130 and 5.3 μg/L, respectively (USEPA, 1980b).

Benzene hexachloride (BHC)

Benzene hexachloride, also known as hexachlorocyclohexane (HCH) or lindane, is an organochlorine insecticide consisting of eight stereo isomers, of which four (alpha, beta, gamma, and delta) predominate in the technical product due to relatively strainless bonds. BHC isomers degrade to chlorophenols at different rates in order of their solubilities in fat (delta > gamma > alpha > beta) (Deo et al., 1982). The gamma isomer is the only isomer that is highly insecticidal (Deo et al., 1982), and constitutes at least 99 percent of lindane (Manahan, 1992). Signs of toxicity are very similar to those of DDT, and include tremors, ataxia, and convulsions (Murphy, 1986).

Newell et al. (1987) selected 0.1 mg/kg total BHC as a non-carcinogenic based wildlife criterion, and

0.51 mg/kg total BHC as a 1 in 100 cancer risk level for piscivorous wildlife.

Benzylalcohol

Benzylalcohol is used in perfumes and flavors, as a solvent, and in inks and surfactants. Limited toxicity data exist for this chemcical. The 96 hr LC_{50} for the bluegill sunfish (*Lepomis macrochirus*) was 10 ppm and 15 ppm for *Menidia beryllina* in saltwater. The 96 hr LC_{50} for fathead minnows exposed to benzylalcohol in water was 460 mg/L. A single oral LD_{50} in rats was 3.10 g/kg (Verschueren, 1983).

Bis(2-chloroisopropyl)ether

Bis(2-chloroisopropyl)ether is used in processing fats, waxes, greases and textile manufacturing. It is also used as a solvent and as a component in paint, varnish, and spotting agents. It has an odor threshold of 0.32 ppm in air and water. A single oral LD_{50} in rats was 0.24 g/kg. A decrease in growth rate was observed in rats administered a dose of 0.01 g/kg for 31 days (Verschueren, 1983).

Bromomethane

Bromomethane is a colorless liquid or gas. It is used as a soil and space fumigant and in the synthsis of organic chemicals. Toxicity data are limited for bromomethane. The 96-hr LC_{50} for *Lepomis macrochirus* was 11 ppm and 12 ppm for *Menidia beryllina* (Verschueren, 1983).

2-Butanone

2-Butanone, also known as methylethylketone, is used as a solvent, paint stripper, cleaning fluid, and in cements and adhesives. It has a sweet sharp odor and has 100 percent recognition at 6.0 ppm. Toxicity and fate and transport data for 2-Butaone are lacking. The single oral lethal dose in rats was reported by Verschueren (1983) to be 3.3 g/kg.

Cadmium

To date, no evidence exists to suggest that cadmium is either biologically essential or beneficial (Venugopal and Luckey, 1978; USFWS, 1985). Freshwater biota are particularly sensitive to this heavy metal; concentrations as low as 0.8 to 9.9 μg/L produce lethality among insects, crustaceans, and fish (USFWS, 1985; USEPA, 1985a). This heavy metal does not bioconcentrate to an appreciable extent; bioconcentration data listed in USEPA (1985a) for freshwater species range from 3 (brook trout) to 4190 (caddisfly; *Hydropsyche betteni*) with a geometric mean value of 404.

Elemental cadmium is insoluble in water, although its chloride and sulfate salts are freely soluble (USFWS, 1985). The availability of cadmium to aquatic biota from their immediate physical and chemical environs depends on numerous factors, including adsorption and desorption rates of cadmium from terrigenous materials, pH, Eh, chemical speciation, and many other modifiers. Adsorption and desorption processes are likely to be major factors in controlling the concentration of cadmium in natural waters and tend to counteract changes in the concentration of cadmium ions in solution (USFWS, 1985). Water hardness also alters the bioavailability of cadmium. Adsorption and desorption rates of cadmium are rapid on mud solids and particles of clay, silica, humic material, and other naturally occurring solids. It should be borne in mind that mobility and availability of cadmium, like most heavy metals, is a function of a large number of interrelated factors (e.g., CEC). Beyer et al. (1985) demonstrated that only a small portion of all metals measured in the soil become incorporated into plant foliage and suggested that most of the metal contamination detected in biota came from aerial deposition.

Compared to aquatic biota, mammals and birds are relatively less sensitive to cadmium exposure. Adult mallards fed a diet containing up to 200 mg Cd/kg survived and exhibited no loss in body weight, although egg production of laying hens was suppressed (White and Finely, 1978). The lowest oral

doses producing lethality among mammals were 250 and 150 mg/kg body weight in rats and guinea pigs, respectively (USEPA, 1985a).

Carbon Disulfide

Carbon disulfide is a colorless liquid with a slightly pungent odor. It is used in the manufacture of rayon, cellophane, rubber chemicals and flotation chemicals, soil disinfectants, and carbon tetrachloride, although it has been replaced by other solvents for many of these processes in recent years. Currently, carbon disulfide is widely used due to its ability to dissolve fats, and its use is expected to continue.

Common adverse effects of carbon disulfide include effects on the cardiovascular system, neurological effects, and developmental effects. In mice, the oral 24-hour LD_{50} was determined to be 3,020 mg/kg (Gibson and Roberts, 1972). Male Wistar rats have administered 253 mg/kg/day of carbon disulfide for four weeks exhibited a 10% decrease in body weight (Hoffman and Klapperstuck, 1990).
Carbon disulfide is rapidly absorbed through all major exposure routes, and is distributed throughout the body. It is metabolized by cytochrome P-450. Some major metabolites, mainly dithiocarbamates, are responsible for neurological effects (ATSDR, 1995a).

Carbon Tetrachloride

Carbon tetrachloride is a colorless liquid with a wide range of industrial and chemical applications. For the most part, this chemical is used in the manufacture of refrigerants, aerosols, and propellants. It is also used as a solvent, metal degreaser, and fumigant (Verscheuren, 1983). Historically, carbon tetrachloride was used as an inhalation anesthetic and as a waterless shampoo. In the early 1900s recommendations were made to label the compound as a poison after its use in these capacities resulted in deaths. As early as 1915, health hazards were being reported from industrial uses of carbon tetrachloride (USEPA, 1980c).

Studies have indicated that carbon tetrachloride has a full spectrum of toxic effects. Industrial and accidental exposures by ingestion, inhalation, and dermal routes have produced acute, subacute, and chronic poisonings, some of which were fatal. Carbon tetrachloride is readily absorbed through the lungs and more slowly through the gastrointestinal tract. It can also enter the body by penetration through the skin (USEPA, 1980c). Upon entering the body, the distribution of carbon tetrachloride varies with the route of administration, its concentration, and the duration of exposure. Studies involving oral administration have found the highest concentrations in bone marrow, while other studies involving inhalation found concentrations in the brain higher than in the heart, liver, or blood (USEPA, 1980c). Pathological changes resulting from inhalation and ingestion of carbon tetrachloride are generally limited to findings in the liver and kidney. When carbon tetrachloride is administered to mammals, it is metabolized to a small extent, but mostly excreted through the lungs. USEPA (1980c) reports as much as 78.7 percent of the amount of inhaled carbon tetrachloride is excreted through the lungs within six hours after exposure. Other studies have shown that 85 percent of the excretion products are the parent compound, 10 percent carbon dioxide, and smaller quantities of other metabolites (USEPA, 1980c).

Verschueren (1983) reports 96 hr LC_{50}s for fish, *Lepomis macrochirus* and *Menidia beryllina*, to be 125 ppm and 150 ppm, respectively. The LD_{50} for rats administered carbon tetrachloride orally was 2.92 g/kg (Verschueren, 1983). In humans, symptoms of illness occurred after 60 minute exposure to 500 ppm, and severe toxic effects were reported after 60 minute exposure to 2,000 ppm (Verschueren, 1983). The most significant effect to consider in terms of dose/response is the cancer-causing potential of the chemical. A number of studies reviewed by the USEPA (1980c) showed carbon tetrachloride to be carcinogenic in animals, with the target organ being the liver. Current knowledge leads to the conclusion that carcinogenesis is a nonthreshold, nonreversible process. Based upon the potential carcinogenic effects from exposure to carbon tetrachloride through the ingestion of contaminated water

or aquatic organisms, the ambient water concentrations should be zero. However, zero level is not attainable, at present. Based upon a 10^{-6} incremental increase of cancer risk over a lifetime, the recommended water quality criteria is 0.40 ug/L (USEPA, 1980c).

Chloromethane

Chloromethane is a colorless liquid used in the manufacture of organic chemicals. Other uses include medicine, propellants, and herbicides. The 96-hr LC_{50} for bluegill sunfish was 550 ppm while 270 ppm for silverside minnows (Verschueren, 1983).

Chromium VI

Chromium VI generally does not exist in biological systems, as it is reduced rapidly to Chromium III. Chromium VI, however, is much more toxic to living systems than Chromium III. Several studies exists regarding the toxicity of Chromium VI in mammals. Mice given oral doses of 57, 120, and 234 mg/kg/day during early gestation experienced increased preimplantation and postimplantation losses, along with decreased litter size (ATSDR, 1993). A LOAEL of 57 mg/kg/day was reported for reproductive effects. A decrease in motor activity was seen in rats given oral doses of Chromium VI at 98 mg/kg/day for 28 days, and a NOAEL of 9.8 mg/kg/day was reported for these effects (Diaz-Mayans et al., 1986). In addition, mice fed potassium dichromate at 4.6 mg/kg/day exhibited reduced sperm count after 7 weeks, and morphologically altered sperm at 9.1 mg/kg/day after 7 weeks (Zahid et al., 1990).

Since Diaz-Mayans et al. (1986) established a clear dose-response relationship, the NOAEL was chosen for derivation of a benchmark value.

Only one avian study exists for Chromium VI. Chickens were fed diets up to 100 ppm Chromium VI and no adverse effects on survival or growth were observed after 32 days, suggesting a NOAEL of 100 ppm (Rosomer et al. 1961).

A multitude of studies exist on the effects of Chromium VI on fish. Since the National Ambient Water Quality Criteria value of 0.011 mg/L was the most conservative value, it was chosen as the value for forage, small, and large fish. For fish and terrestrial organisms, the data show that Chromium VI does not effectively bioaccumulate.

Cobalt

Cobalt is a relatively rare metal and one of the seven essential metals. Trace levels are essential in mammals for the production of red blood cells. Cobalt is produced primarily as a by-product of other metals, chiefly copper. Cobalt salts are generally well absorbed after oral ingestion. Despite this fact, increased exposure levels tend not to cause significant accumulation (Amdur et. al, 1991).

Plants are known to accumulate large quantities of cobalt and appear to have a mechanism of cobalt tolerance similar to that adopted by other metalliferous plant species. Symptoms of cobalt toxicity are seldom observed in nature, despite the wide range in plant tissue concentrations. Soil concentrations that may result in toxic effects to plants range from 20 to 50 mg/kg (Kabata-Pendias and Pendias, 1992).

Copper

Copper is an essential component of many enzymes, and most animals have some ability to regulate its balance. Higher organisms typically employ cellular mechanisms to conserve copper when it is deficient and excrete it when body burdens increase. These copper regulatory mechanisms may

successfully prevent severe abnormalities if neither periods of deficiency nor excess are extreme (Rand and Petrocelli, 1985).

The toxicity of copper to aquatic biota has been shown to be related primarily to the activity of the cupric ion (Cu^{+2}), and possibly to some of the hydroxy complexes. The cupric ion is highly reactive and forms moderate to strong complexes and subsequently precipitates with any inorganic and organic constituents of natural waters. The portion of copper present as a free cupric ion is generally low and may be less than 1 percent in eutrophic waters where complexation predominates. It appears that organic and inorganic copper complexes and precipitates are less toxic than free cupric ion, thus reducing the toxicity attributable to total copper. The chemistry of copper complicates the interpretation of its toxicity because the portion of free cupric ion present in solution is highly variable (Rand and Petrocelli, 1985). Like a number of other cation metals, both calcium hardness and carbonate alkalinity are also known to reduce the acute toxicity of copper; expression of Virginia water quality criteria allows adjustment for these water quality effects.

Data compiled by USEPA (1984b) indicated that both freshwater invertebrates and fish exhibit a wide range of sensitivities to acute exposures to copper; neither group appeared to be more sensitive than the other to copper. Embryos of the blue mussel and the Pacific oyster were the most sensitive saltwater species tested, with acute values of 5.8 and 7.8 μg/L, respectively. Acute values for saltwater fish ranged from 13.93 to 411.7 μg/L, with embryo-larval forms more sensitive than adults.

DDT

DDT has not been marketed in the United States since 1972 but is ubiquitous due to its widespread use in previous decades and its relatively long half-life. DDT's close structural analogs, DDE and DDD, are metabolites of DDT and have also been formulated as pesticides in the past (Hayes, 1982). Because of its persistent nature, coupled with its hydrophobic properties and solubility in lipids, DDT and its metabolites are concentrated from water by aquatic organisms at all trophic levels. It also readily enters the food web and is bioaccumulated by organisms at higher trophic levels (USEPA, 1980d).

DDT is intermediate in toxicity to fish in comparison to other chlorinated hydrocarbon pesticides. It is less toxic that aldrin, dieldrin, endrin, and toxaphene, but more toxic than chlordane, lindane, and methoxychlor (USEPA, 1980d). Invertebrates are, for the most part, more sensitive than fish species, but the range of species LC_{50}s for macroinvertebrates (10,000) is much greater than that for fish (300). The least sensitive species listed in USEPA (1980d) was a stonefly (*Pteronarcys californica*) with a 96 hr LC_{50} of 1.8 mg/L. Week-old crayfish were the most sensitive reported species (LC_{50} = 0.00018 mg/L) although 10-week old crayfish of the same species had an LC_{50} of 0.003 mg/L. USEPA (1980d) reported that of the species for which data were available, yellow perch was the most sensitive freshwater species tested (96 hr LC_{50} of 0.6 μg/L) where as the least sensitive species was the goldfish (96 hr LC_{50} = 180 μg/L).

Bioconcentration factors from laboratory tests with DDT and saltwater organisms ranged from 1200 to 76300 for fish and shellfish, respectively (USEPA, 1980d).

Data for DDE indicate that long-term dietary dosage at 2.8 to 3.0 mg/kg DDE (wet weight) can have adverse effects on reproduction of mallards, black ducks, and screech owls. Species that feed on saltwater animals containing DDT and its metabolites have exhibited reductions in their reproductive capacity (Rand and Petrocelli, 1985). Anderson et al. (1975) studied the impacts of DDT in northern anchovies (a species with a high lipid content) on the reproductive success of brown pelicans. The concentrations of this contaminant steadily declined in anchovies over this 5-year study, and pelican reproduction improved. The authors concluded that even the lowest concentrations detected in anchovies (0.15 mg/kg) and the subsequent 97 mg/kg concentration in pelican eggs was unacceptably high, because pelican eggshell thickness was still too low and pelican recruitment was still not high

enough to sustain a stable population.

Dichlorobenzene

Dichlorobenzenes are a class of halogenated aromatic compounds represented by three structurally similar isomers: 1,2-dichloro-, 1,3-dichloro-, and 1,4-dichlorobenzene. 1,2-dichlorobenzene and 1,3-dichlorobenzene are liquids at normal environmental temperatures, while 1,4-dichlorobenzene is a solid. The major uses of 1,2-dichlorobenzene are as a process solvent in the manufacturing of toluene diisocyanate and as an intermediate in the synthesis of dyestuffs, herbicides, and degreasers (USEPA, 1980e). The production, use, transport, and disposal of dichlorobenzene result in widespread dispersal to environmental media, with resulting opportunity for exposure of the biosphere (USEPA, 1980e). The 96 hr LC_{50} for the bluegill (*Lepomis macrochirus*) and silverside minnow (*Menidia beryllina*) were 27 ppm and 7.3 ppm, respectively (Verschueren, 1983). Fathead minnows had a 96 hr LC_{50} of 57 mg/L, while grass shrimp were more sensitive (96 hr LC_{50} = 9.4 mg/L). A "single oral lethal dose" for guinea pigs was 2.0 g/kg. Based on a 192 day exposure, the NOAEL in rats ranged from 18.8 to 188 mg/kg/day (Verschueren, 1983).

1,4-dichlorobenzene is primarily used as an air deodorant and an insecticide, which account for 90 percent of the total production of this isomer (USEPA, 1980e). LC_{50} values for rainbow trout, fathead minnows, and bluegill are 1.12 mg/L, 4.0 mg/L, and 4.28 mg/L, respectively (USEPA, 1980e). The results of a 96 hr LC_{50} test for bluegill with 1,2-, 1,3-, and 1,4-dichlorobenzene (5.59, 5.020, and 4.28 mg/L, respectively) indicate that the position of the chlorine atom on the benzene ring probably does not influence the toxicity of dichlorobenzene. A "single lethal oral dose" for guinea pigs as 2.8 mg/L (USEPA, 1980e).

Bioconcentration factors for the bluegill were 89, 66, and 60 for 1,2-, 1,3-, and 1,4-dichlorobenzene, respectivley. Equilibrium occurred within 14 days, and the half-life of each dichlorobenzene was less than 1 day (USEPA, 1980e). These results suggest dichlorobenzenes are unlikely to be a bioconcentrate in the aquatic environment.

Dichloroethene

1,1-Dichloroethene is a colorless liquid used in adhesives and as a component of synthetic fibers. The 96 hr LC_{50} for bluegill sunfish was 220 mg/l; the 96 hr LC_{50} for the inland silverside minnow (*Menidia beryllina*) was 250 mg/l (Verschueren, 1983). 1,2-Dichloroethene is a colorless liquid used as a solvent in a wide variety of manufacturing processes. It is an additive to dye and lacquer solutions and is a constituent of perfumes and thermoplastics; it is also used in organic synthesis and medicine. Data on effects to aquatic organisms and terrestrial wildlife were not available (Verschueren, 1983).

Dichloropropane

1,2-dichloropropane is used as a lead scavenger for anti-knock fluids, solvent, and soil fumigant for nematodes. It is a colorless liquid with a sweet odor. Toxicity and fate and transport data for this chemcical are limited. It is reported to be a mild skin irritant in man, and the oral lethal dose in guinea pigs ranges from 2-4 g/kg (Verchueren, 1983).

Dimethylphenol

2,4-Dimethylphenol is found in asphalt and roadway runoff; is generally used in pharmaceuticals, fuels, plastics, pesticides, washing of dyed materials; and is a constituent in domestic sewage. The 24-hr median threshold level in crucian carp was 30 mg/L, 13 mg/L in tench; and 28 mg/L for "trout" embryos (Verschueren, 1983).

Endosulfan

Endosulfan is an organochlorine insecticide and is comprised of sterioisomers designated I and II which have similar toxicities (USEPA, 1993a). Endosulfan has been found widely in food samples, absorbed through the GI tract and distributed throughout the body. Endosulfan is metabolized to lipophilic compounds, and both parent and metabolites are found initially primarily in the kidney and liver and fatty tissue, with distribution to other organs occurring over time. Endosulfan can induce microsomal enzyme activity. Based on laboratory studies, females may accumulate endosulfan more readily than males; this phenomenon may account for the higher toxicity seen in females (USEPA, 1994a). The oral LD_{50} of endosulfan in three studies where mallards were dosed with endosulfan was 31.2, 33.0, and 45.0 mg/kg (Hudson et al., 1984).

Endrin

Endrin was widely used as a broad spectrum pesticide until its registration was cancelled in 1984. This chlorinated cyclodiene is highly toxic to humans; its long-term persistence and mammalian toxicity had been recognized at least as early as 1964 (USEPA, 1993a). Like other organochlorine pesticides, endrin is lipophilic and bioaccumulates in lipid. Studies indicate that this pesticide can move across the placenta (USEPA, 1994a). Avian oral LD_{50}s for endrin range from 1.06 mg/kg in sharp tailed grouse to 5.0 mg/kg in rock doves (Hudson et al., 1984).

Heptachlor

Heptachlor epoxide is a breakdown product of the organochlorine pesticides, heptachlor and chlordane. It is a contaminant of both products (USEPA, 1994a). It is more toxic than either parent compound (USEPA, 1993a). Although most uses of heptachlor were suspended in 1978 and chlordane was removed from the market in 1988 (USEPA, 1993a), heptachlor epoxide continues to be a widespread contaminant due to its relatively long biological half-life. Based on animal and limited human data, heptachlor epoxide is absorbed through the GI tract and is found primarily in the liver, bone marrow, brain, and fat, although it is distributed widely to other tissues as well. Heptachlor epoxide has a high affinity for adipose tissue. In a single LD_{50} study reported by Hudson et al (1984), the oral LD_{50} in mallards was $\geq$ 2,080 mg/kg; signs of toxicity consisted of ataxia and other behavioral abnormalities.

2-Hexanone

2-Hexanone is a solvent used in lacquers, ink thinners, nitrocellulose, resins, oils, fats, and waxes. The release of 2-hexanone to the environment occurs through its manufacture, formulation, and use as a specialized organic solvent. If released to the atmosphere, reaction with photochemically produced hydroxyl radicals is the most rapid method of degradation, with an estimated half-life of one to two days. If released to soil, 2-hexanone is expected to display high mobility and is capable of rapid biodegradation. If released to water, it is not expected to accumulate in the sediment or bioconcentrate. Volatilization from both water and soil to the atmosphere is expected to be an important fate process (USEPA, 1994b. Ecotoxicological and fate and transport data are limited for this compound. The oral LD_{50} in rats was 2.6 g/kg (USEPA,1994b).

Hydrogen Cyanide

Hydrocyanic acid is very reactive and occurs only rarely in nature. The cyanide ion is highly water soluble and readily forms complexes with a variety of metal ions, especially those of the transition series. Compounds containing cyanide are often associated with steel, petroleum, plastics, synthetic fibers, metal plating, and chemical industries (USEPA, 1984c). The toxicity to aquatic organisms of most simple cyanides and metallocyanide complexes is due mostly to the presence of HCN as derived from ionization, dissociation, and photodecomposition of cyanide-containing compounds, although the

cyanide ion is also toxic. Cyanide appears to be more toxic to fish than to most invertebrates, although *Daphnia pulex* is apparently as sensitive to cyanide as are most fish. Concentrations as low as 50 μg/L can be fatal to sensitive fish species while exposure to concentrations much above 200 μg/L result in lethality to almost all fish species (USEPA, 1984c).
Cyanide is known to uncouple oxidative phosphorylation.

Iodomethane

Iodomethane, or methyliodide, is used in medicine, organic synthesis, microscopy, and testing for pyridine. Toxicity and fate adn transport data for iodomethane are scarce. In the rat, a subcutaneous LD_{50} of 0.15-0.22 was observed, and an oral LD_{50} of 0.15-0.22 was observed (Verschueren, 1983). The carcinogenicity of the compound is unknown, though it is known to be weakly mutagenic.

Isopropyl Alcohol

Isopropyl alcohol, also known as isopropanol, 2-propanol, perspirit, and avantine, is used in the manufacture of acetone, glyerol, and isopropylate, as a deicing solution, in pharmacueticals, and as a preservative.

Little is known about the ecotoxicological effects of isopropyl alcohol, although some toxicity data do exist. A 48-hour LC_{50} of 1,400 mg/L and a 96-hour LC_{50} of 1,150 mg/L have been observed for the brown shrimp (*Crangon crangon*) (Verscheuren, 1983). For fish, an LD100 of 1,100 mg/L in Detroit river water has been noted for the creek chub (Versheuren, 1983). A 7-day LC_{50} of 7060 ppm has been observed for the guppy (*Poecilia reticulata*) (Verschueren, 1983).

For mammals, an oral LD_{50} of 10.0 ml/kg has been observed for the rabbit, and an oral LD_{50} of 5.84 g/kg has been noted in the rat (Verschueren, 1983).

Lead

As summarized in USFWS (1988b), research to date has determined that lead is neither essential nor beneficial, and that all measured effects are adverse. Invertebrates exhibit a wide range of sensitivities to lead, and the toxicity of lead to fish has been found to be greater in soft water than in hard water. Organolead compounds are typically more toxic than inorganic compounds, food chain biomagnification is generally negligible, and younger organisms tend to be more sensitive to lead exposure than older individuals (USFWS, 1988b). Reported bioconcentration factors range from 42 for brook trout to 1700 for a gastropod (*Lymnaea palustris*); the geometric mean value of data listed in USEPA (1985b) for freshwater species is 403. Studies summarized by USFWS (1988b) show that among sensitive species of birds, survival was reduced at doses of 50 to 75 mg Pb^{2+}/kg body weight or 28 mg organolead/kg body weight, reproduction was impaired at dietary levels of 50 mg Pb^{2+}/kg, and symptoms of toxicity (hyperactivity, reduced food consumption) were seen at doses as low as 2.8 mg organolead/kg body weight.

As with a number of other metals, hardness has a major effect on the bioavailability of lead, although the observed effect is probably due to the presence of one or more interrelated ions such as hydroxide, carbonate, calcium, or magnesium (USEPA, 1985b).

Plants readily accumulate lead from soils of low pH or low organic content (USFWS, 1988b). Lead seems to be tightly bound in most soils, and substantial amounts must accumulate before it affects growth of higher plants. There is no convincing evidence that any terrestrial vegetation is important in food chain biomagnification of lead (USFWS, 1988b; Kabata-Pendias and Pendias, 1992).

Manganese

Manganese does not occur naturally as a metal but is found in various salts and minerals, frequently in association with iron compounds (USEPA, 1986). Manganese is a vital micronutrient for both plants and animals. McKee and Wolfe (1963) summarized the data concerning the toxicity of manganese to freshwater life. Manganese ions rarely occur in concentrations above 1 mg/L. The reported tolerance values for freshwater organisms range from 1.5 to >1000 mg Mn/L.

All plants require manganese; its most important functions in plants appear to be associated with oxidation-reduction reactions. Like that of many other soil constituents, the chemistry of manganese is relatively complex and closely related to the formation of iron hydroxides and redox reactions (Kabata-Pendias and Pendias, 1992). While toxicity of manganese to plants has been reported in acid soils (pH < 5.5) containing high concentrations of this metal, like iron, manganese toxicity is the function of a number of other environmental factors. Soil concentrations associated with plant toxicity range from 1500 to 3000 mg/kg (Kabata-Pendias and Pendias, 1992).

Mercury

Mercury is widely distributed in the environment due to both natural and industrial processes. In a review of the hazards of mercury (Hg) to fish, wildlife, and invertebrates. USFWS (1987a) noted that mercury and its compounds have no known biological function; its presence is regarded as undesirable and potentially hazardous, and it is a mutagen, teratogen, and carcinogen. Forms of mercury with relatively low toxicity can be transformed into forms with very high toxicity through biological and other processes. Methylmercury is lipophilic, allowing it to pass through lipid membranes of cells and facilitating its distribution to all tissues, following absorption through the gills and gastrointestinal tract. Methylmercury also binds readily to protein sulfhydryl groups. Methylmercury and other organic mercury compounds are transformed via oxidation-reduction cycle into an inorganic form in most tissues, most significantly in the liver, kidney, and brain. The central nervous system is a major target organ for methylmercury-induced toxicity (USEPA, 1994a).

Methylmercury can be bioconcentrated in organisms and biomagnified through foodchains, returning mercury to upper trophic level consumers in a concentrated form. Bioconcentration factors for methylmercury range from 10,000 for brook trout to 81,670 for fathead minnows (*Pimephales promelas*); the geometric mean value of bioconcentration values listed in USEPA (1985c) for freshwater organisms is 25,400. For all organisms tested, early developmental stages were the most sensitive, and organomercury compounds, especially methylmercury, were more toxic than inorganic forms. Numerous biotic and abiotic factors modify the toxicity of mercury compounds, sometimes by an order of magnitude or more, but mechanisms of action are unclear (USFWS, 1987a).

The chemical speciation of mercury is probably the most important variable influencing its ecotoxicology, but Hg speciation is complicated, especially in natural environments (Boudou and Ribeyre, 1983; USFWS, 1987a). Most mercury entering aquatic systems is inorganic (Hg II) although recent studies have measured methylated mercury (CH_3HgH^+) in rain and surface runoff (Bloom and Watras, 1989; Lee and Hultberg, 1990). Methylmercury is the major form of mercury in fish; methylation of inorganic mercury takes place in the terrestrial environment, the water column, and in sediment. The net amount of methylmercury in an aquatic system is the result not only of its rate of formation, but also the result of the rates of those processes that alter the availability of inorganic mercury for methylation and methylmercury decomposition (demethylation) (Winfrey and Rudd, 1990).

Inorganic mercury readily adsorbs to inorganic and organic particles as well as dissolved organic carbon (DOC) (Benes and Havelik, 1979; Rudd and Turner, 1983; Rogers et al., 1984). The degree and extent of this binding, while not well understood, will affect the availability of mercury for methylation. Methylation of mercury in most aquatic systems is thought to be primarily a function of microbiological activity in the sediment (Winfrey and Rudd, 1990). Rates of methylation peak at the sediment-water interface and decrease in the overlying water and subsurface sediment (Korthals and Winfrey, 1987). Reduced pH also appears to increase the availability of methylated mercury by expediting its release

from sediment into the water column.

Plants seem to take up mercury easily from solution culture. There is also much evidence that increasing soil concentrations of mercury generally cause an increase in the mercury contents of the plants. The rate of increase of mercury content in plants when the soil was the only source of mercury was reported to be highest for the roots, but leaves and grains also accumulated much mercury (Kabata-Pendias and Pendias, 1992). These findings show that mercury is easily absorbed by the root system and is also translocated within plants. However, in a report entitled *Environmental Mercury and Man* (Anon., 1976), it stated "for most plants, even when grown on soils having much higher concentrations of mercury, there is little additional uptake."

Adverse effects (predominantly on reproduction) have been reported in birds at 50 to 100 μg/kg diet and daily intakes of 640 μg/kg body weight. Mink are among the mammals most sensitive to mercury, and adverse effects in mink have been reported at dietary levels of 1,100 μg/kg (USFWS, 1987a).

Methylacrylonitrile and Methyl Methacrylate

Methylacrylonitrile and methyl methacrylate are industrial chemicals that are uncommon in the environment. Little is known about the fate and transport and ecotoxicity of these compounds. For methylacrylonitrile, an acute oral LD_{50} of 20-25 mg/kg has been observed for the mouse, and an acute oral LD_{50} of 25-50 mg/kg have been observed in the rat (Verschueren, 1983). For methyl methacrylate, 24-96-hour median lethal doses of 499-159, 368-232, 423-277, and 368 mg/L have been observed for the fathead minnow, bluegill, goldfish, and guppy, respectively (Verschueren, 1983). For mammals acute oral LD_{50}s of 8.4 and 6-7 mg/kg have been noted for the rat and rabbit, respectively (Verschueren, 1983).

Nickel

Nickel is commonly found in most surface water bodies and may exist in as many as 6 different valence states (USEPA, 1986). However, under most natural conditions, the divalent form of this metal predominates. Like many other heavy metals, the bioavailability and toxicity of this metal to aquatic species is a function of water quality characteristic, including alkalinity, hardness, pH, salinity and humic acid concentrations (USEPA, 1986). The toxic effects of nickel, like many other heavy metals, frequently take place at the level of the gills. Results of tests conducted to date indicate that this metal does not bioconcentrate to any appreciable extent nor does it biomagnify in foodchains (USEPA, 1986).

Nickel is readily and rapidly uptaken from soils, and until certain nickel concentrations in plant tissues are reached, the absorption is positively correlated with soil nickel concentrations. Both plant and pedological factors affect the nickel uptake by plants, but the most pronounced factor is the influence of the soil pH. Soil concentrations that may result in toxic impacts range from 20 to 100 mg/kg (Kabata-Pendias and Pendias, 1992). Rats given a subchronic gavage study with nickel chloride in water experienced lethargy, ataxia, irregular breathing, reduced body temperature, and discolored extremities (USEPA, 1994b). Inhalation of nickel subsulfide in rats increased the incidence of lung tumors (ATSDR, 1991). The CNS appears to be the target organ for nickel oral toxicity, while the lung is the target organ for inhalation exposure.

PAHs

Polycyclic aromatic hydrocarbons (PAHs) are base/neutral organic compounds that have a fused ring structure of two or more benzene rings. Those PAHS with two to five rings are generally of greatest concern for environmental health (USEPA, 1993c). PAHS are ubiquitous in nature and usually occur as complex mixtures with other toxic chemicals. They are components of crude and refined petroleum products and of coal. They are also produced by the incomplete combustion of organic materials.

Major sources of PAHs found in marine and freshwaters include biosynthesis (restricted to anoxic sediments), spillage and seepage of fossil fuels, discharge of domestic and industrial wastes, atmospheric deposition, and runoff (Neff, 1985).

PAHs can accumulate in aquatic organisms from water, sediments, and food. Bioconcentration factors of PAHs in fish and crustaceans have frequently been reported to be in the range of 100 to 2000 (USFWS, 1987b). In general, bioconcentration was greater for the higher molecular weight PAHs than for lower molecular weight PAHs. Biotransformation by mixed function oxidase in the fish liver can result in the formation of carcinogenic and mutagenic intermediates, and exposure to PAHs has been linked to the development of tumors to fish (USFWS, 1987b).

Sediment-associated PAHs can be accumulated by bottom dwelling invertebrates and fish (USFWS, 1987b). For example, Great Lakes sediments containing elevated levels of PAHs were reported by Eadie et al. (1983) to be the source of the body burdens of the compounds in bottom-dwelling invertebrates. Varanasi et al. (1985) found that benzo[a]pyrene was accumulated in fish, amphipods crustaceans, shrimp, and clams when estuarine sediment was the source of the compound. Approximate tissue-to-sediment ratios were 0.6 to 1.2 for amphipods, 0.1 for clams, and 0.05 for fish and shrimp. Varanasi et al. (1985) ranked benzo[a]pyrene metabolism by aquatic organisms as follows: fish > shrimp> amphipods > clams. Because of their limited ability to metabolize some PAHs, clams tend to readily bioaccumulate these compounds. For most other organisms, PAHS show little tendency to bioconcentrate, despite their high lipid solubility (Pucknat, 1981), probably because most PAHs are rapidly metabolized. Animals and microorganisms can metabolize PAHs to products that may ultimately experience complete degradation (USFWS, 1987b).

Physical and chemical characteristics of polycyclic aromatics generally vary with molecular weight. Of major environmental concern are mobile PAHs that range in molecular weight from 128.16 to 300.36. Higher molecular weight PAHs are relatively immobile because their large molecular volumes and their extremely low volatility and solubility. The lower molecular weight, un-substituted PAH compounds, containing 2 to 3 rings, can be acutely toxic to some organisms, whereas the higher molecular weight (4 to 7 ring) aromatics generally are not (USFWS, 1987b).

PAHs may be adsorbed or assimilated by plant leaves before entering the animal food chain, although some adsorbed PAHs may be washed off by rain, chemically oxidized to other products or returned to the soil as plants decay (USFWS, 1987b). PAHS assimilated by vegetation may be translocated, metabolized, and possibly photodegraded within the plant. In some plants growing within highly contaminated areas, assimilation may exceed metabolism and degradation, resulting in an accumulation in the plant tissues (Edwards, 1983).

Plant uptake rates are governed, in part, by PAH concentration, PAH water solubility, soil type, and PAH physicochemical state (vapor or particulate). Lower molecular weight PAHs are absorbed more readily than are higher molecular weight PAHs. Phytotoxic effects are rare; however, the data base on this subject is small (USFWS, 1987b).

The degradation of most PAHs is not completely understood. Those in soils may be assimilated by plants, degraded by soil organisms, or accumulated to relatively high levels in soil. Wang and Bartha (1990) studied the persistence and toxicity of three types of fuels (jet fuel, heating oil, and diesel fuel) in soils. The results of their study indicated that of the three fuels tested, jet fuel exhibited the least amount of environmental persistence and toxicity to soil microbes and seedlings. Soil concentrations of jet fuel hydrocarbons decreased from 75 mg/g to approximately 5 mg/g in twenty weeks with no treatment. The concentration of easily metabolized aliphatics (C_{12} to C_{22}) in each fuel was correlated with its degradation rate. Of the three fuels tested, jet fuel was comprised of the greatest portion of aliphatics (Wang and Bartha, 1990).

Because of their complex chemical composition, the toxicity of PAHs is variable and not well

understood (NAS, 1985). In addition, research has demonstrated that different organisms and different life stages for a given species can vary widely in sensitivity to PAHs (USFWS, 1987b; NAS, 1985; Neff and Anderson, 1981). However, it is generally agreed that in aquatic ecosystems, the toxicity of PAHs is correlated with water solubility (Neff and Anderson, 1981) and molecular weight, with high molecular weight PAHs exhibiting low acute toxicity (due to low water solubility) (USFWS, 1987b). In all but a few cases, PAH concentrations that are acutely toxic to aquatic organisms are several orders of magnitude higher than concentrations found in even the most heavily polluted waters. Sediment from polluted areas, however, may contain PAHs in concentrations approaching those similar to those which are acutely toxic, but their limited bioavailability would probably render them substantially less toxic than PAHs in solution (USFWS, 1987b).

Patton and Drieter (1980) fed mallards a diet that contained 4000 mg/kg (primarily naphthalenes, naphthenes, and phenanthrene) for 7 months. No mortality or visible signs of toxicity were noted, but both liver weight and hepatic blood flow were significantly greater than that of the controls. However, the authors concluded that these modifications in the liver did not represent an adverse effect, and that adult mallards could tolerate long-term exposures to relatively high concentrations of PAHs. Mammalian toxicity data are limited for PAHs, but the ability of some PAHs to induce tumor formation is well documented (USFWS, 1987b). Bioaccumulated PAHs with a four-ring structure or less are rapidly metabolized. Therefore, long term partitioning into biota is not considered a significant fate process (USFWS, 1987b; USEPA, 1993a).

PCBs

Polychlorinated biphenyls (PCBs) are a mixture of chlorinated biphenyl chemicals which occur individually as 209 congeners, comprised of various chlorine substitution patterns. PCBs are closely related to many chlorinated hydrocarbon pesticides (e.g, DDT, dieldrin, and aldrin) in their chemical, physical, and toxicological properties and in their widespread occurrence in the aquatic environment (Nimmo, 1985). Mixtures of PCBs were marketed under the trade name Aroclor, with a numeric designation that indicated their chlorine content. Although production and use was banned in 1979, the chemical group is extremely persistent in the environment and bioaccumulates through the foodchain. There is evidence that the most potent, dioxin-like PCB congeners are preferentially accumulated in higher organisms. Additional research indicates that there is evidence that PCB risks increase with increased chlorination because more highly chlorinated PCBs are retained more efficiently in fatty tissues (USEPA, 1994a). The non-ortho-substituted coplanar PCB congeners and some of the mono-ortho-substituted congeners have been shown to exhibit dioxin-like effects. There is increasing evidence that many of the toxic effects of PCBs result from alterations in hormonal function. Consequently, the aggregate toxicity of a PCB mixture may increase as it moves up the foodchain (USEPA, 1993b).

The three effects of PCB exposure on terrestrial wildlife are mortality, decreased reproductive success, and behavioral modifications (USEPA, 1993b). Mink (*Mustela vison*) appear to be among the most sensitive species to the toxic effects of PCBs (Gillette et al., 1987). Single oral doses of PCBs administered to mink have produced LD_{50} values of 750 mg/kg for Aroclor 1221 and 4000 mg/kg for Aroclor 1254 (Aulerich and Ringer, 1977; Ringer, 1983). The primary chronic effect documented as a result of dietary exposure to PCBs has been decreased reproductive success, as evidenced by reduced whelping rates, fetal death, and reduced growth among the young. Based on a review of available data, USEPA determined that 30 μg/kg/d represented an no observable effect level (NOEL) value for reproductive effects of Aroclor 1254 (USEPA, 1993b).

Birds have been shown to be more resistant than mammalian species to the acute effects of PCBs. PCB doses greater than 200 ppm in the diet (10 mg/kg body weight) caused some mortality among northern bobwhite (*Colinus virginians*), mallards (*Anas plythynchos*), and ring-necked pheasants (*Phasianus colchicus*). PCBs provided to these birds at dietary concentrations of 1500 ppm (100 mg/kg body weight) caused extensive mortality (USFWS, 1986a). Exposure to PCBs resulted in some mortality

among all the avian species tested, with lethal concentrations depending on the length of exposure and the particular PCB mixture (Aulerich et al., 1977). For all avian species, PCB residue concentrations of at least 310 mg/kg fresh weight in the brain were associated with an increased likelihood of death from PCB poisoning (USFWS, 1986a). An evaluation of the results of various toxicity studies performed on a number of bird species led USEPA (1993b) to conclude that 0.18 mg/kg/body weight represented an appropriate NOEL for avian wildlife.

Phenol

As summarized in USEPA (1980f), phenol is predominantly used as an intermediate in a wide variety of chemical processes including production of epoxy and phenolic resins, pharmaceutical, pesticides, dyes, and numerous industrially-important acids. The phenol molecule easily substitutes in the environment to form compounds such as halophenols, which may be more toxic than the parent compound. The acute toxicity of phenols to aquatic organisms has been characterized, but information on chronic toxicity is limited. Acute toxicity of phenol to freshwater species has been expressed over 2 to 3 orders of magnitude. Test results have indicated that cladocerans are the most sensitive invertebrate species examined (*Daphnia pulex* LC_{50} = 5000 μg/L), while rainbow trout are among the most sensitive fish species tested (LC_{50} =5020 μg/L). Bioconcentration factors range from 1.2 to 2.3 for goldfish (*Carassius auratus*), indicating that phenol is not likely to bioconcentrate or biomagnify (USEPA, 1980f).

Phthalates (Bis(2-ethylhexyl)phthalate)

Phthalates, or phthalate esters such as Bis(2-ethylhexyl)phthalate, represent a large family of chemicals widely used as plasticizers. For the most part, these are colorless liquids with low volatility and are poorly water soluble (USEPA, 1980g; Verschueren 1983). Available data indicate that the toxicity of phthalate varies widely. However, acute toxicity values reported by USEPA (1980g) all exceed 1000 μg/L while chronic values as low as 3 μg/L had been determined for di(2-ethylhexyl)phthalate. Reported bioconcentration values ranged from 14 to 2680 (USEPA, 1980g).

Selenium

Selenium is the most strongly enriched element in coal, being present as an organoselenium compound, a chelated species, or an adsorbed element. On combustion of coal, the sulfur dioxide formed reduces the selenium to elemental selenium (USFWS, 1986b). Selenium is an element that is required in trace amounts by some organisms. While considered to be an essential element for plants and animals, Se is toxic at higher concentrations (Masscheleyn and Patrick, 1993).

Selenium biogeochemistry is complex and governed by many factors. The solubility of minerals containing Se, the complexing ability of solid and soluble ligands, microbiologically mediated oxidation-reduction reactions, methylation, and volatilization are all potential processes controlling Se concentration, mobility, and toxicity in both the aquatic and sedimentary environment (Masscheleyn and Patrick, 1993). The quantification of Se species present at the sediment-water interface and the extent of species transformations are critical to understanding Se biogeochemical behavior and its biotic and abiotic reactivity. According to Masscheleyn and Patrick (1993), redox potential and pH are the most important parameters determining chemical speciation and stability of selenium in aquatic systems. Its chemistry resembles that of sulfur. Selenium, like sulfur, can exist in four different oxidation states: selenide (Se -II), elemental selenium (Se0), selenite (Se IV), and selenate (Se VI).

It has been suggested that selenite is more toxic than selenate, particularly to early life stages and that these effects are most pronounced at elevated temperatures. Also, Se salts may be converted to methylated forms by microorganisms, and these forms are readily accumulated by freshwater vertebrates (USEPA, 1987a). Selenium is readily taken up and transferred in the aquatic food chain.

The high availability and intrinsic toxicity of selenium oxyanions to aquatic organisms, plants, and wildlife make selenium a harmful trace element. At high concentrations, detoxification by means of the formation of volatile metallothien and subsequent excretion become increasingly important (Masscheleyn and Patrick, 1993).

Selenium metabolism and degradation is significantly modified by interaction with heavy metals, agricultural chemicals, microorganisms, and a variety of physicochemical factors. Results of laboratory studies and field investigations with fish, mammals, and birds have led to the general agreement that elevated concentrations of selenium in diet or water are associated with reproductive abnormalities, including congenital malformations, selective bioaccumulation by the organisms, and growth retardation. These signs have been observed in birds fed diets containing selenium at concentrations as low as 5 ppm (USFWS, 1986b).

Accumulation of selenium by aquatic organisms is highly variable. In short-term tests, exposures to concentrations ranging from 0.015 to 3.3 μg/L, resulted in biological concentration factors of 460 for the mosquito fish (*Gambusia* sp.) to 32,000 for a freshwater gastropod (Nassos et al., 1980). Selenium accumulation is modified by water temperature, age of the organism, organ or tissue specificity, mode of administration, and other factors (USEPA, 1987a).

In a lake in North Carolina receiving selenium (as flyash waste from a coal-fired power station), reproduction of green sunfish (*Lepomis cyanellus*) failed, and the population declined markedly. In these fish, selenium levels were elevated in liver and other tissues; kidney, heart, liver, and gills exhibited altered histopathology and blood chemistry. It is probable that selenium uptake by plankton [containing 41-97 parts per million (ppm) dry weight] from the lake water [9-12 parts per billion (ppb)] introduced selenium into the foodchain where it ultimately reached levels in fish through biomagnification (Cumbie and van Horn, 1978).

Silver

Numerous studies have indicated that free soluble silver is among the most toxic metals to freshwater organisms. In most natural waters, the monovalent form of silver is of greatest concern. Silver may exist as a simple hydrated monovalent ion, or it may exist in various degrees of association with inorganic ions such as sulfate, bicarbonate, or nitrate (USEPA, 1980h). Silver is more toxic in soft water than in hard water (USEPA, 1980h). The sorption of silver by manganese dioxide, various ferric compounds, and clay minerals, and its subsequent partitioning by the sediment layer is strongly pH-dependent (Dyck 1968). Olcott (1950) administered 0.1 percent silver nitrate to rats in drinking water for 218 days. Upon necropsy, advanced pigmentation and ventricular hypertrophy were observed, although the hypertrophy was not attributed to silver toxicity.

Silver exhibits a limited ability to bioconcentrate. Bioconcentration factors for freshwater species reported by USEPA (1980h) ranged from <1 for bluegill sunfish (*Lepomis macrochirus*) to 240 for a mayfly (*Ephemeralla grandis)* with a geometric mean bioconcentration factor of 57. Based on studies of rats, chickens, and turkeys, the maximum tolerable level for silver in animal food is 100 mg/kg (NRC, 1980).

Styrene

Styrene, also known as vinylbenzene, cinnamene, phenylethylene, ethenylbenzene, is a common compound used in the chemical industry. It used used in the manufacture of polystyrene, synthtic rubber, plastics, resins, insulators, and protective coatings.

A LD_{50} of 1000 mg/kg has been observed in rats (Vershueren, 1983). In addition, a 24-hr LD_{50} of 26

mg/L has been observed for goldfish (Vershueren, 1983). Median lethal doses for 24-hour tests of 56.7, 25.1, 64.7, and 74.8 mg/L have been noted for fathead minnows, bluegills, goldfish, and guppies, respectively.

Tetrachloroethane

Historically, the only major use for tetrachloroethane (primarily 1,1,2,2-tetrachloroethane) was as a feedstock in the production of trichloroethylene, tetrachloroethylene, and 1,2-dichloroethylene. It was also used as a solvent, extractant, and insecticide. However, tetrachloroethane in the environment is usually associated with the presence of other similar chemicals, such as trichloroethylene, dichloroethylene, and tetrachloroethylene, and present production of tetrachloroethane as an end product is limited (ATSDR, 1995b). Since tetrachloroethane is also produced as a by-product when some of these simlilar compounds are produced, it is normally present when they are released into the environment.

In a chronic mouse study, a level of 280 mg/kg/day caused death in a majority of those exposed after 70 weeks of exposure (NCI, 1978). Hepatic and reproductive effects are common in rats and mice. Reproductive effects were observed in rats given 3.2 mg/kg/day (Gohlke et al., 1977). Tetrachloroethane is not known to cause cancer in animals.

In both humans and animals, the compound is readily absorbed throuth the lungs, GI tract, and skin (ATSDR, 1995b). It is extensively metabolized soon after exposure. Tetrachloroethane is known to produce reactive radical and acid chloride metabolic intermidiates (ATSDR, 1995b). The compound and metabolites are usually excreted rapidly after exposure.

Tetrachloroethylene

Tetrachloroethylene (PCE) is a synthetic chlorinated hydrocarbon widely used for dry cleaning fabrics and metal-degreasing. It enters the environment mainly through evaporation, sludge and factory waste disposal, and storage leaks (ATSDR, 1995c). This chemical does not appear to accumulate in aquatic organisms. Accumulation in terrestrial plants is not known. It is readily absorbed following inhalation, oral exposure, and dermal exposure. Upon absorption, PCE is distributed to fatty tissues, with a half life of approximately 55 hours (ATSDR, 1995c).

The liver is the principal target organ in rodents (ATSDR, 1995c). LD_{50} values of 3,835 and 3,005 mg/kg were determined for male and female rats, respectively (Hayes et al., 1986). Increase in relative liver weights and peroxisomal proliferation were observed in mice after an oral dose of 1000 mg/kg/day (Goldsworthy and Popp, 1987). Renal effects are also common in rodents exposed to tetrachloroethylene, cancer effects have also been observed. PCE administered by gavage at 995 mg/kg/day was observed to promote type II altered foci in rat livers (Story et al., 1986). A NOAEL of 100 mg/kg was observed in rats for developmental effects (Nelson et al., 1980).

Thallium

Thallium is considered highly toxic. It was used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with deleterious side effects. Acute ingestion by laboratory animals induced gastroenteritis, neuropathy, and renal and liver damage, while chronic ingestion causes alopecia (Kazanntzis, 1986). Rats treated with thallium compounds for 90 days experienced liver damage (USEPA, 1994b). Several thallic compounds (thallic oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, and thallium sulfate) were designated as weight-of-evidence Group D compounds; not classifiable as carcinogenic to humans. A chronic reference dose of 0.07 ug/kg/day has been established for human exposure to thallic oxide (USEPA, 1994b).

Tin

Inorganic tin compounds are used in a variety of industrial processes, such as the strengthening of glass, as a base for colors, as catalysts in chemical reactions, as stabilizers in perfumes and soaps, and as dental anticariogenic agents. Organotin compounds are used in antifouling marine paints, in molluscicides, and in pesticides. In addition, the uses of tin compounds is presently increasing.

Inorganic tin compounds are of low toxicological value due to their low solubility, poor absorption, low accumulation in tissue, and rapid excretion (USFWS, 1989). However, some organotin compounds, such as trialkyltins, are highly toxic. Bioconcentration of organotins is high, but excretion is sufficient to preclude biomagnification. Bioconcentration factors up to 1,900 in marine algae have been measured (Maguire et al., 1984). Benthic fauna are capable of transferring organotins from sediments to botton-feeding teleosts.

The toxicity of organotins is diverse and complex due to the many different types of organotin compounds. Adverse effects on molluscs have been noted at water concentrations of 0.001 to 0.06 ug/L (USFWS, 1989). Diets containing 50 mg of tin as trimethyltin chloride/kg are fatal to all mallard ducklings within 75 days (Eisler, 1989). Toxicities of different organotin compounds also vary in mammalian species. Trimethyltin, triethyltin, and tributyltin compounds are highly toxic to animals and man. Mammals poisoned by organotin compounds exhibit muscular weakness, tremors, hyperexcitability, and paralysis (USFWS, 1989).

Toxaphene

Toxaphene is an insecticide containing over 670 chemicals. It is also known as campheclor, chlorocamphene, polychlorocamphene, and chlorinated camphene. Toxaphene was one of the most commonly used insecticides in the United States until 1982, and was used to control insect pests on livestock and crops, and to kill unwanted fish in lakes. In 1990, EPA banned all uses of toxaphene in the United States due to human and ecological health concerns, and its tendency to persist and bioaccumulate in the environment.

Oral LD_{50}s in rats range from 60 to 293 mg/kg (ATSDR, 1995d). Most LD_{50}s for rats are similar to those observed for rats. Intermediate and chronic exposure of toxaphene administered in feed to rates and mice indicates that mice are more sensitive to the toxic effects of toxaphene (NCI, 1977). Most common observed adverse effects for toxaphene include hepatic, renal, endocrine, immunological, developmental, and neurological effects. Signs of neurological stimulation are the most common signs of toxaphene poisoning in both humans and animals (ATSDR, 1995d).

Toxaphene is rapidly circulated to all tissues and degraded in mammals following oral exposure. The principle metabolic pathways include dechlorination, oxidation, and dehydrochlorination, and conjugation (ATSDR, 1995d). However, since toxaphene is comprised of many different compounds, characterization of biotransformation is difficult.

Trichloroethane

1,1,1-Trichloroethane, also known as methylchloroform, is a colorless liquied with a sweetish odor. The 96 hr LC_{50} for the fathead minnow was 105 mg/L (static bioassay) and 52.8 mg/L (flow throughbioassay). The single oral LC_{50} for rats ranged from 10.3 to 12.3 g/kg; 5.66 g/kg for the femal rabbit; and 9.47 g/kg for the male guinea pig. Humans exposed to 500 ppm 1,1,1-trichloroethane for 180 minutes complained of eye irritation and headache (Verschueren, 1983).

Trichloroethene

A lack of data exists for TCE toxicity. Prolonged inhalation exposure of animals effected the liver and kidneys. The main target organs are th CNS, heart, liver, and kidney. Exposure to TCE has been

shown to cause increased incidence of liver tumors (gavage) and lymphomas (inhalation) in mice, and increased renal tumors in rats (gavage; USEPA, 1988b).

Vanadium

Vanadium is an ubiquitous element, frequently associated with petroleum refining and products. It is also used in the hardening of steel, production of pigments, and the manufacture of insecticides. It is common in many foods, particularly milk, cereals, and vegetables. While the majority of vanadium encountered in mammals is stored in fatty tissue, bone and teeth contribute to the body burden (Amdur et al., 1991). It has been postulated that homeostatic processes exist for this element in that normal tissue levels can be maintained in the face of excessive uptake. The toxic action of vanadium in mammals is largely confined to the respiratory tract. Acute vanadium poisoning via ingestion is characterized by effects on the nervous system, hemorrhage, and respiratory distress (Amdur et al., 1991). No reports exist regarding vanadium phytoxicity under field conditions. However, experimental greenhouse studies have indicated that concentrations of 140 mg/kg in the soil and 0.5 mg/kg in the nutrient solution may be toxic to plants (Kabata-Pendias and Pendias, 1992).

Vinyl Chloride

Vinyl chloride is an industrial chemical which is widely and extensively produced due to its wide variety of uses and the low cost of producing polymers from it. Major end-use products include polyvinyl chloride (PVC) products, such as pipes, automotive parts, and wire coverings, as well as vinyl chloride-vinyl acetate copolymer products such as films and resins (ATSDR, 1995e). It was also used in the past as a refrigerant, extraction solvent, and in the production of methyl chloroform.

Acute exposures to high levels of vinyl chloride ranging from 100,000 to 400,000 ppm have been shown to be fatal in rats, guinea pigs, and mice (ATSDR, 1995e). Decreased longevity has been observed in intermediate and chronic studies. Substantial increases in mortality in mice and rats exposed to 250 vinyl chloride for 12 months (Lee et al., 1978). Common adverse effects associated with vinyl chloride exposure include cardiovascular, hematological, neurological, reproductive, genotoxic, musculoskeletal, hepatic, renal, and immunological effects.

In animals, vinyl chloride has been found to be almost completely absorbed from the gastrointestinal tract after oral exposure. Vinyl chloride metabolites have not been found to accumulate in tissues. Metabolism generally occurs via the oxidation of vinyl chloride by the mixed-function oxidase system. Vinyl chloride toxicosis exhibits many of the same signs as autoimmune diseases, and vinyl chloride is known to be carcinogenic to both humans and animals (ATSDR, 1995e). Metabolic intermidiaries are known to interact with specific locii on the the chromosome (ATSDR, 1995e). Hepatotoxicity is also common.

Xylene

Xylene is used in petroleum distillation, coal tar distillation, and used extensively in the organic chemical industry. The chemical is relatively volatile, with a characteristic sweet odor. Xylene is found in the environment in ortho, meta, and para forms.

Bacteria are known to aggressively metabolize xylene. The 96 hr LC_{50} for shrimp (*Crangon francisorum*) was 1.3 ppm (Verschueren, 1983). A 96 hr LC_{50} of 13.5 mg/l was observed for rainbow trout (Verschueren, 1983). A bioconcentration factor of 23.6 was observed in the eel (*Anguilla japonica*). Humans has been observed to exhibit symptoms of illness after inhalation of xylene at 1000 ppm (Verschueren, 1983).

Zinc

Zinc is the fourth most widely used metal in the world. Its major uses are for galvanizing steel, producing alloys, and as an ingredient in paints and rubber. Zinc occurs in many forms in natural waters and sediment. At pH 6.0, the dominant forms of dissolved zinc are the free ion (98 percent) and zinc sulfate, whereas at pH 9.0, the dominant forms are the mono-hydroxide ion (78 percent), zinc carbonate (16 percent), and the free ion (6 percent). Like many other cationic metals, the concentration of dissolved zinc is a function of both water hardness and pH (USEPA, 1987b).

This ubiquitous trace metal is essential for normal cell differentiation and growth in both plants and animals (Rand and Petrocelli, 1985). Although zinc is an essential micronutrient for all living organisms, acute values for freshwater invertebrates range from 32 to 40,930 μg/L, and those for fish range from 66 to 40,900 μg/L. Chronic values for invertebrates have been reported at concentrations as low as 46.7 μg/L, while exposure of fish to 36.4 μg/L has resulted in chronic toxicity. Acute and chronic toxicity of this metal is a function of water hardness (USEPA, 1987a). Zinc toxicity in terrestrial animals is not well established. Experimental animals have been given zinc at 100 times the dietary requirements without perceived effects (Goyer et al., 1979).

The important factors controlling the mobility of zinc in soils are very similar to those listed for copper, but zinc appears to occur in more readily soluble forms. Zinc is considered to be readily soluble relative to other heavy metals in soils. Soluble forms of zinc are readily available to plants, and the uptake of zinc has been reported to be linear with concentration in the nutrient solution and in soils. The rate of zinc absorption differs greatly among both plant species and growth media. Roots often contain much more zinc than do tops, particularly if the plants are grown in zinc-rich soils (Kabata-Pendias and Pendias, 1992).

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APPENDIX E

DOSE CALCULATIONS FOR THE LOWER KEYS MARSH RABBIT

DOSE CALCULATIONS FOR THE LOWER KEYS MARSH RABBIT

SWMU 1

MAXIMUM CONTAMINANT CONCENTRATIONS

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
ALUMINUM	7810.00	0.00E+00	0.00E+00	3.12E+01	0.00E+00	0.00E+00
ANTIMONY	21.70	0.00E+00	0.00E+00	4.34E-01	0.00E+00	0.00E+00
ARSENIC	6.40	0.00E+00	0.00E+00	2.56E-01	0.00E+00	0.00E+00
BARIUM	99.60	0.00E+00	0.00E+00	1.49E+01	0.00E+00	0.00E+00
BERYLLIUM	0.20	0.00E+00	0.00E+00	2.00E-03	0.00E+00	0.00E+00
CADMIUM	11.20	0.00E+00	0.00E+00	6.16E+00	0.00E+00	0.00E+00
CHROMIUM	184.00	0.00E+00	0.00E+00	1.38E+00	0.00E+00	0.00E+00
COBALT	4.60	0.00E+00	0.00E+00	9.20E-02	0.00E+00	0.00E+00
COPPER	407.00	0.00E+00	0.00E+00	1.63E+02	0.00E+00	0.00E+00
LEAD	740.00	0.00E+00	0.00E+00	3.33E+01	0.00E+00	0.00E+00
MANGANESE	467.00	0.00E+00	0.00E+00	1.17E+02	0.00E+00	0.00E+00
MERCURY	6.20	0.00E+00	0.00E+00	5.58E+00	0.00E+00	0.00E+00
NICKEL	50.20	0.00E+00	0.00E+00	3.01E+00	0.00E+00	0.00E+00
SELENIUM	0.61	0.00E+00	0.00E+00	1.53E-02	0.00E+00	0.00E+00
SILVER	7.60	0.00E+00	0.00E+00	3.04E+00	0.00E+00	0.00E+00
TIN	11.80	0.00E+00	0.00E+00	3.54E-01	0.00E+00	0.00E+00
VANADIUM	11.10	0.00E+00	0.00E+00	6.11E-02	0.00E+00	0.00E+00
ZINC	869.50	0.00E+00	0.00E+00	1.30E+03	0.00E+00	0.00E+00
2-BUTANONE	0.032	0.00E+00	0.00E+00	1.54E-01	0.00E+00	0.00E+00
4,4'-DDD	1.4	0.00E+00	0.00E+00	6.45E-02	0.00E+00	0.00E+00
4,4'-DDE	1.73	0.00E+00	0.00E+00	2.13E-02	0.00E+00	0.00E+00
4,4'-DDT	4.7	0.00E+00	0.00E+00	6.22E-02	0.00E+00	0.00E+00
ACETONE	0.23	0.00E+00	0.00E+00	3.32E+00	0.00E+00	0.00E+00
ANTHRACENE	0.28	0.00E+00	0.00E+00	4.72E-03	0.00E+00	0.00E+00
AROCLOR-1260	0.9	0.00E+00	0.00E+00	1.36E-02	0.00E+00	0.00E+00
BENZO(A)PYRENE	2.185	0.00E+00	0.00E+00	8.83E-02	0.00E+00	0.00E+00
BIS(2-ETHYLHEXYL)PHTHALA	2.2	0.00E+00	0.00E+00	2.14E-02	0.00E+00	0.00E+00
CHLORODIBROMOMETHANE	0.00044	0.00E+00	0.00E+00	7.94E-05	0.00E+00	0.00E+00
DI-N-BUTYL PHTHALATE	0.23	0.00E+00	0.00E+00	7.09E-04	0.00E+00	0.00E+00
ENDRIN	0.0197	0.00E+00	0.00E+00	3.79E-04	0.00E+00	0.00E+00
ENDRIN ALDEHYDE	0.045	0.00E+00	0.00E+00	8.66E-04	0.00E+00	0.00E+00
ETHYLBENZENE	0.002	0.00E+00	0.00E+00	8.97E-05	0.00E+00	0.00E+00
FLUORANTHENE	7.1	0.00E+00	0.00E+00	9.13E-02	0.00E+00	0.00E+00
HEXACHLOROPHENE	0.89	0.00E+00	0.00E+00	5.47E-03	0.00E+00	0.00E+00
METHYLENE CHLORIDE	0.07	0.00E+00	0.00E+00	5.54E-02	0.00E+00	0.00E+00
PYRENE	6.29	0.00E+00	0.00E+00	7.99E-02	0.00E+00	0.00E+00
TOLUENE	0.007	0.00E+00	0.00E+00	2.41E-04	0.00E+00	0.00E+00
XYLENES, TOTAL	0.007	0.00E+00	0.00E+00	7.36E-05	0.00E+00	0.00E+00

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN VEGETATION (PAGE TWO)
MCAS, Key West - SWMU 1 maximum
EXPOSURE SCENARIO: CALCULATE VEGETATION CONCENTRATIONS BASED MEASURED SOIL CONCENTRATIONS (ACTUAL)

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to
ecomodel

CALCULATE CONCENTRATION IN SOIL:

CHEMICAL	GROUND LEVEL CONCENTRATION (UG/M3)	DAILY DEPOSITION ON VEGETATION (MG/M2/DAY)	LAMBDA-C (1/DAY)	X	SOIL CONC. (MG/KG)	Koc	Kow	UPTAKE FACTOR TRANSLOCATION	VEG CON TRANSLOC (MG/KG)
Aluminum	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7810.00			4.00E-03	3.12E+01
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00	21.70			2.00E-02	4.34E-01
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.40			4.00E-02	2.56E-01
Barium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	99.60			1.50E-01	1.49E+01
Beryllium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.20			1.00E-02	2.00E-03
Cadmium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	11.20			5.50E-01	6.16E+00
Chromium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	184.00			7.50E-03	1.38E+00
Cobalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.60			2.00E-02	9.20E-02
Copper	0.00E+00	0.00E+00	0.00E+00	0.00E+00	407.00			4.00E-01	1.63E+02
Lead	0.00E+00	0.00E+00	0.00E+00	0.00E+00	740.00			4.50E-02	3.33E+01
Manganese	0.00E+00	0.00E+00	0.00E+00	0.00E+00	467.00			2.50E-01	1.17E+02
Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.20			9.00E-01	5.58E+00
Nickel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	50.20			6.00E-02	3.01E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.61			2.50E-02	1.53E-02
Silver	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60			4.00E-01	3.04E+00
Tin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	11.80			3.00E-02	3.54E-01
Vanadium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	11.10			5.50E-03	6.11E-02
Zinc	0.00E+00	0.00E+00	0.00E+00	0.00E+00	869.50			1.50E+00	1.30E+03
2-Butanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.032	1.80E+00	1.82E+00	4.82E+00	1.54E-01
4,4'-DDD	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.4	2.82E+05	1.05E+06	4.61E-02	6.45E-02
4,4'-DDE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73	2.51E+06	3.24E+06	1.23E-02	2.13E-02
4,4'-DDT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.7	1.79E+06	2.29E+06	1.32E-02	6.22E-02
Acetone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.23	5.81E-01	5.75E-01	1.45E+01	3.32E+00
Anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.28	2.82E+04	1.40E+04	1.69E-02	4.72E-03
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.9	1.01E+06	1.29E+06	1.51E-02	1.36E-02
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.185	1.15E+06	5.50E+06	4.04E-02	8.83E-02
Bis(2-ethylhexyl)phthalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.2	1.29E+05	5.00E+04	9.72E-03	2.14E-02
Chlorodibromomethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00044	1.13E+02	1.23E+02	1.81E-01	7.94E-05
Di-n-butylphthalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.23	5.25E+04	3.30E+03	3.08E-03	7.09E-04
Endrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0197	3.20E+05	3.98E+05	1.93E-02	3.79E-04
Endrin Aldehyde	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.045	3.20E+05	3.98E+05	1.93E-02	8.66E-04
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.002	1.41E+03	8.70E+02	4.48E-02	8.97E-05
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.1	7.90E+04	3.80E+04	1.29E-02	9.13E-02
Hexachlorophene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.89	2.04E+05	5.00E+04	6.15E-03	5.47E-03
Methylene chloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.07	1.78E+01	4.78E+01	7.92E-01	5.54E-02
Pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29	8.00E+04	3.80E+04	1.27E-02	7.99E-02
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.007	5.40E+02	1.00E+02	3.44E-02	2.41E-04
Xylenes	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.007	1.43E+03	5.80E+01	1.05E-02	7.36E-05

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
ALUMINUM			6.17E+00
ANTIMONY			6.86E+01
ARSENIC			2.01E+00
BARIUM			7.77E+00
BERYLLIUM			1.20E-02
CADMIUM			1.76E+00
CHROMIUM			1.58E+01
COBALT			1.16E-01
COPPER			2.44E-01
LEAD			3.65E+00
MANGANESE			2.10E-01
MERCURY			1.85E-02
NICKEL			4.96E-02
SELENIUM			3.21E-02
SILVER			1.66E+00
TIN			9.32E-01
VANADIUM			3.84E-02
ZINC			2.15E-01
2-BUTANONE			7.14E-06
4,4'-DDD			6.91E-02
4,4'-DDE			8.54E-02
4,4'-DDT			2.32E-01
ACETONE			9.08E-05
ANTHRACENE			1.11E-03
AROCLOR-1260			2.63E-01
BENZO(A)PYRENE			8.63E-01
BIS(2-ETHYLHEXYL)PHTHALATE			4.75E-03
CHLORODIBROMOMETHANE			5.79E-06
DI-N-BUTYL PHTHALATE			6.86E-04
ENDRIN			1.65E-05
ENDRIN ALDEHYDE			8.46E-03
ETHYLBENZENE			1.93E-02
FLUORANTHENE			1.94E-05
HEXACHLOROPHENE			2.24E-03
METHYLENE CHLORIDE			3.51E-02
PYRENE			5.53E-03
TOLUENE			3.31E-01
XYLENES, TOTAL			1.06E-06
TOTAL			1.11E+02

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
ALUMINUM			3.67E-01
ANTIMONY			2.04E+01
ARSENIC			1.19E+00
BARIUM			1.73E+01
BERYLLIUM			1.78E-03
CADMIUM			1.44E+01
CHROMIUM			1.76E+00
COBALT			3.44E-02
COPPER			1.45E+00
LEAD			2.44E+00
MANGANESE			7.79E-01
MERCURY			2.48E-01
NICKEL			4.42E-02
SELENIUM			1.19E-02
SILVER			9.86E+00
TIN			4.16E-01
VANADIUM			3.15E-03
ZINC			4.79E+00
2-BUTANONE			5.12E-04
4,4'-DDD			4.74E-02
4,4'-DDE			1.56E-02
4,4'-DDT			4.56E-02
ACETONE			1.95E-02
ANTHRACENE			2.77E-04
AROCLOR-1260			5.90E-02
BENZO(A)PYRENE			5.19E-01
BIS(2-ETHYLHEXYL)PHTHALATE			6.86E-04
CHLORODIBROMOMETHANE			1.56E-05
DI-N-BUTYL PHTHALATE			7.57E-07
ENDRIN			2.42E-03
ENDRIN ALDEHYDE			5.53E-03
ETHYLBENZENE			1.29E-05
FLUORANTHENE			4.29E-04
HEXACHLOROPHENE			3.21E-03
METHYLENE CHLORIDE			6.51E-02
PYRENE			6.26E-02
TOLUENE			5.45E-07
XYLENES, TOTAL			2.10E-05
TOTAL			7.63E+01

ALUMINUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.81E+03							3.86E+01		1.00E+00	8.00E-01	3.08E+01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.12E+01				2.29E+00					1.00E+00	8.00E-01	1.83E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ANTIMONY	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.17E+01							1.07E-01		1.00E+00	8.00E-01	8.57E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.34E-01				3.19E-02					1.00E+00	8.00E-01	2.55E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

ALUMINUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.81E+03	3.08E+01	5.00E+00	6.17E+00	
Water	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Food	3.12E+01	1.83E+00	5.00E+00	3.67E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Total					6.54E+00

ANTIMONY	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.17E+01	8.57E-02	1.25E-03	6.86E+01	
Water	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Food	4.34E-01	2.55E-02	1.25E-03	2.04E+01	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Total					8.89E+01

ARSENIC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.40E+00							3.16E-02		1.00E+00	8.00E-01	2.53E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.56E-01				1.88E-02					1.00E+00	8.00E-01	1.50E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

BARIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.96E+01							4.92E-01		1.00E+00	8.00E-01	3.93E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.49E+01				1.10E+00					1.00E+00	8.00E-01	8.77E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

ARSENIC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.40E+00	2.53E-02	1.26E-02	2.01E+00	
Water	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Food	2.56E-01	1.50E-02	1.26E-02	1.19E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Total					3.20E+00

BARIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.96E+01	3.93E-01	5.06E-02	7.77E+00	
Water	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Food	1.49E+01	8.77E-01	5.06E-02	1.73E+01	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Total					2.51E+01

BERYLLIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.00E-01							9.87E-04		1.00E+00	8.00E-01	7.90E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.00E-03				1.47E-04					1.00E+00	8.00E-01	1.17E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

CADMIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.12E+01							5.53E-02		1.00E+00	8.00E-01	4.42E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.16E+00				4.52E-01					1.00E+00	8.00E-01	3.62E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

BERYLLIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.00E-01	7.90E-04	6.60E-02	1.20E-02	
Water	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Food	2.00E-03	1.17E-04	6.60E-02	1.78E-03	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Total					1.37E-02

CADMIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.12E+01	4.42E-02	2.52E-02	1.76E+00	
Water	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Food	6.16E+00	3.62E-01	2.52E-02	1.44E+01	
Inhalation					
Air	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Total					1.61E+01

CHROMIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.84E+02							9.08E-01		1.00E+00	8.00E-01	7.27E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.38E+00				1.01E-01					1.00E+00	8.00E-01	8.10E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

COBALT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.60E+00							2.27E-02		1.00E+00	8.00E-01	1.82E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.20E-02				6.75E-03					1.00E+00	8.00E-01	5.40E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

CHROMIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.84E+02	7.27E-01	4.60E-02	1.58E+01	
Water	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Food	1.38E+00	8.10E-02	4.60E-02	1.76E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Total					1.76E+01

COBALT	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.60E+00	1.82E-02	1.57E-01	1.16E-01	
Water	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Food	9.20E-02	5.40E-03	1.57E-01	3.44E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Total					1.50E-01

COPPER	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.07E+02							2.01E+00		1.00E+00	8.00E-01	1.61E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.63E+02				1.20E+01					1.00E+00	8.00E-01	9.56E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

LEAD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.40E+02							3.65E+00		1.00E+00	8.00E-01	2.92E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.33E+01				2.44E+00					1.00E+00	8.00E-01	1.96E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

COPPER	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.07E+02	1.61E+00	6.60E+00	2.44E-01	
Water	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Food	1.63E+02	9.56E+00	6.60E+00	1.45E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Total					1.69E+00

LEAD	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.40E+02	2.92E+00	8.00E-01	3.65E+00	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	3.33E+01	1.96E+00	8.00E-01	2.44E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					6.10E+00

MANGANESE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.67E+02							2.31E+00		1.00E+00	8.00E-01	1.84E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.17E+02				8.57E+00					1.00E+00	8.00E-01	6.86E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

MERCURY	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.20E+00							3.06E-02		1.00E+00	8.00E-01	2.45E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.58E+00				4.10E-01					1.00E+00	8.00E-01	3.28E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

MANGANESE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.67E+02	1.84E+00	8.80E+00	2.10E-01	
Water	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Food	1.17E+02	6.86E+00	8.80E+00	7.79E-01	
Inhalation					
Air	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Total					9.89E-01

MERCURY	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.20E+00	2.45E-02	1.32E+00	1.85E-02	
Water	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Food	5.58E+00	3.28E-01	1.32E+00	2.48E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Total					2.67E-01

NICKEL	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	5.02E+01							2.48E-01		1.00E+00	8.00E-01	1.98E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.01E+00				2.21E-01					1.00E+00	8.00E-01	1.77E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

SELENIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.10E-01							3.01E-03		1.00E+00	8.00E-01	2.41E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.53E-02				1.12E-03					1.00E+00	8.00E-01	8.96E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

NICKEL	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.02E+01	1.98E-01	4.00E+00	4.96E-02	
Water	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Food	3.01E+00	1.77E-01	4.00E+00	4.42E-02	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Total					9.38E-02

SELENIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.10E-01	2.41E-03	7.50E-02	3.21E-02	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	1.53E-02	8.96E-04	7.50E-02	1.19E-02	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					4.41E-02

SILVER	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.60E+00							3.75E-02		1.00E+00	8.00E-01	3.00E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.04E+00				2.23E-01					1.00E+00	8.00E-01	1.79E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

TIN	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.18E+01							5.82E-02		1.00E+00	8.00E-01	4.66E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.54E-01				2.60E-02					1.00E+00	8.00E-01	2.08E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

SILVER	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.60E+00	3.00E-02	1.81E-02	1.66E+00	
Water	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Food	3.04E+00	1.79E-01	1.81E-02	9.86E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Total					1.15E+01

TIN	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.18E+01	4.66E-02	5.00E-02	9.32E-01	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	3.54E-01	2.08E-02	5.00E-02	4.16E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					1.35E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

VANADIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.11E+01							5.48E-02		1.00E+00	8.00E-01	4.38E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.11E-02				4.48E-03					1.00E+00	8.00E-01	3.59E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ZINC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	8.70E+02							4.29E+00		1.00E+00	8.00E-01	3.43E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.30E+03				9.57E+01					1.00E+00	8.00E-01	7.66E+01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

VANADIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.11E+01	4.38E-02	1.14E+00	3.84E-02	
Water	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Food	6.11E-02	3.59E-03	1.14E+00	3.15E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Total					4.16E-02

ZINC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.70E+02	3.43E+00	1.60E+01	2.15E-01	
Water	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Food	1.30E+03	7.66E+01	1.60E+01	4.79E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Total					5.00E+00

2-BUTANONE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.20E-02							1.58E-04		1.00E+00	8.00E-01	1.26E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.54E-01				1.13E-02					1.00E+00	8.00E-01	9.06E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.40E+00							6.91E-03		1.00E+00	8.00E-01	5.53E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.45E-02				4.74E-03					1.00E+00	8.00E-01	3.79E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

2-BUTANONE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.20E-02	1.26E-04	1.77E+01	7.14E-06	
Water	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Food	1.54E-01	9.06E-03	1.77E+01	5.12E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Total					5.19E-04

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	5.53E-03	8.00E-02	6.91E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	6.45E-02	3.79E-03	8.00E-02	4.74E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.16E-01

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.73E+00							8.54E-03		1.00E+00	8.00E-01	6.83E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.13E-02				1.56E-03					1.00E+00	8.00E-01	1.25E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.70E+00							2.32E-02		1.00E+00	8.00E-01	1.86E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.22E-02				4.56E-03					1.00E+00	8.00E-01	3.65E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.73E+00	6.83E-03	8.00E-02	8.54E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	2.13E-02	1.25E-03	8.00E-02	1.56E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.01E-01

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.70E+00	1.86E-02	8.00E-02	2.32E-01	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	6.22E-02	3.65E-03	8.00E-02	4.56E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					2.78E-01

Dose Calculations for Individual Contaminants - Maximum Concentration

ACETONE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.30E-01							1.14E-03		1.00E+00	8.00E-01	9.08E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.32E+00				2.44E-01					1.00E+00	8.00E-01	1.95E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ANTHRACENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.80E-01							1.38E-03		1.00E+00	8.00E-01	1.11E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.72E-03				3.47E-04					1.00E+00	8.00E-01	2.77E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

ACETONE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.30E-01	9.08E-04	1.00E+01	9.08E-05	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	3.32E+00	1.95E-01	1.00E+01	1.95E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					1.96E-02

ANTHRACENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.80E-01	1.11E-03	1.00E+00	1.11E-03	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	4.72E-03	2.77E-04	1.00E+00	2.77E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					1.38E-03

AROCLOR-1260	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.00E-01							4.44E-03		1.00E+00	8.00E-01	3.55E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.36E-02				9.96E-04					1.00E+00	8.00E-01	7.97E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

BENZO(A)PYRENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.19E+00							1.08E-02		1.00E+00	8.00E-01	8.63E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.83E-02				6.48E-03					1.00E+00	8.00E-01	5.19E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

AROCLOR-1260	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.00E-01	3.55E-03	1.35E-02	2.63E-01	
Water	0.00E+00	0.00E+00	1.35E-02	0.00E+00	
Food	1.36E-02	7.97E-04	1.35E-02	5.90E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.35E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.35E-02	0.00E+00	
Total					3.22E-01

BENZO(A)PYRENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.19E+00	8.63E-03	1.00E-02	8.63E-01	
Water	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Food	8.83E-02	5.19E-03	1.00E-02	5.19E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Total					1.38E+00

BIS(2-ETHYLHEXYL)PHTHALA	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.20E+00							1.09E-02		1.00E+00	8.00E-01	8.69E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.14E-02				1.57E-03					1.00E+00	8.00E-01	1.26E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

CHLORODIBROMOMETHANE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.40E-04							2.17E-06		1.00E+00	8.00E-01	1.74E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.94E-05				5.83E-06					1.00E+00	8.00E-01	4.67E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

BIS(2-ETHYLHEXYL)PHTHALATE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.20E+00	8.69E-03	1.83E+00	4.75E-03	
Water	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Food	2.14E-02	1.26E-03	1.83E+00	6.86E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Total					5.43E-03

CHLORODIBROMOMETHANE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.40E-04	1.74E-06	3.00E-01	5.79E-06	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	7.94E-05	4.67E-06	3.00E-01	1.56E-05	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					2.13E-05

DI-N-BUTYL PHTHALATE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.30E-01							1.14E-03		1.00E+00	8.00E-01	9.08E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.09E-04				5.20E-05					1.00E+00	8.00E-01	4.16E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ENDRIN	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.97E-02							9.72E-05		1.00E+00	8.00E-01	7.78E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.79E-04				2.78E-05					1.00E+00	8.00E-01	2.23E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

DI-N-BUTYL PHTHALATE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.30E-01	9.08E-04	5.50E+01	1.65E-05	
Water	0.00E+00	0.00E+00	5.50E+01	0.00E+00	
Food	7.09E-04	4.16E-05	5.50E+01	7.57E-07	
Inhalation					
Air	0.00E+00	0.00E+00	5.50E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.50E+01	0.00E+00	
Total					1.73E-05

ENDRIN	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.97E-02	7.78E-05	9.20E-03	8.46E-03	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	3.79E-04	2.23E-05	9.20E-03	2.42E-03	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					1.09E-02

ENDRIN ALDEHYDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.50E-02							2.22E-04		1.00E+00	8.00E-01	1.78E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.66E-04				6.36E-05					1.00E+00	8.00E-01	5.09E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ETHYLBENZENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.00E-03							9.87E-06		1.00E+00	8.00E-01	7.90E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.97E-05				6.58E-06					1.00E+00	8.00E-01	5.27E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ENDRIN ALDEHYDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.50E-02	1.78E-04	9.20E-03	1.93E-02	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	8.66E-04	5.09E-05	9.20E-03	5.53E-03	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					2.48E-02

ETHYLBENZENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.00E-03	7.90E-06	4.08E-01	1.94E-05	
Water	0.00E+00	0.00E+00	4.08E-01	0.00E+00	
Food	8.97E-05	5.27E-06	4.08E-01	1.29E-05	
Inhalation					
Air	0.00E+00	0.00E+00	4.08E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.08E-01	0.00E+00	
Total					3.23E-05

FLUORANTHENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.10E+00							3.50E-02		1.00E+00	8.00E-01	2.80E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.13E-02				6.71E-03					1.00E+00	8.00E-01	5.37E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

HEXACHLOROPHENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	8.90E-01							4.39E-03		1.00E+00	8.00E-01	3.51E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.47E-03				4.02E-04					1.00E+00	8.00E-01	3.21E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

FLUORANTHENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.10E+00	2.80E-02	1.25E+01	2.24E-03	
Water	0.00E+00	0.00E+00	1.25E+01	0.00E+00	
Food	9.13E-02	5.37E-03	1.25E+01	4.29E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E+01	0.00E+00	
Total					2.67E-03

HEXACHLOROPHENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.90E-01	3.51E-03	1.00E-01	3.51E-02	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	5.47E-03	3.21E-04	1.00E-01	3.21E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					3.84E-02

METHYLENE CHLORIDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.00E-02							3.46E-04		1.00E+00	8.00E-01	2.76E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.54E-02				4.07E-03					1.00E+00	8.00E-01	3.25E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

PYRENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.29E+00							3.10E-02		1.00E+00	8.00E-01	2.48E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.99E-02				5.87E-03					1.00E+00	8.00E-01	4.69E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

METHYLENE CHLORIDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-02	2.76E-04	5.00E-02	5.53E-03	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	5.54E-02	3.25E-03	5.00E-02	6.51E-02	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					7.06E-02

PYRENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.29E+00	2.48E-02	7.50E-02	3.31E-01	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	7.99E-02	4.69E-03	7.50E-02	6.26E-02	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					3.94E-01

TOLUENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.00E-03							3.46E-05		1.00E+00	8.00E-01	2.76E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.41E-04				1.77E-05					1.00E+00	8.00E-01	1.42E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

XYLENES, TOTAL	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.00E-03							3.46E-05		1.00E+00	8.00E-01	2.76E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.36E-05				5.40E-06					1.00E+00	8.00E-01	4.32E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

TOLUENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-03	2.76E-05	2.60E+01	1.06E-06	
Water	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Food	2.41E-04	1.42E-05	2.60E+01	5.45E-07	
Inhalation					
Air	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Total					1.61E-06

XYLENES, TOTAL	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-03	2.76E-05	2.06E-01	1.34E-04	
Water	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Food	7.36E-05	4.32E-06	2.06E-01	2.10E-05	
Inhalation					
Air	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Total					1.55E-04

DOSE CALCULATIONS FOR THE LOWER KEYS MARSH RABBIT

SWMU 1

MEAN CONTAMINANT CONCENTRATIONS

Predicted Chemical Concentration by Media (mg/kg)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
ALUMINUM	4032.000000	0.00E+00	0.00E+00	1.61E+01	0.00E+00	0.00E+00
ANTIMONY	4.500000	0.00E+00	0.00E+00	9.00E-02	0.00E+00	0.00E+00
ARSENIC	3.090000	0.00E+00	0.00E+00	1.24E-01	0.00E+00	0.00E+00
BARIUM	30.650000	0.00E+00	0.00E+00	4.60E+00	0.00E+00	0.00E+00
BERYLLIUM	0.090000	0.00E+00	0.00E+00	9.00E-04	0.00E+00	0.00E+00
CADMIUM	3.170000	0.00E+00	0.00E+00	1.74E+00	0.00E+00	0.00E+00
CHROMIUM	32.910000	0.00E+00	0.00E+00	2.47E-01	0.00E+00	0.00E+00
COBALT	1.510000	0.00E+00	0.00E+00	3.02E-02	0.00E+00	0.00E+00
COPPER	95.660000	0.00E+00	0.00E+00	3.83E+01	0.00E+00	0.00E+00
LEAD	111.200000	0.00E+00	0.00E+00	5.00E+00	0.00E+00	0.00E+00
MANGANESE	107.130000	0.00E+00	0.00E+00	2.68E+01	0.00E+00	0.00E+00
MERCURY	0.890000	0.00E+00	0.00E+00	8.01E-01	0.00E+00	0.00E+00
NICKEL	11.480000	0.00E+00	0.00E+00	6.89E-01	0.00E+00	0.00E+00
SELENIUM	0.570000	0.00E+00	0.00E+00	1.43E-02	0.00E+00	0.00E+00
SILVER	2.670000	0.00E+00	0.00E+00	1.07E+00	0.00E+00	0.00E+00
TIN	7.780000	0.00E+00	0.00E+00	2.33E-01	0.00E+00	0.00E+00
VANADIUM	6.740000	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00
ZINC	300.260000	0.00E+00	0.00E+00	4.50E+02	0.00E+00	0.00E+00
2-BUTANONE	0.009660	0.00E+00	0.00E+00	4.66E-02	0.00E+00	0.00E+00
4,4'-DDD	0.234700	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00
4,4'-DDE	0.322000	0.00E+00	0.00E+00	3.97E-03	0.00E+00	0.00E+00
4,4'-DDT	0.792000	0.00E+00	0.00E+00	1.05E-02	0.00E+00	0.00E+00
ACETONE	0.044000	0.00E+00	0.00E+00	6.36E-01	0.00E+00	0.00E+00
ANTHRACENE	0.739000	0.00E+00	0.00E+00	1.25E-02	0.00E+00	0.00E+00
AROCLOR-1260	0.526000	0.00E+00	0.00E+00	7.93E-03	0.00E+00	0.00E+00
BENZO(A)PYRENE	0.904000	0.00E+00	0.00E+00	3.65E-02	0.00E+00	0.00E+00
BIS(2-ETHYLHEXYL)PHTHALA	0.687000	0.00E+00	0.00E+00	6.68E-03	0.00E+00	0.00E+00
CHLORODIBROMOMETHANE	0.002960	0.00E+00	0.00E+00	5.34E-04	0.00E+00	0.00E+00
DI-N-BUTYL PHTHALATE	0.661000	0.00E+00	0.00E+00	2.04E-03	0.00E+00	0.00E+00
ENDRIN	0.074880	0.00E+00	0.00E+00	1.44E-03	0.00E+00	0.00E+00
ENDRIN ALDEHYDE	0.087760	0.00E+00	0.00E+00	1.69E-03	0.00E+00	0.00E+00
ETHYLBENZENE	0.002930	0.00E+00	0.00E+00	1.31E-04	0.00E+00	0.00E+00
FLUORANTHENE	1.404000	0.00E+00	0.00E+00	1.81E-02	0.00E+00	0.00E+00
HEXACHLOROPHENE	4.588000	0.00E+00	0.00E+00	2.82E-02	0.00E+00	0.00E+00
METHYLENE CHLORIDE	0.012250	0.00E+00	0.00E+00	9.70E-03	0.00E+00	0.00E+00
PYRENE	1.395000	0.00E+00	0.00E+00	1.77E-02	0.00E+00	0.00E+00
TOLUENE	0.004090	0.00E+00	0.00E+00	1.41E-04	0.00E+00	0.00E+00
XYLENES, TOTAL	0.004530	0.00E+00	0.00E+00	4.76E-05	0.00E+00	0.00E+00

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN VEGETATION (PAGE TWO)
MCAS, Key West - SWMU 1 mean
EXPOSURE SCENARIO: CALCULATE VEGETATION CONCENTRATIONS BASED MEASURED SOIL CONCENTRATIONS (ACTUAL)

copy
to
ecomodel

CALCULATE CONCENTRATION IN SOIL:

CHEMICAL	GROUND LEVEL CONCENTRATION (UG/M3)	DAILY DEPOSITION ON VEGETATION (MG/M2/DAY)	LAMBDA-C (1/DAY)	X	SOIL CONC. (MG/KG)	Koc	Kow	UPTAKE FACTOR TRANSLOCATION	VEG CON TRANSLOC (MG/KG)
Aluminum	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4032.000000			4.00E-03	1.61E+01
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.500000			2.00E-02	9.00E-02
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.090000			4.00E-02	1.24E-01
Barium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	30.650000			1.50E-01	4.60E+00
Beryllium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.090000			1.00E-02	9.00E-04
Cadmium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.170000			5.50E-01	1.74E+00
Chromium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	32.910000			7.50E-03	2.47E-01
Cobalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.510000			2.00E-02	3.02E-02
Copper	0.00E+00	0.00E+00	0.00E+00	0.00E+00	95.660000			4.00E-01	3.83E+01
Lead	0.00E+00	0.00E+00	0.00E+00	0.00E+00	111.200000			4.50E-02	5.00E+00
Manganese	0.00E+00	0.00E+00	0.00E+00	0.00E+00	107.130000			2.50E-01	2.68E+01
Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.890000			9.00E-01	8.01E-01
Nickel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	11.480000			6.00E-02	6.89E-01
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.570000			2.50E-02	1.43E-02
Silver	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.670000			4.00E-01	1.07E+00
Tin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.780000			3.00E-02	2.33E-01
Vanadium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.740000			5.50E-03	3.71E-02
Zinc	0.00E+00	0.00E+00	0.00E+00	0.00E+00	300.260000			1.50E+00	4.50E+02
2-Butanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.009660	1.80E+00	1.82E+00	4.82E+00	4.66E-02
4,4'-DDD	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.234700	2.82E+05	1.05E+06	4.61E-02	1.08E-02
4,4'-DDE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.322000	2.51E+06	3.24E+06	1.23E-02	3.97E-03
4,4'-DDT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.792000	1.79E+06	2.29E+06	1.32E-02	1.05E-02
Acetone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.044000	5.81E-01	5.75E-01	1.45E+01	6.36E-01
Anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.739000	2.82E+04	1.40E+04	1.69E-02	1.25E-02
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.526000	1.01E+06	1.29E+06	1.51E-02	7.93E-03
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.904000	1.15E+06	5.50E+06	4.04E-02	3.65E-02
Bis(2-ethylhexyl)phthalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.687000	1.29E+05	5.00E+04	9.72E-03	6.68E-03
Chlorodibromomethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.002960	1.13E+02	1.23E+02	1.81E-01	5.34E-04
Di-n-butylphthalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.661000	5.25E+04	3.30E+03	3.08E-03	2.04E-03
Endrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.074880	3.20E+05	3.98E+05	1.93E-02	1.44E-03
Endrin Aldehyde	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.087760	3.20E+05	3.98E+05	1.93E-02	1.69E-03
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.002930	1.41E+03	8.70E+02	4.48E-02	1.31E-04
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.404000	7.90E+04	3.80E+04	1.29E-02	1.81E-02
Hexachlorophene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.588000	2.04E+05	5.00E+04	6.15E-03	2.82E-02
Methylene chloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.012250	1.78E+01	4.78E+01	7.92E-01	9.70E-03
Pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.395000	8.00E+04	3.80E+04	1.27E-02	1.77E-02
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.004090	5.40E+02	1.00E+02	3.44E-02	1.41E-04
Xylenes	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.004530	1.43E+03	5.80E+01	1.05E-02	4.76E-05

NOTE: THIS PAGE IS NOT NECESSARY FOR CALCULATIONS AT KEY WEST

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN VEGETATION (PAGE THREE)
MCAS, Key West - SWMU 1 mean

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL
EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL

RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
ALUMINUM			3.18E+00
ANTIMONY			1.42E+01
ARSENIC			9.68E-01
BARIUM			2.39E+00
BERYLLIUM			5.38E-03
CADMIUM			4.97E-01
CHROMIUM			2.83E+00
COBALT			3.80E-02
COPPER			5.72E-02
LEAD			5.49E-01
MANGANESE			4.81E-02
MERCURY			2.66E-03
NICKEL			1.13E-02
SELENIUM			3.00E-02
SILVER			5.83E-01
TIN			6.14E-01
VANADIUM			2.33E-02
ZINC			7.41E-02
2-BUTANONE			2.16E-06
4,4'-DDD			1.16E-02
4,4'-DDE			1.59E-02
4,4'-DDT			3.91E-02
ACETONE			1.74E-05
ANTHRACENE			2.92E-03
AROCLOR-1260			1.54E-01
BENZO(A)PYRENE			3.57E-01
BIS(2-ETHYLHEXYL)PHTHALATE			1.48E-03
CHLORODIBROMOMETHANE			3.90E-05
DI-N-BUTYL PHTHALATE			2.14E-04
ENDRIN			4.75E-05
ENDRIN ALDEHYDE			3.21E-02
ETHYLBENZENE			3.77E-02
FLUORANTHENE			2.84E-05
HEXACHLOROPHENE			4.44E-04
METHYLENE CHLORIDE			1.81E-01
PYRENE			9.67E-04
TOLUENE			7.34E-02
XYLENES, TOTAL			6.21E-07
TOTAL			2.70E+01

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD
EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL

RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
ALUMINUM			1.89E-01
ANTIMONY			4.23E+00
ARSENIC			5.76E-01
BARIUM			5.34E+00
BERYLLIUM			8.01E-04
CADMIUM			4.06E+00
CHROMIUM			3.15E-01
COBALT			1.13E-02
COPPER			3.40E-01
LEAD			3.67E-01
MANGANESE			1.79E-01
MERCURY			3.56E-02
NICKEL			1.01E-02
SELENIUM			1.12E-02
SILVER			3.47E+00
TIN			2.74E-01
VANADIUM			1.91E-03
ZINC			1.65E+00
2-BUTANONE			1.54E-04
4,4'-DDD			7.94E-03
4,4'-DDE			2.91E-03
4,4'-DDT			7.69E-03
ACETONE			3.73E-03
ANTHRACENE			7.32E-04
AROCLOR-1260			3.45E-02
BENZO(A)PYRENE			2.15E-01
BIS(2-ETHYLHEXYL)PHTHALATE			2.14E-04
CHLORODIBROMOMETHANE			1.05E-04
DI-N-BUTYL PHTHALATE			2.18E-06
ENDRIN			9.20E-03
ENDRIN ALDEHYDE			1.08E-02
ETHYLBENZENE			1.89E-05
FLUORANTHENE			8.49E-05
HEXACHLOROPHENE			1.66E-02
METHYLENE CHLORIDE			1.14E-02
PYRENE			1.39E-02
TOLUENE			3.18E-07
XYLENES, TOTAL			1.36E-05
TOTAL			2.14E+01

Dose Calculations for Individual Contaminants - Mean Concentration

ALUMINUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.03E+03							1.99E+01		1.00E+00	8.00E-01	1.59E+01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.61E+01				1.18E+00					1.00E+00	8.00E-01	9.47E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ANTIMONY	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.50E+00							2.22E-02		1.00E+00	8.00E-01	1.78E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.00E-02				6.61E-03					1.00E+00	8.00E-01	5.29E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

ALUMINUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.03E+03	1.59E+01	5.00E+00	3.18E+00	
Water	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Food	1.61E+01	9.47E-01	5.00E+00	1.89E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Total					3.37E+00

ANTIMONY	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.50E+00	1.78E-02	1.25E-03	1.42E+01	
Water	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Food	9.00E-02	5.29E-03	1.25E-03	4.23E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Total					1.84E+01

Dose Calculations for Individual Contaminants - Mean Concentration

ARSENIC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.09E+00							1.53E-02		1.00E+00	8.00E-01	1.22E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.24E-01				9.07E-03					1.00E+00	8.00E-01	7.26E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

BARIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.07E+01							1.51E-01		1.00E+00	8.00E-01	1.21E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.60E+00				3.38E-01					1.00E+00	8.00E-01	2.70E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

ARSENIC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.09E+00	1.22E-02	1.26E-02	9.68E-01	
Water	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Food	1.24E-01	7.26E-03	1.26E-02	5.76E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Total					1.54E+00

BARIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.07E+01	1.21E-01	5.06E-02	2.39E+00	
Water	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Food	4.60E+00	2.70E-01	5.06E-02	5.34E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Total					7.73E+00

Dose Calculations for Individual Contaminants - Mean Concentration

BERYLLIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.00E-02							4.44E-04		1.00E+00	8.00E-01	3.55E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.00E-04				6.61E-05					1.00E+00	8.00E-01	5.29E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

CADMIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.17E+00							1.56E-02		1.00E+00	8.00E-01	1.25E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.74E+00				1.28E-01					1.00E+00	8.00E-01	1.02E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

BERYLLIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.00E-02	3.55E-04	6.60E-02	5.38E-03	
Water	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Food	9.00E-04	5.29E-05	6.60E-02	8.01E-04	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Total					6.19E-03

CADMIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.17E+00	1.25E-02	2.52E-02	4.97E-01	
Water	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Food	1.74E+00	1.02E-01	2.52E-02	4.06E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Total					4.56E+00

Dose Calculations for Individual Contaminants - Mean Concentration

CHROMIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.29E+01							1.62E-01		1.00E+00	8.00E-01	1.30E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.47E-01				1.81E-02					1.00E+00	8.00E-01	1.45E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

COBALT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.51E+00							7.45E-03		1.00E+00	8.00E-01	5.96E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.02E-02				2.22E-03					1.00E+00	8.00E-01	1.77E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

CHROMIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.29E+01	1.30E-01	4.60E-02	2.83E+00	
Water	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Food	2.47E-01	1.45E-02	4.60E-02	3.15E-01	
Inhalation					
Air	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Total					3.14E+00

COBALT	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.51E+00	5.96E-03	1.57E-01	3.80E-02	
Water	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Food	3.02E-02	1.77E-03	1.57E-01	1.13E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Total					4.93E-02

Dose Calculations for Individual Contaminants - Mean Concentration

COPPER	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.57E+01							4.72E-01		1.00E+00	8.00E-01	3.78E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.83E+01				2.81E+00					1.00E+00	8.00E-01	2.25E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

LEAD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.11E+02							5.49E-01		1.00E+00	8.00E-01	4.39E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.00E+00				3.67E-01					1.00E+00	8.00E-01	2.94E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

COPPER	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.57E+01	3.78E-01	6.60E+00	5.72E-02	
Water	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Food	3.83E+01	2.25E+00	6.60E+00	3.40E-01	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Total					3.98E-01

LEAD	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.11E+02	4.39E-01	8.00E-01	5.49E-01	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	5.00E+00	2.94E-01	8.00E-01	3.67E-01	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					9.16E-01

Dose Calculations for Individual Contaminants - Mean Concentration

MANGANESE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.07E+02							5.29E-01		1.00E+00	8.00E-01	4.23E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.68E+01				1.97E+00					1.00E+00	8.00E-01	1.57E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

MERCURY	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	8.90E-01							4.39E-03		1.00E+00	8.00E-01	3.51E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.01E-01				5.88E-02					1.00E+00	8.00E-01	4.70E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

MANGANESE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.07E+02	4.23E-01	8.80E+00	4.81E-02	
Water	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Food	2.68E+01	1.57E+00	8.80E+00	1.79E-01	
Inhalation					
Air	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Total					2.27E-01

MERCURY	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.90E-01	3.51E-03	1.32E+00	2.66E-03	
Water	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Food	8.01E-01	4.70E-02	1.32E+00	3.56E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Total					3.83E-02

Dose Calculations for Individual Contaminants - Mean Concentration

NICKEL	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.15E+01							5.67E-02		1.00E+00	8.00E-01	4.53E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.89E-01				5.06E-02					1.00E+00	8.00E-01	4.05E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

SELENIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	5.70E-01							2.81E-03		1.00E+00	8.00E-01	2.25E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.43E-02				1.05E-03					1.00E+00	8.00E-01	8.37E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

NICKEL	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.15E+01	4.53E-02	4.00E+00	1.13E-02	
Water	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Food	6.89E-01	4.05E-02	4.00E+00	1.01E-02	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Total					2.14E-02

SELENIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.70E-01	2.25E-03	7.50E-02	3.00E-02	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	1.43E-02	8.37E-04	7.50E-02	1.12E-02	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					4.12E-02

SILVER	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.67E+00							1.32E-02		1.00E+00	8.00E-01	1.05E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.07E+00				7.84E-02					1.00E+00	8.00E-01	6.27E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

TIN	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.78E+00							3.84E-02		1.00E+00	8.00E-01	3.07E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.33E-01				1.71E-02					1.00E+00	8.00E-01	1.37E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

SILVER	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.67E+00	1.05E-02	1.81E-02	5.83E-01	
Water	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Food	1.07E+00	6.27E-02	1.81E-02	3.47E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Total					4.05E+00

TIN	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.78E+00	3.07E-02	5.00E-02	6.14E-01	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	2.33E-01	1.37E-02	5.00E-02	2.74E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					8.89E-01

VANADIUM	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.74E+00							3.33E-02		1.00E+00	8.00E-01	2.66E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.71E-02				2.72E-03					1.00E+00	8.00E-01	2.18E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ZINC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.00E+02							1.48E+00		1.00E+00	8.00E-01	1.19E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.50E+02				3.31E+01					1.00E+00	8.00E-01	2.65E+01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

VANADIUM	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.74E+00	2.66E-02	1.14E+00	2.33E-02	
Water	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Food	3.71E-02	2.18E-03	1.14E+00	1.91E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Total					2.53E-02

ZINC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E+02	1.19E+00	1.60E+01	7.41E-02	
Water	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Food	4.50E+02	2.65E+01	1.60E+01	1.65E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Total					1.73E+00

Dose Calculations for Individual Contaminants - Mean Concentration

2-BUTANONE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.66E-03							4.77E-05		1.00E+00	8.00E-01	3.81E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.66E-02				3.42E-03					1.00E+00	8.00E-01	2.73E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.35E-01							1.16E-03		1.00E+00	8.00E-01	9.27E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.08E-02				7.94E-04					1.00E+00	8.00E-01	6.35E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

2-BUTANONE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.66E-03	3.81E-05	1.77E+01	2.16E-06	
Water	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Food	4.66E-02	2.73E-03	1.77E+01	1.54E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Total					1.57E-04

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.35E-01	9.27E-04	8.00E-02	1.16E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	1.08E-02	6.35E-04	8.00E-02	7.94E-03	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.95E-02

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.22E-01							1.59E-03		1.00E+00	8.00E-01	1.27E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.97E-03				2.91E-04					1.00E+00	8.00E-01	2.33E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.92E-01							3.91E-03		1.00E+00	8.00E-01	3.13E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.05E-02				7.69E-04					1.00E+00	8.00E-01	6.15E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.22E-01	1.27E-03	8.00E-02	1.59E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	3.97E-03	2.33E-04	8.00E-02	2.91E-03	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.88E-02

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.92E-01	3.13E-03	8.00E-02	3.91E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	1.05E-02	6.15E-04	8.00E-02	7.69E-03	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					4.68E-02

ACETONE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.40E-02							2.17E-04		1.00E+00	8.00E-01	1.74E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.36E-01				4.67E-02					1.00E+00	8.00E-01	3.73E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ANTHRACENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.39E-01							3.65E-03		1.00E+00	8.00E-01	2.92E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.25E-02				9.15E-04					1.00E+00	8.00E-01	7.32E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

ACETONE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.40E-02	1.74E-04	1.00E+01	1.74E-05	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	6.36E-01	3.73E-02	1.00E+01	3.73E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					3.75E-03

ANTHRACENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.39E-01	2.92E-03	1.00E+00	2.92E-03	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	1.25E-02	7.32E-04	1.00E+00	7.32E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					3.65E-03

AROCLOR-1260	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	5.26E-01							2.60E-03		1.00E+00	8.00E-01	2.08E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.93E-03				5.82E-04					1.00E+00	8.00E-01	4.66E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

BENZO(A)PYRENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.04E-01							4.46E-03		1.00E+00	8.00E-01	3.57E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.65E-02				2.68E-03					1.00E+00	8.00E-01	2.15E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

AROCLOR-1260	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.26E-01	2.08E-03	1.35E-02	1.54E-01	
Water	0.00E+00	0.00E+00	1.35E-02	0.00E+00	
Food	7.93E-03	4.66E-04	1.35E-02	3.45E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.35E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.35E-02	0.00E+00	
Total					1.88E-01

BENZO(A)PYRENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.04E-01	3.57E-03	1.00E-02	3.57E-01	
Water	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Food	3.65E-02	2.15E-03	1.00E-02	2.15E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Total					5.72E-01

BIS(2-ETHYLHEXYL)PHTHALA	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.87E-01							3.39E-03		1.00E+00	8.00E-01	2.71E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.68E-03				4.90E-04					1.00E+00	8.00E-01	3.92E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

CHLORODIBROMOMETHANE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.96E-03							1.46E-05		1.00E+00	8.00E-01	1.17E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.34E-04				3.92E-05					1.00E+00	8.00E-01	3.14E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

BIS(2-ETHYLHEXYL)PHTHALATE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.87E-01	2.71E-03	1.83E+00	1.48E-03	
Water	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Food	6.68E-03	3.92E-04	1.83E+00	2.14E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Total					1.70E-03

CHLORODIBROMOMETHANE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.96E-03	1.17E-05	3.00E-01	3.90E-05	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	5.34E-04	3.14E-05	3.00E-01	1.05E-04	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					1.44E-04

DI-N-BUTYL PHTHALATE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.61E-01							3.26E-03		1.00E+00	8.00E-01	2.61E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.04E-03				1.50E-04					1.00E+00	8.00E-01	1.20E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ENDRIN	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.49E-02							3.70E-04		1.00E+00	8.00E-01	2.96E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.44E-03				1.06E-04					1.00E+00	8.00E-01	8.47E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

DI-N-BUTYL PHTHALATE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.61E-01	2.61E-03	5.50E+01	4.75E-05	
Water	0.00E+00	0.00E+00	5.50E+01	0.00E+00	
Food	2.04E-03	1.20E-04	5.50E+01	2.18E-06	
Inhalation					
Air	0.00E+00	0.00E+00	5.50E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.50E+01	0.00E+00	
Total					4.96E-05

ENDRIN	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.49E-02	2.96E-04	9.20E-03	3.21E-02	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	1.44E-03	8.47E-05	9.20E-03	9.20E-03	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					4.13E-02

ENDRIN ALDEHYDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	8.78E-02							4.33E-04		1.00E+00	8.00E-01	3.47E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.69E-03				1.24E-04					1.00E+00	8.00E-01	9.92E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ETHYLBENZENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.93E-03							1.45E-05		1.00E+00	8.00E-01	1.16E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.31E-04				9.65E-06					1.00E+00	8.00E-01	7.72E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

ENDRIN ALDEHYDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.78E-02	3.47E-04	9.20E-03	3.77E-02	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	1.69E-03	9.92E-05	9.20E-03	1.08E-02	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					4.85E-02

ETHYLBENZENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.93E-03	1.16E-05	4.08E-01	2.84E-05	
Water	0.00E+00	0.00E+00	4.08E-01	0.00E+00	
Food	1.31E-04	7.72E-06	4.08E-01	1.89E-05	
Inhalation					
Air	0.00E+00	0.00E+00	4.08E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.08E-01	0.00E+00	
Total					4.73E-05

FLUORANTHENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.40E+00							6.93E-03		1.00E+00	8.00E-01	5.54E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.81E-02				1.33E-03					1.00E+00	8.00E-01	1.06E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

HEXACHLOROPHENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.59E+00							2.26E-02		1.00E+00	8.00E-01	1.81E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.82E-02				2.07E-03					1.00E+00	8.00E-01	1.66E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

FLUORANTHENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	5.54E-03	1.25E+01	4.44E-04	
Water	0.00E+00	0.00E+00	1.25E+01	0.00E+00	
Food	1.81E-02	1.06E-03	1.25E+01	8.49E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E+01	0.00E+00	
Total					5.28E-04

HEXACHLOROPHENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.59E+00	1.81E-02	1.00E-01	1.81E-01	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	2.82E-02	1.66E-03	1.00E-01	1.66E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					1.98E-01

METHYLENE CHLORIDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.23E-02							6.05E-05		1.00E+00	8.00E-01	4.84E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.70E-03				7.12E-04					1.00E+00	8.00E-01	5.70E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

PYRENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.40E+00							6.89E-03		1.00E+00	8.00E-01	5.51E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.77E-02				1.30E-03					1.00E+00	8.00E-01	1.04E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

METHYLENE CHLORIDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.23E-02	4.84E-05	5.00E-02	9.67E-04	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	9.70E-03	5.70E-04	5.00E-02	1.14E-02	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					1.24E-02

PYRENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	5.51E-03	7.50E-02	7.34E-02	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	1.77E-02	1.04E-03	7.50E-02	1.39E-02	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					8.73E-02

TOLUENE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.09E-03							2.02E-05		1.00E+00	8.00E-01	1.62E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.41E-04				1.03E-05					1.00E+00	8.00E-01	8.27E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

XYLENES, TOTAL	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.53E-03							2.24E-05		1.00E+00	8.00E-01	1.79E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.76E-05				3.50E-06					1.00E+00	8.00E-01	2.80E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Mean Concentration

TOLUENE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.09E-03	1.62E-05	2.60E+01	6.21E-07	
Water	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Food	1.41E-04	8.27E-06	2.60E+01	3.18E-07	
Inhalation					
Air	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Total					9.39E-07

XYLENES, TOTAL	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.53E-03	1.79E-05	2.06E-01	8.68E-05	
Water	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Food	4.76E-05	2.80E-06	2.06E-01	1.36E-05	
Inhalation					
Air	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Total					1.00E-04

DOSE CALCULATIONS FOR THE LOWER KEYS MARSH RABBIT

SWMU 2

MAXIMUM CONTAMINANT CONCENTRATIONS

Predicted Chemical Concentration by Media (mg/kg) at SWMU 2				
Chemical	Maximum		Mean	
	Soil	Vegetation	Soil	Vegetation
Aluminum	6.14E+03	2.46E+01	2.83E+03	1.13E+01
Antimony	4.70E+00	9.40E-01	1.26E+00	2.52E-01
Arsenic	2.70E+00	1.08E-01	1.59E+00	6.35E-02
Barium	1.49E+01	2.24E+00	9.39E+00	1.41E+00
Beryllium	2.30E-01	2.30E-03	1.42E-01	1.42E-03
Cadmium	8.40E-01	4.62E-01	3.84E-01	2.11E-01
Chromium	1.16E+01	8.70E-02	6.67E+00	5.00E-02
Cobalt	5.50E-01	1.10E-02	6.40E-01	1.28E-02
Copper	7.60E+00	3.04E+00	3.54E+00	1.42E+00
Cyanide	1.80E+01	1.80E+01	1.23E+01	1.23E+01
Lead	5.54E+01	2.49E+00	1.56E+01	7.02E-01
Manganese	2.01E+01	5.03E+00	1.43E+01	3.58E+00
Mercury	5.50E-02	4.95E-02	2.08E-02	1.87E-02
Nickel	3.20E+00	1.92E-01	1.41E+00	8.44E-02
Selenium	6.18E+02	1.55E+01	1.03E+02	2.58E+00
Silver	1.50E-01	6.00E-02	1.76E-01	7.06E-02
Tin	6.20E+00	1.86E-01	2.11E+00	6.34E-02
Vanadium	7.00E+00	3.85E-02	3.09E+00	1.70E-02
Zinc	2.33E+01	3.50E+01	7.86E+00	1.18E+01
2-Butanone	3.00E-03	1.45E-02	6.00E-03	2.89E-02
4,4'-DDD	3.16E-01	1.46E-02	4.33E-01	2.00E-02
4,4'-DDE	1.16E+00	1.43E-02	2.21E-01	2.72E-03
4,4'-DDT	4.40E+00	5.82E-02	2.46E-01	3.25E-03
Acetone	4.70E-02	6.79E-01	1.71E-02	2.47E-01
Alpha BHC	1.00E-03	3.71E-05	1.46E-02	5.40E-04
Beta BHC	2.00E-03	9.71E-05	1.55E-02	7.52E-04
Bis(2-ethylhexyl)phthalate	3.10E-01	3.01E-03	2.55E-01	2.48E-03
cis-1,2-Dichloroethene	8.00E-03	4.04E-03	3.26E-03	1.65E-03
Delta BHC	1.00E-03	3.02E-05	1.55E-02	4.67E-04
Endosulfan I	2.00E-03	1.58E-04	1.56E-02	1.24E-03
Endosulfan II	7.00E-03	5.53E-04	3.14E-02	2.48E-03
Endosulfan sulfate	3.00E-03	1.56E-04	3.19E-02	1.66E-03
Endrin	7.00E-03	1.35E-04	2.94E-02	5.66E-04
Endrin Ketone	3.00E-03	5.78E-05	3.07E-02	5.91E-04
Gamma BHC	1.00E-03	5.02E-05	1.46E-02	7.32E-04
Heptachlor epoxide	1.60E-02	3.40E-04	1.75E-02	3.73E-04
Methoxychlor	9.00E-03	2.44E-04	1.56E-01	4.23E-03
Methylene chloride	2.70E-02	2.14E-02	1.02E-02	8.09E-03
Toxaphene	3.43E-01	3.86E-04	7.40E-01	8.34E-04
Aldrin	1.00E-03	6.39E-05	1.54E-02	9.84E-04

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN VEGETATION
MCAS, Key West - swmu 2 maximum
EXPOSURE SCENARIO: CALCULATE VEGETATION CONCENTRATIONS BASED MEASURED SOIL CONCENTRATIONS (ACTUAL)

CALCULATE CONCENTRATION IN VEGETATION:

CHEMICAL	SOIL CONC. (MG/KG)	Koc	Kow	UPTAKE FACTOR TRANSLOCATION	VEG CONC. TRANSLOCATION (MG/KG)
Aluminum	6140.00			4.00E-03	2.46E+01
Antimony	4.70			2.00E-01	9.40E-01
Arsenic	4.20			4.00E-02	1.68E-01
Barium	14.90			1.50E-01	2.24E+00
Beryllium	0.23			1.00E-02	2.30E-03
Cadmium	1.00			5.50E-01	5.50E-01
Chromium	11.60			7.50E-03	8.70E-02
Cobalt	0.55			2.00E-02	1.10E-02
Copper	8.00			4.00E-01	3.20E+00
Cyanide	18.00			1.00E+00	1.80E+01
Lead	55.40			4.50E-02	2.49E+00
Manganese	20.10			2.50E-01	5.03E+00
Mercury	0.06			9.00E-01	4.95E-02
Nickel	3.20			6.00E-02	1.92E-01
Selenium	1.20			2.50E-02	3.00E-02
Silver	0.15			4.00E-01	6.00E-02
Tin	6.20			3.00E-02	1.86E-01
Vanadium	7.00			5.50E-03	3.85E-02
Zinc	23.30			1.50E+00	3.50E+01
2-Butanone	0.003	1.80E+00	1.82E+00	4.82E+00	1.45E-02
4,4'-DDD	2.6	2.82E+05	1.05E+06	4.61E-02	1.20E-01
4,4'-DDE	4.9	2.51E+06	3.24E+06	1.23E-02	6.04E-02
4,4'-DDT	4.4	1.79E+06	2.29E+06	1.32E-02	5.82E-02
Acetone	0.047	5.81E-01	5.75E-01	1.45E+01	6.79E-01
Alpha BHC	0.001	6.31E+03	5.44E+03	3.71E-02	3.71E-05
Beta BHC	0.002	5.20E+03	6.03E+03	4.86E-02	9.71E-05
Bis(2-ethylhexyl)phthalate	0.31	1.29E+05	5.00E+04	9.72E-03	3.01E-03
cis-1,2-Dichloroethene	0.008	4.90E+01	1.83E+02	5.05E-01	4.04E-03
Delta BHC	0.002	1.38E+04	1.17E+04	3.02E-02	6.03E-05
Endosulfan I	0.009	2.43E+03	4.17E+03	7.91E-02	7.12E-04
Endosulfan II	0.007	2.43E+03	4.17E+03	7.91E-02	5.53E-04
Endosulfan sulfate	0.008	3.96E+03	4.57E+03	5.19E-02	4.15E-04
Endrin	0.142	3.20E+05	3.98E+05	1.93E-02	2.73E-03
Endrin Ketone	0.003	3.20E+05	3.98E+05	1.93E-02	5.78E-05
Gamma BHC	0.001	4.54E+03	5.25E+03	5.02E-02	5.02E-05
Heptachlor epoxide	0.034	2.03E+05	2.51E+05	2.13E-02	7.23E-04
Methoxychlor	0.104	6.71E+04	8.13E+04	2.71E-02	2.82E-03
Methylene chloride	0.027	1.78E+01	4.78E+01	7.92E-01	2.14E-02
Toxaphene	0.355	1.00E+05	2.00E+03	1.13E-03	4.00E-04
Aldrin	0.001	1.02E+03	9.10E+02	6.39E-02	6.39E-05

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION FOR EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
Aluminum			4.85E+00
Antimony			1.48E+01
Arsenic			8.46E-01
Barium			1.16E+00
Beryllium			1.38E-02
Cadmium			1.32E-01
Chromium			9.96E-01
Cobalt			1.38E-02
Copper			4.55E-03
Cyanide			1.03E-01
Lead			2.73E-01
Manganese			9.02E-03
Mercury			1.65E-04
Nickel			3.16E-03
Selenium			3.25E+01
Silver			3.27E-02
Tin			4.90E-01
Vanadium			2.42E-02
Zinc			5.75E-03
2-Butanone			6.69E-07
4,4'-DDD			1.56E-02
4,4'-DDE			5.73E-02
4,4'-DDT			2.17E-01
Acetone			1.86E-05
Alpha BHC			2.88E-03
Beta BHC			5.76E-03
Bis(2-ethylhexyl)phthalate			6.69E-04
cis-1,2-Dichloroethene			6.99E-06
Delta BHC			9.67E-05
Endosulfan I			2.88E-03
Endosulfan II			5.27E-04
Endosulfan sulfate			1.84E-03
Endrin			7.90E-04
Endrin Ketone			3.00E-03
Gamma BHC			1.29E-03
Heptachlor epoxide			4.94E-06
Methoxychlor			7.90E-04
Methylene chloride			8.88E-05
Toxaphene			2.13E-03
Aldrin			1.69E-03
TOTAL			5.67E+01

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION FOR EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
Aluminum			2.88E-01
Antimony			4.42E+01
Arsenic			5.03E-01
Barium			2.59E+00
Beryllium			2.05E-03
Cadmium			1.08E+00
Chromium			1.11E-01
Cobalt			4.11E-03
Copper			2.71E-02
Cyanide			1.54E+00
Lead			1.83E-01
Manganese			3.35E-02
Mercury			2.20E-03
Nickel			2.82E-03
Selenium			1.21E+01
Silver			1.95E-01
Tin			2.18E-01
Vanadium			1.98E-03
Zinc			1.28E-01
2-Butanone			4.80E-05
4,4'-DDD			1.07E-02
4,4'-DDE			1.05E-02
4,4'-DDT			4.27E-02
Acetone			3.99E-03
Alpha BHC			1.59E-03
Beta BHC			4.16E-03
Bis(2-ethylhexyl)phthalate			9.67E-05
cis-1,2-Dichloroethene			5.25E-05
Delta BHC			1.29E-03
Endosulfan I			6.19E-04
Endosulfan II			2.17E-03
Endosulfan sulfate			6.10E-04
Endrin			8.60E-04
Endrin Ketone			3.69E-04
Gamma BHC			3.68E-06
Heptachlor epoxide			2.50E-04
Methoxychlor			3.58E-05
Methylene chloride			2.51E-02
Toxaphene			2.84E-05
Aldrin			1.88E-04
TOTAL			6.33E+01

Aluminum	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.14E+03							3.03E+01		1.00E+00	8.00E-01	2.42E+01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.46E+01				1.80E+00					1.00E+00	8.00E-01	1.44E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Antimony	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.70E+00							2.32E-02		1.00E+00	8.00E-01	1.86E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.40E-01				6.90E-02					1.00E+00	8.00E-01	5.52E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Aluminum	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.14E+03	2.42E+01	5.00E+00	4.85E+00	
Water	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Food	2.46E+01	1.44E+00	5.00E+00	2.88E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Total					5.14E+00

Antimony	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.70E+00	1.86E-02	1.25E-03	1.48E+01	
Water	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Food	9.40E-01	5.52E-02	1.25E-03	4.42E+01	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Total					5.90E+01

Arsenic	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.70E+00							1.33E-02		1.00E+00	8.00E-01	1.07E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.08E-01				7.93E-03					1.00E+00	8.00E-01	6.34E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Barium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.49E+01							7.35E-02		1.00E+00	8.00E-01	5.88E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.24E+00				1.64E-01					1.00E+00	8.00E-01	1.31E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Arsenic	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.70E+00	1.07E-02	1.26E-02	8.46E-01	
Water	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Food	1.08E-01	6.34E-03	1.26E-02	5.03E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Total					1.35E+00

Barium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.49E+01	5.88E-02	5.06E-02	1.16E+00	
Water	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Food	2.24E+00	1.31E-01	5.06E-02	2.59E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Total					3.76E+00

Beryllium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.30E-01							1.14E-03		1.00E+00	8.00E-01	9.08E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.30E-03				1.69E-04					1.00E+00	8.00E-01	1.35E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cadmium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	8.40E-01							4.15E-03		1.00E+00	8.00E-01	3.32E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.62E-01				3.39E-02					1.00E+00	8.00E-01	2.71E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beryllium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.30E-01	9.08E-04	6.60E-02	1.38E-02	
Water	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Food	2.30E-03	1.35E-04	6.60E-02	2.05E-03	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Total					1.58E-02

Cadmium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.40E-01	3.32E-03	2.52E-02	1.32E-01	
Water	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Food	4.62E-01	2.71E-02	2.52E-02	1.08E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Total					1.21E+00

Chromium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.16E+01							5.73E-02		1.00E+00	8.00E-01	4.58E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.70E-02				6.39E-03					1.00E+00	8.00E-01	5.11E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cobalt	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	5.50E-01							2.71E-03		1.00E+00	8.00E-01	2.17E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.10E-02				8.08E-04					1.00E+00	8.00E-01	6.46E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Chromium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.16E+01	4.58E-02	4.60E-02	9.96E-01	
Water	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Food	8.70E-02	5.11E-03	4.60E-02	1.11E-01	
Inhalation					
Air	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Total					1.11E+00

Cobalt	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.50E-01	2.17E-03	1.57E-01	1.38E-02	
Water	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Food	1.10E-02	6.46E-04	1.57E-01	4.11E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Total					1.79E-02

Copper	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.60E+00							3.75E-02		1.00E+00	8.00E-01	3.00E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.04E+00				2.23E-01					1.00E+00	8.00E-01	1.79E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cyanide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.80E+01							8.88E-02		1.00E+00	8.00E-01	7.11E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.80E+01				1.32E+00					1.00E+00	8.00E-01	1.06E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Copper	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.60E+00	3.00E-02	6.60E+00	4.55E-03	
Water	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Food	3.04E+00	1.79E-01	6.60E+00	2.71E-02	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Total					3.16E-02

Cyanide	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.80E+01	7.11E-02	6.87E-01	1.03E-01	
Water	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Food	1.80E+01	1.06E+00	6.87E-01	1.54E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Total					1.64E+00

Lead	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	5.54E+01							2.73E-01		1.00E+00	8.00E-01	2.19E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.49E+00				1.83E-01					1.00E+00	8.00E-01	1.46E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Manganese	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.01E+01							9.92E-02		1.00E+00	8.00E-01	7.94E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.03E+00				3.69E-01					1.00E+00	8.00E-01	2.95E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Lead	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.54E+01	2.19E-01	8.00E-01	2.73E-01	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	2.49E+00	1.46E-01	8.00E-01	1.83E-01	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					4.56E-01

Manganese	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.01E+01	7.94E-02	8.80E+00	9.02E-03	
Water	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Food	5.03E+00	2.95E-01	8.80E+00	3.35E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Total					4.26E-02

Mercury	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	5.50E-02							2.71E-04		1.00E+00	8.00E-01	2.17E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.95E-02				3.63E-03					1.00E+00	8.00E-01	2.91E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Nickel	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.20E+00							1.58E-02		1.00E+00	8.00E-01	1.26E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.92E-01				1.41E-02					1.00E+00	8.00E-01	1.13E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Mercury	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.50E-02	2.17E-04	1.32E+00	1.65E-04	
Water	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Food	4.95E-02	2.91E-03	1.32E+00	2.20E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Total					2.37E-03

Nickel	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.20E+00	1.26E-02	4.00E+00	3.16E-03	
Water	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Food	1.92E-01	1.13E-02	4.00E+00	2.82E-03	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Total					5.98E-03

Selenium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.18E+02							3.05E+00		1.00E+00	8.00E-01	2.44E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.55E+01				1.13E+00					1.00E+00	8.00E-01	9.07E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Silver	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.50E-01							7.40E-04		1.00E+00	8.00E-01	5.92E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.00E-02				4.40E-03					1.00E+00	8.00E-01	3.52E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Selenium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.18E+02	2.44E+00	7.50E-02	3.25E+01	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	1.55E+01	9.07E-01	7.50E-02	1.21E+01	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					4.46E+01

Silver	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E-01	5.92E-04	1.81E-02	3.27E-02	
Water	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Food	6.00E-02	3.52E-03	1.81E-02	1.95E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Total					2.27E-01

Tin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.20E+00							3.06E-02		1.00E+00	8.00E-01	2.45E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.86E-01				1.37E-02					1.00E+00	8.00E-01	1.09E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Vanadium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.00E+00							3.46E-02		1.00E+00	8.00E-01	2.76E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.85E-02				2.83E-03					1.00E+00	8.00E-01	2.26E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Tin	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.20E+00	2.45E-02	5.00E-02	4.90E-01	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	1.86E-01	1.09E-02	5.00E-02	2.18E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					7.08E-01

Vanadium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E+00	2.76E-02	1.14E+00	2.42E-02	
Water	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Food	3.85E-02	2.26E-03	1.14E+00	1.98E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Total					2.62E-02

Zinc	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.33E+01							1.15E-01		1.00E+00	8.00E-01	9.20E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.50E+01				2.57E+00					1.00E+00	8.00E-01	2.05E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2-Butanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.00E-03							1.48E-05		1.00E+00	8.00E-01	1.18E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.45E-02				1.06E-03					1.00E+00	8.00E-01	8.49E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Zinc	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.33E+01	9.20E-02	1.60E+01	5.75E-03	
Water	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Food	3.50E+01	2.05E+00	1.60E+01	1.28E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Total					1.34E-01

2-Butanone	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	1.18E-05	1.77E+01	6.69E-07	
Water	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Food	1.45E-02	8.49E-04	1.77E+01	4.80E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Total					4.86E-05

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.16E-01							1.56E-03		1.00E+00	8.00E-01	1.25E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.46E-02				1.07E-03					1.00E+00	8.00E-01	8.55E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.16E+00							5.73E-03		1.00E+00	8.00E-01	4.58E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.43E-02				1.05E-03					1.00E+00	8.00E-01	8.39E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.16E-01	1.25E-03	8.00E-02	1.56E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	1.46E-02	8.55E-04	8.00E-02	1.07E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					2.63E-02

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.16E+00	4.58E-03	8.00E-02	5.73E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	1.43E-02	8.39E-04	8.00E-02	1.05E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					6.78E-02

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.40E+00							2.17E-02		1.00E+00	8.00E-01	1.74E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.82E-02				4.27E-03					1.00E+00	8.00E-01	3.42E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Acetone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.70E-02							2.32E-04		1.00E+00	8.00E-01	1.86E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.79E-01				4.99E-02					1.00E+00	8.00E-01	3.99E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.40E+00	1.74E-02	8.00E-02	2.17E-01	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	5.82E-02	3.42E-03	8.00E-02	4.27E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					2.60E-01

Acetone	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.70E-02	1.86E-04	1.00E+01	1.86E-05	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	6.79E-01	3.99E-02	1.00E+01	3.99E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					4.01E-03

Alpha BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.00E-03							4.94E-06		1.00E+00	8.00E-01	3.95E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.71E-05				2.72E-06					1.00E+00	8.00E-01	2.18E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beta BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.00E-03							9.87E-06		1.00E+00	8.00E-01	7.90E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.71E-05				7.13E-06					1.00E+00	8.00E-01	5.70E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Alpha BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.00E-03	3.95E-06	1.37E-03	2.88E-03	
Water	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Food	3.71E-05	2.18E-06	1.37E-03	1.59E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Total					4.47E-03

Beta BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.00E-03	7.90E-06	1.37E-03	5.76E-03	
Water	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Food	9.71E-05	5.70E-06	1.37E-03	4.16E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Total					9.93E-03

Bis(2-ethylhexyl)phthalate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.10E-01							1.53E-03		1.00E+00	8.00E-01	1.22E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.01E-03				2.21E-04					1.00E+00	8.00E-01	1.77E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

cis-1,2-Dichloroethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	8.00E-03							3.95E-05		1.00E+00	8.00E-01	3.16E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.04E-03				2.97E-04					1.00E+00	8.00E-01	2.37E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Bis(2-ethylhexyl)phthalate	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.10E-01	1.22E-03	1.83E+00	6.69E-04	
Water	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Food	3.01E-03	1.77E-04	1.83E+00	9.67E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Total					7.66E-04

cis-1,2-Dichloroethene	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.00E-03	3.16E-05	4.52E+00	6.99E-06	
Water	0.00E+00	0.00E+00	4.52E+00	0.00E+00	
Food	4.04E-03	2.37E-04	4.52E+00	5.25E-05	
Inhalation					
Air	0.00E+00	0.00E+00	4.52E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.52E+00	0.00E+00	
Total					5.95E-05

Delta BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.00E-03							4.94E-06		1.00E+00	8.00E-01	3.95E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.02E-05				2.21E-06					1.00E+00	8.00E-01	1.77E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan I	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.00E-03							9.87E-06		1.00E+00	8.00E-01	7.90E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.58E-04				1.16E-05					1.00E+00	8.00E-01	9.29E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Delta BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.00E-03	3.95E-06	1.37E-03	2.88E-03	
Water	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Food	3.02E-05	1.77E-06	1.37E-03	1.29E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Total					4.18E-03

Endosulfan I	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.00E-03	7.90E-06	1.50E-02	5.27E-04	
Water	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Food	1.58E-04	9.29E-06	1.50E-02	6.19E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Total					1.15E-03

Endosulfan II	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.00E-03							3.46E-05		1.00E+00	8.00E-01	2.76E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.53E-04				4.06E-05					1.00E+00	8.00E-01	3.25E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan sulfate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.00E-03							1.48E-05		1.00E+00	8.00E-01	1.18E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.56E-04				1.14E-05					1.00E+00	8.00E-01	9.15E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan II	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-03	2.76E-05	1.50E-02	1.84E-03	
Water	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Food	5.53E-04	3.25E-05	1.50E-02	2.17E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Total					4.01E-03

Endosulfan sulfate	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	1.18E-05	1.50E-02	7.90E-04	
Water	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Food	1.56E-04	9.15E-06	1.50E-02	6.10E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Total					1.40E-03

Endrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.00E-03							3.46E-05		1.00E+00	8.00E-01	2.76E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.35E-04				9.89E-06					1.00E+00	8.00E-01	7.91E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin Ketone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.00E-03							1.48E-05		1.00E+00	8.00E-01	1.18E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.78E-05				4.24E-06					1.00E+00	8.00E-01	3.39E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-03	2.76E-05	9.20E-03	3.00E-03	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	1.35E-04	7.91E-06	9.20E-03	8.60E-04	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					3.86E-03

Endrin Ketone	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	1.18E-05	9.20E-03	1.29E-03	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	5.78E-05	3.39E-06	9.20E-03	3.69E-04	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					1.66E-03

Gamma BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.00E-03							4.94E-06		1.00E+00	8.00E-01	3.95E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.02E-05				3.68E-06					1.00E+00	8.00E-01	2.95E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor epoxide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.60E-02							7.90E-05		1.00E+00	8.00E-01	6.32E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.40E-04				2.50E-05					1.00E+00	8.00E-01	2.00E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Gamma BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.00E-03	3.95E-06	8.00E-01	4.94E-06	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	5.02E-05	2.95E-06	8.00E-01	3.68E-06	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					8.62E-06

Heptachlor epoxide	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.60E-02	6.32E-05	8.00E-02	7.90E-04	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	3.40E-04	2.00E-05	8.00E-02	2.50E-04	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.04E-03

Methoxychlor	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.00E-03							4.44E-05		1.00E+00	8.00E-01	3.55E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.44E-04				1.79E-05					1.00E+00	8.00E-01	1.43E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methylene chloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.70E-02							1.33E-04		1.00E+00	8.00E-01	1.07E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.14E-02				1.57E-03					1.00E+00	8.00E-01	1.26E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methoxychlor	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.00E-03	3.55E-05	4.00E-01	8.88E-05	
Water	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Food	2.44E-04	1.43E-05	4.00E-01	3.58E-05	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Total					1.25E-04

Methylene chloride	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.70E-02	1.07E-04	5.00E-02	2.13E-03	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	2.14E-02	1.26E-03	5.00E-02	2.51E-02	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					2.72E-02

Toxaphene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.43E-01							1.69E-03		1.00E+00	8.00E-01	1.35E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.86E-04				2.84E-05					1.00E+00	8.00E-01	2.27E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Aldrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.00E-03							4.94E-06		1.00E+00	8.00E-01	3.95E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.39E-05				4.69E-06					1.00E+00	8.00E-01	3.75E-06
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Toxaphene	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.43E-01	1.35E-03	8.00E-01	1.69E-03	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	3.86E-04	2.27E-05	8.00E-01	2.84E-05	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					1.72E-03

Aldrin	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.00E-03	3.95E-06	2.00E-02	1.97E-04	
Water	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Food	6.39E-05	3.75E-06	2.00E-02	1.88E-04	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Total					3.85E-04

DOSE CALCULATIONS FOR THE LOWER KEYS MARSH RABBIT

SWMU 2

MEAN CONTAMINANT CONCENTRATIONS

Predicted Chemical Concentration by Media (mg/kg) at SWMU 2				
Chemical	Maximum		Mean	
	Soil	Vegetation	Soil	Vegetation
Aluminum	6.14E+03	2.46E+01	2.83E+03	1.13E+01
Antimony	4.70E+00	9.40E-01	1.26E+00	2.52E-01
Arsenic	2.70E+00	1.08E-01	1.59E+00	6.35E-02
Barium	1.49E+01	2.24E+00	9.39E+00	1.41E+00
Beryllium	2.30E-01	2.30E-03	1.42E-01	1.42E-03
Cadmium	8.40E-01	4.62E-01	3.84E-01	2.11E-01
Chromium	1.16E+01	8.70E-02	6.67E+00	5.00E-02
Cobalt	5.50E-01	1.10E-02	6.40E-01	1.28E-02
Copper	7.60E+00	3.04E+00	3.54E+00	1.42E+00
Cyanide	1.80E+01	1.80E+01	1.23E+01	1.23E+01
Lead	5.54E+01	2.49E+00	1.56E+01	7.02E-01
Manganese	2.01E+01	5.03E+00	1.43E+01	3.58E+00
Mercury	5.50E-02	4.95E-02	2.08E-02	1.87E-02
Nickel	3.20E+00	1.92E-01	1.41E+00	8.44E-02
Selenium	6.18E+02	1.55E+01	1.03E+02	2.58E+00
Silver	1.50E-01	6.00E-02	1.76E-01	7.06E-02
Tin	6.20E+00	1.86E-01	2.11E+00	6.34E-02
Vanadium	7.00E+00	3.85E-02	3.09E+00	1.70E-02
Zinc	2.33E+01	3.50E+01	7.86E+00	1.18E+01
2-Butanone	3.00E-03	1.45E-02	6.00E-03	2.89E-02
4,4'-DDD	3.16E-01	1.46E-02	4.33E-01	2.00E-02
4,4'-DDE	1.16E+00	1.43E-02	2.21E-01	2.72E-03
4,4'-DDT	4.40E+00	5.82E-02	2.46E-01	3.25E-03
Acetone	4.70E-02	6.79E-01	1.71E-02	2.47E-01
Alpha BHC	1.00E-03	3.71E-05	1.46E-02	5.40E-04
Beta BHC	2.00E-03	9.71E-05	1.55E-02	7.52E-04
Bis(2-ethylhexyl)phthalate	3.10E-01	3.01E-03	2.55E-01	2.48E-03
cis-1,2-Dichloroethene	8.00E-03	4.04E-03	3.26E-03	1.65E-03
Delta BHC	1.00E-03	3.02E-05	1.55E-02	4.67E-04
Endosulfan I	2.00E-03	1.58E-04	1.56E-02	1.24E-03
Endosulfan II	7.00E-03	5.53E-04	3.14E-02	2.48E-03
Endosulfan sulfate	3.00E-03	1.56E-04	3.19E-02	1.66E-03
Endrin	7.00E-03	1.35E-04	2.94E-02	5.66E-04
Endrin Ketone	3.00E-03	5.78E-05	3.07E-02	5.91E-04
Gamma BHC	1.00E-03	5.02E-05	1.46E-02	7.32E-04
Heptachlor epoxide	1.60E-02	3.40E-04	1.75E-02	3.73E-04
Methoxychlor	9.00E-03	2.44E-04	1.56E-01	4.23E-03
Methylene chloride	2.70E-02	2.14E-02	1.02E-02	8.09E-03
Toxaphene	3.43E-01	3.86E-04	7.40E-01	8.34E-04
Aldrin	1.00E-03	6.39E-05	1.54E-02	9.84E-04

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN VEGETATION
MCAS, Key West - swmu 2 mean
EXPOSURE SCENARIO: CALCULATE VEGETATION CONCENTRATIONS BASED MEASURED SOIL CONCENTRATIONS (ACTUAL)

CHEMICAL	SOIL CONC. (MG/KG)	Koc	Kow	UPTAKE FACTOR TRANSLOCATION	VEG CONC. TRANSLOCATION (MG/KG)
Aluminum	2830.000000			4.00E-03	1.13E+01
Antimony	1.260000			2.00E-01	2.52E-01
Arsenic	1.588571			4.00E-02	6.35E-02
Barium	9.385714			1.50E-01	1.41E+00
Beryllium	0.141929			1.00E-02	1.42E-03
Cadmium	0.384286			5.50E-01	2.11E-01
Chromium	6.671429			7.50E-03	5.00E-02
Cobalt	0.640000			2.00E-02	1.28E-02
Copper	3.542857			4.00E-01	1.42E+00
Cyanide	12.250000			1.00E+00	1.23E+01
Lead	15.591765			4.50E-02	7.02E-01
Manganese	14.337500			2.50E-01	3.58E+00
Mercury	0.020786			9.00E-01	1.87E-02
Nickel	1.406429			6.00E-02	8.44E-02
Selenium	103.286667			2.50E-02	2.58E+00
Silver	0.176429			4.00E-01	7.06E-02
Tin	2.112857			3.00E-02	6.34E-02
Vanadium	3.092857			5.50E-03	1.70E-02
Zinc	7.857143			1.50E+00	1.18E+01
2-Butanone	0.006000	1.80E+00	1.82E+00	4.82E+00	2.89E-02
4,4'-DDD	0.433178	2.82E+05	1.05E+06	4.61E-02	2.00E-02
4,4'-DDE	0.220935	2.51E+06	3.24E+06	1.23E-02	2.72E-03
4,4'-DDT	0.245999	1.79E+06	2.29E+06	1.32E-02	3.25E-03
Acetone	0.017083	5.81E-01	5.75E-01	1.45E+01	2.47E-01
Alpha BHC	0.014574	6.31E+03	5.44E+03	3.71E-02	5.40E-04
Beta BHC	0.015490	5.20E+03	6.03E+03	4.86E-02	7.52E-04
Bis(2-ethylhexyl)phthalate	0.255000	1.29E+05	5.00E+04	9.72E-03	2.48E-03
cis-1,2-Dichloroethene	0.003256	4.90E+01	1.83E+02	5.05E-01	1.65E-03
Delta BHC	0.015490	1.38E+04	1.17E+04	3.02E-02	4.67E-04
Endosulfan I	0.015643	2.43E+03	4.17E+03	7.91E-02	1.24E-03
Endosulfan II	0.031371	2.43E+03	4.17E+03	7.91E-02	2.48E-03
Endosulfan sulfate	0.031899	3.96E+03	4.57E+03	5.19E-02	1.66E-03
Endrin	0.029399	3.20E+05	3.98E+05	1.93E-02	5.66E-04
Endrin Ketone	0.030698	3.20E+05	3.98E+05	1.93E-02	5.91E-04
Gamma BHC	0.014588	4.54E+03	5.25E+03	5.02E-02	7.32E-04
Heptachlor epoxide	0.017546	2.03E+05	2.51E+05	2.13E-02	3.73E-04
Methoxychlor	0.156042	6.71E+04	8.13E+04	2.71E-02	4.23E-03
Methylene chloride	0.010222	1.78E+01	4.78E+01	7.92E-01	8.09E-03
Toxaphene	0.740208	1.00E+05	2.00E+03	1.13E-03	8.34E-04
Aldrin	0.015400	1.02E+03	9.10E+02	6.39E-02	9.84E-04

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION FOR EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
Aluminum			2.24E+00
Antimony			3.98E+00
Arsenic			4.98E-01
Barium			7.32E-01
Beryllium			8.49E-03
Cadmium			6.02E-02
Chromium			5.73E-01
Cobalt			1.61E-02
Copper			2.12E-03
Cyanide			7.04E-02
Lead			7.70E-02
Manganese			6.43E-03
Mercury			6.22E-05
Nickel			1.39E-03
Selenium			5.44E+00
Silver			3.85E-02
Tin			1.67E-01
Vanadium			1.07E-02
Zinc			1.94E-03
2-Butanone			1.34E-06
4,4'-DDD			2.14E-02
4,4'-DDE			1.09E-02
4,4'-DDT			1.21E-02
Acetone			6.75E-06
Alpha BHC			4.20E-02
Beta BHC			4.46E-02
Bis(2-ethylhexyl)phthalate			5.50E-04
cis-1,2-Dichloroethene			2.84E-06
Delta BHC			7.95E-05
Endosulfan I			4.46E-02
Endosulfan II			4.12E-03
Endosulfan sulfate			8.26E-03
Endrin			8.40E-03
Endrin Ketone			1.26E-02
Gamma BHC			1.32E-02
Heptachlor epoxide			7.20E-05
Methoxychlor			8.66E-04
Methylene chloride			1.54E-03
Toxaphene			8.07E-04
Aldrin			3.65E-03
TOTAL			1.41E+01

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION FOR EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
Aluminum			1.33E-01
Antimony			1.18E+01
Arsenic			2.96E-01
Barium			1.63E+00
Beryllium			1.26E-03
Cadmium			4.93E-01
Chromium			6.39E-02
Cobalt			4.79E-03
Copper			1.26E-02
Cyanide			1.05E+00
Lead			5.15E-02
Manganese			2.39E-02
Mercury			8.32E-04
Nickel			1.24E-03
Selenium			2.02E+00
Silver			2.29E-01
Tin			7.45E-02
Vanadium			8.76E-04
Zinc			4.33E-02
2-Butanone			9.60E-05
4,4'-DDD			1.47E-02
4,4'-DDE			2.00E-03
4,4'-DDT			2.39E-03
Acetone			1.45E-03
Alpha BHC			2.32E-02
Beta BHC			3.22E-02
Bis(2-ethylhexyl)phthalate			7.95E-05
cis-1,2-Dichloroethene			2.14E-05
Delta BHC			2.00E-02
Endosulfan I			4.84E-03
Endosulfan II			9.71E-03
Endosulfan sulfate			6.48E-03
Endrin			3.61E-03
Endrin Ketone			3.77E-03
Gamma BHC			5.37E-05
Heptachlor epoxide			2.74E-04
Methoxychlor			6.21E-04
Methylene chloride			9.51E-03
Toxaphene			6.12E-05
Aldrin			2.89E-03
TOTAL			1.81E+01

Aluminum	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.83E+03							1.40E+01		1.00E+00	8.00E-01	1.12E+01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.13E+01				8.31E-01					1.00E+00	8.00E-01	6.65E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Antimony	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.26E+00							6.22E-03		1.00E+00	8.00E-01	4.98E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.52E-01				1.85E-02					1.00E+00	8.00E-01	1.48E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Aluminum	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.83E+03	1.12E+01	5.00E+00	2.24E+00	
Water	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Food	1.13E+01	6.65E-01	5.00E+00	1.33E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E+00	0.00E+00	
Total					2.37E+00

Antimony	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.26E+00	4.98E-03	1.25E-03	3.98E+00	
Water	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Food	2.52E-01	1.48E-02	1.25E-03	1.18E+01	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-03	0.00E+00	
Total					1.58E+01

Arsenic	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.59E+00							7.84E-03		1.00E+00	8.00E-01	6.27E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.35E-02				4.66E-03					1.00E+00	8.00E-01	3.73E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Barium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	9.39E+00							4.63E-02		1.00E+00	8.00E-01	3.71E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.41E+00				1.03E-01					1.00E+00	8.00E-01	8.27E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Arsenic	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.59E+00	6.27E-03	1.26E-02	4.98E-01	
Water	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Food	6.35E-02	3.73E-03	1.26E-02	2.96E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Total					7.94E-01

Barium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	9.39E+00	3.71E-02	5.06E-02	7.32E-01	
Water	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Food	1.41E+00	8.27E-02	5.06E-02	1.63E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E-02	0.00E+00	
Total					2.37E+00

Beryllium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.42E-01							7.01E-04		1.00E+00	8.00E-01	5.60E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.42E-03				1.04E-04					1.00E+00	8.00E-01	8.34E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cadmium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.84E-01							1.90E-03		1.00E+00	8.00E-01	1.52E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.11E-01				1.55E-02					1.00E+00	8.00E-01	1.24E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beryllium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.42E-01	5.60E-04	6.60E-02	8.49E-03	
Water	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Food	1.42E-03	8.34E-05	6.60E-02	1.26E-03	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Total					9.75E-03

Cadmium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.84E-01	1.52E-03	2.52E-02	6.02E-02	
Water	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Food	2.11E-01	1.24E-02	2.52E-02	4.93E-01	
Inhalation					
Air	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.52E-02	0.00E+00	
Total					5.53E-01

Chromium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.67E+00							3.29E-02		1.00E+00	8.00E-01	2.63E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.00E-02				3.67E-03					1.00E+00	8.00E-01	2.94E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cobalt	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.40E-01							3.16E-03		1.00E+00	8.00E-01	2.53E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.28E-02				9.40E-04					1.00E+00	8.00E-01	7.52E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Chromium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.67E+00	2.63E-02	4.60E-02	5.73E-01	
Water	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Food	5.00E-02	2.94E-03	4.60E-02	6.39E-02	
Inhalation					
Air	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.60E-02	0.00E+00	
Total					6.37E-01

Cobalt	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.40E-01	2.53E-03	1.57E-01	1.61E-02	
Water	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Food	1.28E-02	7.52E-04	1.57E-01	4.79E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E-01	0.00E+00	
Total					2.09E-02

Copper	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.54E+00							1.75E-02		1.00E+00	8.00E-01	1.40E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.42E+00				1.04E-01					1.00E+00	8.00E-01	8.32E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cyanide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.23E+01							6.05E-02		1.00E+00	8.00E-01	4.84E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.23E+01				8.99E-01					1.00E+00	8.00E-01	7.19E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Copper	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.54E+00	1.40E-02	6.60E+00	2.12E-03	
Water	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Food	1.42E+00	8.32E-02	6.60E+00	1.26E-02	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E+00	0.00E+00	
Total					1.47E-02

Cyanide	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.23E+01	4.84E-02	6.87E-01	7.04E-02	
Water	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Food	1.23E+01	7.19E-01	6.87E-01	1.05E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Total					1.12E+00

Lead	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.56E+01							7.70E-02		1.00E+00	8.00E-01	6.16E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.02E-01				5.15E-02					1.00E+00	8.00E-01	4.12E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Manganese	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.43E+01							7.08E-02		1.00E+00	8.00E-01	5.66E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.58E+00				2.63E-01					1.00E+00	8.00E-01	2.11E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Lead	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.56E+01	6.16E-02	8.00E-01	7.70E-02	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	7.02E-01	4.12E-02	8.00E-01	5.15E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					1.28E-01

Manganese	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.43E+01	5.66E-02	8.80E+00	6.43E-03	
Water	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Food	3.58E+00	2.11E-01	8.80E+00	2.39E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.80E+00	0.00E+00	
Total					3.04E-02

Mercury	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.08E-02							1.03E-04		1.00E+00	8.00E-01	8.21E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.87E-02				1.37E-03					1.00E+00	8.00E-01	1.10E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Nickel	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.41E+00							6.94E-03		1.00E+00	8.00E-01	5.55E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.44E-02				6.20E-03					1.00E+00	8.00E-01	4.96E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Mercury	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.08E-02	8.21E-05	1.32E+00	6.22E-05	
Water	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Food	1.87E-02	1.10E-03	1.32E+00	8.32E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.32E+00	0.00E+00	
Total					8.95E-04

Nickel	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.41E+00	5.55E-03	4.00E+00	1.39E-03	
Water	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Food	8.44E-02	4.96E-03	4.00E+00	1.24E-03	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Total					2.63E-03

Selenium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.03E+02							5.10E-01		1.00E+00	8.00E-01	4.08E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.58E+00				1.90E-01					1.00E+00	8.00E-01	1.52E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Silver	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.76E-01							8.71E-04		1.00E+00	8.00E-01	6.97E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.06E-02				5.18E-03					1.00E+00	8.00E-01	4.14E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Selenium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.03E+02	4.08E-01	7.50E-02	5.44E+00	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	2.58E+00	1.52E-01	7.50E-02	2.02E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					7.46E+00

Silver	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.76E-01	6.97E-04	1.81E-02	3.85E-02	
Water	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Food	7.06E-02	4.14E-03	1.81E-02	2.29E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E-02	0.00E+00	
Total					2.67E-01

Tin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.11E+00							1.04E-02		1.00E+00	8.00E-01	8.34E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.34E-02				4.65E-03					1.00E+00	8.00E-01	3.72E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Vanadium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.09E+00							1.53E-02		1.00E+00	8.00E-01	1.22E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.70E-02				1.25E-03					1.00E+00	8.00E-01	9.99E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Tin	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.11E+00	8.34E-03	5.00E-02	1.67E-01	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	6.34E-02	3.72E-03	5.00E-02	7.45E-02	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					2.41E-01

Vanadium	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.09E+00	1.22E-02	1.14E+00	1.07E-02	
Water	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Food	1.70E-02	9.99E-04	1.14E+00	8.76E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+00	0.00E+00	
Total					1.16E-02

Zinc	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.86E+00							3.88E-02		1.00E+00	8.00E-01	3.10E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.18E+01				8.65E-01					1.00E+00	8.00E-01	6.92E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2-Butanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	6.00E-03							2.96E-05		1.00E+00	8.00E-01	2.37E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.89E-02				2.12E-03					1.00E+00	8.00E-01	1.70E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Zinc	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.86E+00	3.10E-02	1.60E+01	1.94E-03	
Water	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Food	1.18E+01	6.92E-01	1.60E+01	4.33E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Total					4.52E-02

2-Butanone	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.00E-03	2.37E-05	1.77E+01	1.34E-06	
Water	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Food	2.89E-02	1.70E-03	1.77E+01	9.60E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+01	0.00E+00	
Total					9.73E-05

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	4.33E-01							2.14E-03		1.00E+00	8.00E-01	1.71E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.00E-02				1.47E-03					1.00E+00	8.00E-01	1.17E-03
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.21E-01							1.09E-03		1.00E+00	8.00E-01	8.72E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.72E-03				2.00E-04					1.00E+00	8.00E-01	1.60E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	4.33E-01	1.71E-03	8.00E-02	2.14E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	2.00E-02	1.17E-03	8.00E-02	1.47E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					3.60E-02

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.21E-01	8.72E-04	8.00E-02	1.09E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	2.72E-03	1.60E-04	8.00E-02	2.00E-03	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.29E-02

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.46E-01							1.21E-03		1.00E+00	8.00E-01	9.71E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.25E-03				2.39E-04					1.00E+00	8.00E-01	1.91E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Acetone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.71E-02							8.43E-05		1.00E+00	8.00E-01	6.75E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.47E-01				1.81E-02					1.00E+00	8.00E-01	1.45E-02
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.46E-01	9.71E-04	8.00E-02	1.21E-02	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	3.25E-03	1.91E-04	8.00E-02	2.39E-03	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.45E-02

Acetone	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.71E-02	6.75E-05	1.00E+01	6.75E-06	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	2.47E-01	1.45E-02	1.00E+01	1.45E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					1.46E-03

Alpha BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.46E-02							7.19E-05		1.00E+00	8.00E-01	5.75E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.40E-04				3.97E-05					1.00E+00	8.00E-01	3.17E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beta BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.55E-02							7.65E-05		1.00E+00	8.00E-01	6.12E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.52E-04				5.52E-05					1.00E+00	8.00E-01	4.42E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Alpha BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.46E-02	5.75E-05	1.37E-03	4.20E-02	
Water	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Food	5.40E-04	3.17E-05	1.37E-03	2.32E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Total					6.52E-02

Beta BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.55E-02	6.12E-05	1.37E-03	4.46E-02	
Water	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Food	7.52E-04	4.42E-05	1.37E-03	3.22E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Total					7.69E-02

Bis(2-ethylhexyl)phthalate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.55E-01							1.26E-03		1.00E+00	8.00E-01	1.01E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.48E-03				1.82E-04					1.00E+00	8.00E-01	1.46E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

cis-1,2-Dichloroethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.26E-03							1.61E-05		1.00E+00	8.00E-01	1.29E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.65E-03				1.21E-04					1.00E+00	8.00E-01	9.66E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Bis(2-ethylhexyl)phthalate	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.55E-01	1.01E-03	1.83E+00	5.50E-04	
Water	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Food	2.48E-03	1.46E-04	1.83E+00	7.95E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.83E+00	0.00E+00	
Total					6.30E-04

cis-1,2-Dichloroethene	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.26E-03	1.29E-05	4.52E+00	2.84E-06	
Water	0.00E+00	0.00E+00	4.52E+00	0.00E+00	
Food	1.65E-03	9.66E-05	4.52E+00	2.14E-05	
Inhalation					
Air	0.00E+00	0.00E+00	4.52E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.52E+00	0.00E+00	
Total					2.42E-05

Delta BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.55E-02							7.65E-05		1.00E+00	8.00E-01	6.12E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.67E-04				3.43E-05					1.00E+00	8.00E-01	2.74E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan I	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.56E-02							7.72E-05		1.00E+00	8.00E-01	6.18E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.24E-03				9.08E-05					1.00E+00	8.00E-01	7.26E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Delta BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.55E-02	6.12E-05	1.37E-03	4.46E-02	
Water	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Food	4.67E-04	2.74E-05	1.37E-03	2.00E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-03	0.00E+00	
Total					6.47E-02

Endosulfan I	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.56E-02	6.18E-05	1.50E-02	4.12E-03	
Water	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Food	1.24E-03	7.26E-05	1.50E-02	4.84E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Total					8.96E-03

Endosulfan II	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.14E-02							1.55E-04		1.00E+00	8.00E-01	1.24E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.48E-03				1.82E-04					1.00E+00	8.00E-01	1.46E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan sulfate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.19E-02							1.57E-04		1.00E+00	8.00E-01	1.26E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.66E-03				1.22E-04					1.00E+00	8.00E-01	9.72E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan II	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.14E-02	1.24E-04	1.50E-02	8.26E-03	
Water	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Food	2.48E-03	1.46E-04	1.50E-02	9.71E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Total					1.80E-02

Endosulfan sulfate	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.19E-02	1.26E-04	1.50E-02	8.40E-03	
Water	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Food	1.66E-03	9.72E-05	1.50E-02	6.48E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E-02	0.00E+00	
Total					1.49E-02

Endrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	2.94E-02							1.45E-04		1.00E+00	8.00E-01	1.16E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.66E-04				4.15E-05					1.00E+00	8.00E-01	3.32E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin Ketone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	3.07E-02							1.52E-04		1.00E+00	8.00E-01	1.21E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.91E-04				4.34E-05					1.00E+00	8.00E-01	3.47E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.94E-02	1.16E-04	9.20E-03	1.26E-02	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	5.66E-04	3.32E-05	9.20E-03	3.61E-03	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					1.62E-02

Endrin Ketone	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.07E-02	1.21E-04	9.20E-03	1.32E-02	
Water	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Food	5.91E-04	3.47E-05	9.20E-03	3.77E-03	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-03	0.00E+00	
Total					1.69E-02

Gamma BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.46E-02							7.20E-05		1.00E+00	8.00E-01	5.76E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.32E-04				5.37E-05					1.00E+00	8.00E-01	4.30E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor epoxide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.75E-02							8.66E-05		1.00E+00	8.00E-01	6.93E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.73E-04				2.74E-05					1.00E+00	8.00E-01	2.19E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Gamma BHC	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.46E-02	5.76E-05	8.00E-01	7.20E-05	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	7.32E-04	4.30E-05	8.00E-01	5.37E-05	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					1.26E-04

Heptachlor epoxide	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.75E-02	6.93E-05	8.00E-02	8.66E-04	
Water	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Food	3.73E-04	2.19E-05	8.00E-02	2.74E-04	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-02	0.00E+00	
Total					1.14E-03

Methoxychlor	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.56E-01							7.70E-04		1.00E+00	8.00E-01	6.16E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	4.23E-03				3.11E-04					1.00E+00	8.00E-01	2.48E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methylene chloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.02E-02							5.05E-05		1.00E+00	8.00E-01	4.04E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.09E-03				5.94E-04					1.00E+00	8.00E-01	4.75E-04
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methoxychlor	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.56E-01	6.16E-04	4.00E-01	1.54E-03	
Water	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Food	4.23E-03	2.48E-04	4.00E-01	6.21E-04	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Total					2.16E-03

Methylene chloride	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.02E-02	4.04E-05	5.00E-02	8.07E-04	
Water	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Food	8.09E-03	4.75E-04	5.00E-02	9.51E-03	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-02	0.00E+00	
Total					1.03E-02

Toxaphene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	7.40E-01							3.65E-03		1.00E+00	8.00E-01	2.92E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	8.34E-04				6.12E-05					1.00E+00	8.00E-01	4.90E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Aldrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	9.59E+04									
Soil	1.54E-02							7.60E-05		1.00E+00	8.00E-01	6.08E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.84E-04				7.22E-05					1.00E+00	8.00E-01	5.78E-05
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Toxaphene	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.40E-01	2.92E-03	8.00E-01	3.65E-03	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	8.34E-04	4.90E-05	8.00E-01	6.12E-05	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					3.71E-03

Aldrin	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.54E-02	6.08E-05	2.00E-02	3.04E-03	
Water	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Food	9.84E-04	5.78E-05	2.00E-02	2.89E-03	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Total					5.93E-03

APPENDIX F

TOXICOLOGICAL EVALUATION OF SURFACE WATER AND SEDIMENT SAMPLES

TOXICOLOGICAL EVALUATION OF SURFACE WATER AND SEDIMENT SAMPLES

January 1996

Naval Air Station Key West, Florida
SOUTHDIV CLEAN Contract Number N62467-94-D-0888

Prepared for

Brown & Root Environmental, Incorporated
900 Trail Ridge Road
Aiken, South Carolina 29803

By

EnviroSystems, Incorporated
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January 1996
Reference Number B&RE5563-96-01

STUDY NUMBER 5563
EXECUTIVE SUMMARY

The following summarizes the results of screening assays conducted during January and February 1996 on sediment and soil samples from sites at NAS Key West Florida as part of SOUTHDIV CLEAN Contract N62467-94-D-0888. Samples were provided by Brown & Root Environmental, Aiken, South Carolina. Surface waters were evaluated using the mysid shrimp, *Mysidopsis bahia*, tidewater silverside minnow, *Menidia beryllina*, mytilid, *Mytilus edulis*, larvae, and sea urchin, *Strongylocentrotus franciscana*, gametes. Soils and sediments were evaluated using the freshwater amphipod species, *Hyalella azteca* and earthworm, *Eisenia foetida*.

Sample Site	Date Collected	Date Received	Mysid 10 Day Survival	Menidia 96 Hour Survival	Mussel Larvae Normal	Urchin Eggs Fertilized	Hyalella 10 Day Survival	Earthworm 14 Day Survival
					Values Expressed as Percentages			
BG1SD-01	1/26/96	1/29/96					61	
BG1SS-01	1/26/96	1/27/96						0
BG1SW-01	1/26/96	1/27/96		60				
BG2SD-01	1/26/96	1/29/96	91					
BG2SS-01	1/26/96	1/29/96						68
BG2SW-01	1/26/96	1/27/96		25	12	92		
BG3SD-01	1/26/96	1/27/96	90					
BG3SS-01	1/26/96	1/27/96						16
BG3SW-01	1/26/96	1/27/96		20	95	87		
S1SD-01	1/22/96	1/23/96	92					
S1SD-02	1/22/96	1/23/96	95					
S1SD-03	1/24/96	1/25/96	85					
S1SD-04	1/24/96	1/25/96	88					
S1SD-05	1/24/96	1/25/96	88					
S1SS-04	1/31/96	2/01/96						57
S1SS-05	1/31/96	2/01/96						0
S1SS-07	1/31/96	2/01/96						46
S1SW-01	1/22/96	1/23/96		80	96	99		
S1SW-02	1/22/96	1/23/96		75	94	99		
S1SW-03	1/24/96	1/25/96		50	94	61		
S1SW-04	2/01/96	2/02/96		90	94	93		
S1SW-05	2/01/96	2/02/96		85	93	79		
S2SD-01	1/24/96	1/25/96					56	
S2SD-02	1/25/96	1/26/96					65	
S2SD-03	1/25/96	1/26/96					51	
S2SD-04	1/25/96	1/26/96					68	
S2SD-05	1/24/96	1/25/96					66	
S2SW-01	1/31/96	2/01/96		100				
S2SW-02	1/25/96	1/26/96		65				
S2SW-03	1/25/96	1/26/96		70				
S2SW-04	1/25/96	1/26/96		70				
S2SW-05	1/31/96	2/01/96		100				

Sample Site	Date Collected	Date Received	Mysid 10 Day Survival	Menidia 96 Hour Survival	Mussel Larvae Normal	Urchin Eggs Fertilized	Hyalella 10 Day Survival	Earthworm 14 Day Survival
					Values Expressed as Percentages			
S3SD-01	1/25/96	1/26/96					73	
S3SD-02	1/25/96	1/26/96					63	
S3SD-03	1/25/96	1/26/96					84	
S3SD-04	1/25/96	1/26/96					79	
S3SD-05	1/25/96	1/26/96					90	
S3SW-01	1/25/96	1/26/96		80				
S3SW-02	1/25/96	1/26/96		80				
S3SW-03	1/25/96	1/26/96		85				
S3SW-04	1/25/96	1/26/96		90				
S3SW-05	1/25/96	1/26/96		95				
S9SD-01	1/23/96	1/24/96	85					
S9SD-02	1/23/96	1/24/96	90					
S9SD-03	1/23/96	1/24/96	85					
S9SD-04	1/23/96	1/24/96	100					
S9SD-05	1/23/96	1/24/96	85					
S9SW-01	1/23/96	1/24/96		95	96	100		
S9SW-02	1/23/96	1/24/96		75	95	100		
S9SW-03	1/23/96	1/24/96		85	96	100		
S9SW-04	1/23/96	1/24/96		90	95	100		
S9SW-05	1/23/96	1/24/96		90	88	100		

Authorized Signature: Kenneth H. Simon 3/19/96
EnviroSystems, Incorporated Date

NAS Key West SOUTHDIV CLEAN Contract No. N62467-94-D-0888
Surface Water and Sediment Toxicity Evaluation, January 1996.
ESI Study Number 5563.

TOXICOLOGICAL EVALUATION OF SURFACE WATER AND SEDIMENT SAMPLES

January 1996

Naval Air Station Key West, Florida
SOUTHDIV CLEAN Contract Number N62467-94-D-0888

1.0 INTRODUCTION

Acute exposure toxicity tests expose groups of test organisms to environmental samples and laboratory controls for a specified period to assess potential impact on survival. The survival data are used to determine the relative toxicity of the samples compared to the laboratory standard and field reference sites. Chronic toxicity tests measure sublethal effects, growth, through exposing test organisms to samples during a sensitive period in the life cycle. In both acute and chronic exposure tests, analysis of the data can be carried out using Analysis of Variance techniques to determine if the test sediments and soil had a significant impact on these variables when compared to a control sediment.

This report presents the results of acute and chronic exposure toxicity tests on surface water and soil/sediments from four solid waste management units (SWMUs) and three reference sites at the NAS Key West, Florida. A total of 23 surface waters and 29 soil/sediments were collected from the project sites and reference area. Samples were collected between January 22 and February 1, 1996 and received by ESI between January 23 and February 3, 1996. The acute toxicity of the surface water samples was assessed using a series of acute, 2-hour, 48-hour and 96-hour assays conducted with sea urchin sperm and eggs, mytilid larvae and tidewater silverside minnows, respectively. Toxicity of soil and sediment samples was assessed by conducting 10-day static toxicity tests using the mysid shrimp and amphipod and a 14-day assays using the earthworm, *Eisenia foetida*. All bioassays were performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire.

2.0 MATERIALS AND METHODS

2.1 General Methods, Biological Evaluations

Toxicological and analytical protocols used in this program follow procedures outlined in the bid specifications and *Methods for Measuring the Acute Toxicity of Effluent and Receiving Water to Freshwater and Marine Organisms. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (EPA 1989), *Protocol for Short Term Toxicity Screening of Hazardous Waste Sites* (EPA 1989), *Aquatic Toxicology and Risk Assessment: Thirteenth Volume* (ASTM 1990), *Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates* (ASTM 1991), and *Standard Methods for the Examination of Water and Wastewater* (APHA 1989). These programs provide standard approaches for the evaluation of acute and chronic toxicological effects of surface waters and sediments on aquatic organisms and for the analysis of water samples.

2.2 Test Species

Mysid shrimp, *Mysidopsis bahia*, used in the 10-day sediment assays were 5 to 7 days old at the start of the assay. Organisms were from cultures maintained by ESI. Mysids were acclimated to approximate test conditions prior to use in the assay. Mysids were transferred to the test chambers using a large bore pipet, minimizing the amount of water added to test solutions.

Tidewater silverside minnows, *Menidia beryllina*, were approximately 10 to 14 days old at the start of the tests. Silversides were obtained from cultures maintained by ESI and Aquatic Research Organisms of Hampton, New Hampshire. Original adults in the culture were from commercial suppliers and field collected populations. The fish were acclimated to test condition for 24 hours prior to test initiation. Fish were transferred to test chambers using a large bore pipet, minimizing the amount of culture water added to test solutions.

Adult mytilids, *Mytilus edulis*, were obtained from a commercial source in California. Prior to use, the mussels were maintained in recirculating culture system at ESI. Culture water temperatures were maintained at 12 to 15°C. Gametes used in the assay were obtained by artificially stimulating spawning of the adult brood stock. Adult mussels were placed in 2 liter spawning vessels with filtered seawater. The organisms were undisturbed for approximately one hour. Spawning was induced by a rapid increase in water temperature, to a maximum level of 18°C. Eggs and sperm were collected by glass pipet and transferred to filtered seawater.

Sea urchins, *Strongylocentrotus franciscana*, used for the sperm mobility/fertilization assay were obtained from a commercial supply in California. Urchins were maintained in a flow through culture system at a temperature of 15°C. Adults were provided kelp as a food source. Adults were induced to spawn by injection of potassium chloride into the body cavity. Sperm and eggs released were collected with glass pipettes and transferred to filtered seawater. Eggs and sperm were not allowed to mix prior to use in the assay.

Earthworms, *Eisenia foetida*, were obtained from cultures maintained by ESI. Original cultures were obtained from commercial supply sources. Worms were maintained in artificial sediment prepare according to protocol developed by the EPA (EPA 1989). This soil is composed of a mixture of peat moss, silica sand and clay. Moisture content is maintained at approximately 30%. Organisms are fed a commercially prepared ration. Temperature during culture is maintained at approximately 20°C. Worms used in the assay were mature, approximately 300 to 500 mg per individual and had a well-developed clitellum.

Amphipods, *Hyalella azteca*, were from stocks maintained by ARO. Amphipods chosen for the test were between the second and third instar (2-3 mm in length) stages of development. The amphipods were cultured at test temperature and photoperiod. The amphipods were acclimated to the overlying water in the test chambers in the following manner; 4 hours in a 50:50 mixture of culture water and diluent, 4 hours in a 25:75 mixture of culture water and diluent, and then transferred to the test vessel.

2.3 Control and Test Samples

Natural seawater obtained from the Hampton Estuary was used as the laboratory control for the mysid, mussel, inland silverside and sea urchin assays. Water from the same source was also used as the overlying water in the mysid sediment assay. This water has been used for the culture of marine organisms at ESI for the past 15 years. The water is identified as Class "A" water by the State of New Hampshire.

Laboratory control water used in the amphipod assays was synthetic, moderately hard reconstituted water prepared according to protocol (EPA 1991). The same water was used to adjust moisture content in the earthworm assays.

The control substrate for the amphipod assay was obtained from the Taylor River. This stream is located in a rural area and is free of industrial and residential runoff and contamination. Stream sediments are fine grained sands with organic detritus. The sediments have been used as a laboratory control for more than 5 years. The sediment has been used to successfully maintain and culture *H. azteca*. Prior to use the sediment was screened through a 1.0 mm screen to remove living organisms, large organic detritus and stones.

Soil used as a laboratory control for the earthworm assays was an artificial soil prepared according to protocol developed by the EPA (EPA 1989). The soil consisted of (by weight) 10% screened sphagnum peat moss, 20% kaolinite clay and 70% fine silica sand. The silica sand was classified as 200 mesh. The peat moss was blended prior to use to breakup clods. After blending the peat moss was screened to remove any large sticks and twigs. The moisture content of the soil was adjusted to approximately 30% using moderately hard reconstituted water. The pH of the soil was checked to insure values were within the range of 5.0 to 9.0 SU.

Laboratory control sediment used in the mysid sediment assay was a fine grained crushed coral. Prior to use the coral was rinsed several times with filtered seawater. The coral was inoculated with approximately 5 to 10 grams of crushed coral from biological filters used in marine culture systems. This latter material provided a bacterial population to reduce ammonia levels during the assay.

A total of 52 samples from 4 project area and 3 background locations were provided for analysis by Brown and Root Environmental. Samples represented surface waters, sediments and upland soils. Collection dates ranged from January 22 through February 1, 1996. Table 1 provides a summary of sample collection and receipt data by individual sample.

2.4 Acute Toxicity Tests

2.4.1 *Menidia beryllina* Acute Toxicity Test

The 96-hour static acute toxicity test was conducted at 25±1°C with a photoperiod of 16:8 hours light:dark. Test chambers for the minnows were 250 mL glass culture bowls containing 200 mL of test solution in each of 2 replicates with 10 organisms/replicate. Laboratory control treatments were handled in the same manner as the sample treatments with one exception. The number of replicates in the laboratory control varied from the required minimum of 2 to a maximum of 6. In order to evaluate potential impacts associated with the varying salinities of the samples tested, the salinity of the laboratory controls was adjusted to match that of the samples. This resulted in as many as three sets of control being included in the study design. Survival and dissolved oxygen levels were recorded daily in all replicates, and pH was measured in one replicate of each test treatment. Salinity and conductivity were measured in one replicate of each test treatment at the start of the assay. Tests were started on January 24, 27, and February 02, 1996.

2.4.2 *Mysidopsis bahia* Sediment Toxicity Test

The 10-day assay was conducted as a static exposure toxicity test with addition of distilled water to compensate for evaporation, stabilizing salinity during the assay. On day 5 of the assay 50% of the overlying water was replaced with fresh seawater. The assay was conducted at 20±2°C with a photoperiod of 16:8 hours light:dark. Mysids were maintained in 1000 mL beakers with 200 mL of test sediments placed in the bottom of each chamber. Approximately 750 mL of seawater was added to each test vessel. Test vessels were allowed to settle for 24 hours prior the addition of test organisms. This period allowed fine particles to settle prior to starting the assay. Each treatment utilized 4 replicates with 15 organisms/replicate. One sample, BG2SD-01, was tested using 20 organisms per replicate. The additional animals, as compared to the other tests in this series, were inadvertently added to the test chambers. All assays were started on January 29, 1996 except for BG2SD-01 which was started on January 30, 1996.

During the test, mysids were fed <24 hour old *Artemia* nauplii on a daily basis. At the end of the 10-day exposure period, all sediments were removed from the test chambers and passed through a series of screens. All surviving mysids were recovered and placed in filtered seawater. The water was carefully removed and the mysids quickly rinsed with deionized water. The mysids were then transferred to weighing foils to determine dry weights. The mysids were dried at 60°C for six hours, or until constant weight was obtained. Dry weights were determined to the nearest 0.001 mg.

Water quality data including; dissolved oxygen, pH, specific conductance, salinity and temperature were recorded daily in all replicates. Temperature was also monitored in the incubator during the assay.

2.4.3 *Strongylocentrotus fransiscana* Sperm Motility and Fertilization Assay

Sea urchin sperm collected prior to the start of the assay were evaluated to determine viability and density. A 5 mL aliquot of each sample was placed into one of three (3) replicates. Test chambers were 20 mL glass scintillation vials. The density of the sperm solution was adjusted to achieve a final concentration of 4.6 to 7.2 X 10^7 sperm per mL in the test solutions. Sperm were exposed to the surface water samples for a period of 60 minutes. After the 60 minute exposure period sufficient eggs were added to the sperm/water solution to achieve a final density 2800 to 3000 eggs per mL. Fertilization was allowed to proceed until the development of a fertilization membrane, 30 to 40 minutes. A preservative was then added to the solution to stop development and preserve the eggs. Eggs were examined microscopically to determine the number fertilized and unfertilized. Assays were started on January 24, and 28, 1996 and February 1, 1996.

2.4.4 *Mytilus edulis* Larval Development Assay

The mytilid egg larval development assay utilized a 48-hour exposure period. The assay was conducted in a static mode. Eggs and sperm were mixed and fertilization allowed to proceed. After 60 minutes the eggs were checked to determine the fertilization rate. Two (2) hours after fertilization, the eggs were added to the test solutions. Egg densities were set at approximately 200 eggs per mL. Test vessels were 50 mL beakers containing 25 mL of solution. Each surface water treatment and laboratory utilized 4 replicates. Eggs were incubated at 16 ±1°C for 48 hours. At the end of the incubation period a preservative was added to each test vessel. Larvae were examined microscopically to determine the larval stage and normality of the larvae. Larvae should have progressed to the "straight hinge" stage and developed a larval shell. Larvae were considered as normal if they had developed the larval shell. Misshapen larvae were considered as normal as long as the larval shell was present. Assays were started on January 25, 1996 and February 2, 1996.

2.4.5 *Eisenia foetida* Acute Exposure Assay

The earthworm, *Eisenia foetida*, assay was conducted as a 14-day acute, static, exposure assay with survival as the endpoint. The assay specified use of 4 replicates while the laboratory control soil treatment incorporated 7 replicates. The additional laboratory control replicates were incorporated into the study design to provide additional tissue mass to serve for duplicate and spiked samples in subsequent chemical analyses. Protocol for this assay specifies 10 worms per replicate. In order to achieve sufficient tissue for future chemical analysis, all treatments utilized 25 worms per replicate. Prior to use all soil samples were evaluated to determine percent moisture. Soil for the assay was screened through a 2.0 mm screen to remove stones and large pieces of detritus. As a guideline OECD (1992) protocol for a worm assay were reviewed. This protocol calls for hydrating the soil to a moisture level of approximately 30%, or to a point in time that when squeezed in the hand, no excess water drips from the soil. The pH of each soil sample was checked prior to the start of the assay. The protocol specified that soil pH was to be adjusted to between 6.0 and 8.0 SU as required. None of the test soils required pH adjustment. Approximately 1000 grams (500 grams specified by protocol) of the hydrated soil was added to a 1000 mL clear glass bottle. A 2 mm hole was drilled in the cap to allow ventilation. Bottles were place in an incubator at 20 ±2°C. Lighting was set at 18 hour light and 6 hours dark. Light intensity was approximately 50 foot candles. During the exposure period incubator temperature was checked daily. After 7 and 14 days exposure the bottles were opened and the contents spilled into a tray. Living worms were removed from the soil and counted. Assays were started on February 1, 1996.

2.4.6 *Hyalella azteca* Survival and Growth assay

The 10-day chronic sediment test was conducted according to the methods of US EPA (1989) and ASTM (1990), which calls for the sifting of the test and control sediments to remove all rocks, twigs, and other debris. Approximately 200 mL of the sediment was placed in a 1000 mL beaker, the beaker was filled with approximately 750 mL of moderately hard reconstituted laboratory water. As the amphipod is a freshwater organism, the overlying water was moderately hard reconstituted water as specified by the protocol. Sediment and overlying water were gently aerated overnight. Any floating detritus was removed from the water surface. The next day, the test organisms were added below the surface of the overlying water. Test replicates were maintained at 22±2°C with a 16:8 hour light:dark photoperiod. The amphipod test used 4 replicates with 20 organisms/replicate for the each test sediment. The laboratory control sediment treatment incorporated 4 replicates with 20 organisms per replicate. Organisms were acclimated to the overlying water prior to adding to the test chambers. Acclimation called for changing the culture water, moderately hard reconstituted water, to overlying water in three steps. In the first step 25% of the culture water was replaced with overlying water. After 2 hours 50% of the water containing the amphipods was replaced with overlying water. After an additional two hours 50% of the holding water was replaced with overlying water. Each replicate was fed 0.5 ml suspension of rabbit food and deionized water or a yeast-trout chow-cerophyll mixture on Mondays, Wednesdays, and Fridays. Temperature, pH, dissolved oxygen and specific conductance were measured daily. At the end of the assay test sediments were removed from the test vessels and the amphipods recovered. Amphipods were rinsed with deionized water and place in pre-weighted containers. Amphipods were dried to a constant weight at 60°C. Amphipods were weighed to the nearest 0.001 mg. The amphipod assays were started on January 30, 1996.

2.5 Data Analysis

Survival and growth data were analyzed using Analysis of Variance techniques (ANOVA) to determine if a significant difference existed between treatments and the laboratory controls. Data were analyzed using the TOXSTAT program developed by the University of Wyoming. Data sets were evaluated to determine the homogeneity of variances and normality of the distribution of the data points. Data sets determined to be both normally distributed and homogenous were evaluated using parametric statistical techniques. Data sets that did not meet the specification of normal distributions and homogenous variances were evaluated using less rigorous, non-parametric, statistics. Replicate data were combined and statistical significance was accepted at $p < 0.05$.

2.8 Quality Control

As part of the laboratory quality control program, standard reference toxicant tests, which provide relative health and response data of test organisms, were performed on the minnow, mysids, earthworms and amphipods. The Sodium Dodecyl Sulfate (SDS) assays resulted in 48 hour LC-50 values of 8.05 mg/L (Binomial Method) with *M. beryllina* and 18.0 mg/L (Binomial) with *M. bahia*. These values were within 2 and 1 standard deviations of the historic mean for each species, respectively. The SDS assay conducted with *H. azteca* resulted in a 48 hour LC-50 value of 0.01 mg/L (Moving Average). The copper reference toxicant test run with *S. fransciscana* resulted in an EC-50 of 15.9 μg/L copper (Spearman-Karber Method) and a C-NOEC of 10.0 μg/L copper. Both values were within one standard deviation of their historic means.

3.0 RESULTS AND DISCUSSION

Table 1 provides a summary of sample collection and receipt data. Table 2 provides a summary of results from the 96-hour acute exposure *M. beryllina* assays. Data from the mussel larvae assays are summarized in Table 3. Table 4 provides a review of data collected from the sea urchin, *S. franciscana*, sperm motility tests. Survival and growth data from the 10-day mysid, *M. bahia*, and amphipod, *H. azteca*, sediment assays are provided in Tables 5 and 6, respectively. Table 7 provides a summary of data from the 14-day earthworm, *E. foetida*, tests. Table 8 incorporates general water quality data collected, alkalinity, pH, specific conductance, salinity, and ammonia, from the surface water samples at the start of the assays. Support data, laboratory bench sheets and statistical printouts are included in Appendix A.

3.1 *Menidia beryllina* 96-Hour Acute Exposure Assays

Review of laboratory control data at the end of the assays showed survival in the control treatments for assays started on January 24 was 100%. Assays started on January 27 were grouped into three (3) separate series based on the salinity of the samples. Laboratory controls for these groups of tests had salinities of 5‰, 10‰ and 25‰, corresponding to the approximate salinities of the samples. Test organisms were acclimated to the altered salinities over a 4 hour period. During this time the salinity was decreased from approximately 25‰ to the target salinity. Survival in the laboratory control treatments for the 3 sets of assays started on January 27 varied from 70 to 95%.

Review of the individual tests showed that survival in laboratory controls having salinities of 10‰ and 25‰ were 95 and 90%, respectively. Survival in the laboratory control treatment with a salinity of 5‰ was 70%. On February 2, two (2) sets of laboratory control treatments were required to match salinity ranges of 20‰ and 30‰ observed for the samples. Survival in both sets of laboratory controls for assays started on February 2 was 100%. Minimum acceptable survival for these assays was 90%, lower control survival suggests that either the organisms or the physical environment may have had an impact on the outcome of the assays. The data from the assays started on January 27 suggest that the low salinity, and not stressed organisms was responsible for the low survival.

Survival in the background "BG" sites collected on January 26, and tested on January 27, 1996 was as follows; 20% in BG3SW-01, 25% IN BG2SW-01, 60% in BG1SW-O1. Analysis of the data documents that the survival in all three background sites was statistically different from the laboratory control. Review of the support data associated with the background sites indicates that salinity of the overlying water at sites BG2SW-01 and BG3SW-01 was 38‰ and 37‰, respectively. As the minnows were not acclimated to elevated salinities, the relatively high salinity of these two samples may have been responsible for the low survival. Data from site BG1SW-01 showed this sample had a low salinity, 5‰. Even with acclimation over a 4 hour period, it is possible the low salinity may have contributed to the reduced survival.

Survival of the silversides in surface waters from sites in the "S1" and "S9" areas, collected on January 22, 1996 and January 23, 1996 respectively, showed mean survival values ranging from 75% in waters from site S1SW-02 to 95% in waters from site S9SW-01 after 96 hours exposure. The salinity of samples in this group was approximately 25‰. Survival in the associated laboratory controls was 100%. Analysis of the data sets, using non-parametric t-Tests, showed that there was no difference in survival rates between any of the treatments and the laboratory controls.

Survival of the silversides exposed to surface waters from sites in the "S2" and "S3" project locations, collected on January 25, 1996, showed mean survival values after 96 hours exposure ranging from 65% in waters from site S2SW-02 to 95% in waters from site S3SW-05. These samples had a salinity of 10‰. Survival in the associated 10‰ laboratory controls was 95%. Statistical analysis of the individual data sets showed that silverside survival in waters from site S2SW-02 was significantly different from survival in the laboratory control. Survival in the other treatments was not different from the control.

Silversides exposed to surface waters from sites in the "S1" and "S2" project areas, collected between January 30, 1996 and February 1, 1996 exhibited mean 96 hour exposure survival values ranging from 75% in waters from site S1SW-05 to 100% in waters from sites S2SW-01 and S2SW-05. Analysis of the data showed that the survival of the silversides was not significantly impacted by exposure to these waters.

3.2 *Mytilus edulis* 48-Hour Larval Development Assays

Data collected at the end of the 48 hour exposure period (Table 3) showed that "normal" development, having developed a larval shell and reaching the straight hinge development stage, of the mytilid larvae in the three sets of laboratory controls ranged from 91.5 to 96.5%. These values were greater than the minimum acceptable value of ≥ 80% specified by the protocol.

Normal development of the mytillid larvae in surface water samples provided from the two background sites, "BG2SW-01" and "BG3SW-01" was observed to be 11.8% and 94.6%, respectively. Surface waters from site "BG2SW-01" appeared to have had a significant negative impact on the development of the mussel larvae.

Data from the surface water collected at various locations in the "S1" and "S9" project areas collected on January 2 and 23, 1996 showed normal development rates ranging from 88.0% at location "S9SW-05" to 96.3% at locations "S9SW-01" and "S9SW-03". Analysis of surface waters collected on January 24 at three sites from project area "S1" showed normal development rates ranging from 93.0% at site S1SW-05 to 94.2% in waters from site S1SW-04. Analysis of the data showed that development of the mussel larvae was not significantly impacted by exposure to surface waters from any of the 10 locations within the two project areas.

3.3 *Strongylocentrotus franciscana* 2-Hour Sperm Motility/Fertilization Assays

Data collected at the end of the 2-hour exposure period showed fertilization rates for the three sets of laboratory controls ranged from 84.1% to 99.7%(Table 4). This exceeds the minimum requirement of 70% to 90% fertilization required by the protocol. Surface water samples provided from the two background sites, "BG2SW-01" and "BG3SW-01" showed fertilization rates of 92.1% and 86.6%, respectively. Analysis of the data showed that fertilization rates for both background sites were statistically similar to that observed in the laboratory controls.

Data from the surface water collected at various locations in the "S1" and "S9" project areas showed fertilization rates ranging from 61.4% at location "S1SW-03" to 100% at locations "S9SW-01", "S9SW-02" and "S9SW-03". Analysis of the data showed that fertilization of the sea urchin eggs was not significantly impacted by exposure to surface waters from any of the 10 locations within the two project areas.

3.4 *Mysidopsis bahia* 10-Day Sediment Assays

After 10 days exposure, there was 86.7% survival in the laboratory control replicates (Table 5). Surviving control mysids had a mean dry weight of 0.252 mg per individual. Survival data indicate that the organisms were healthy and not stressed by handling.

Survival in the background sediment provided with this series of assays, BG3SD-01 was 90.0% and surviving mysids had a mean dry weight of 0.301 mg/individual. Analysis of the data showed that survival in the background sample was not significantly different from that observed in the laboratory control. A review of growth data, dry weights, showed that mysids maintained in the background sediment had growth rates that were not significantly different from the laboratory control.

Review of survival data showed that mysids exposed to sediments from the 5 locations with the "S1" and "S9" project areas had mean survival rates ranging from 85.0% at location S9SD-04 to 100% at location S9SD-05. The survival of the mysids maintained in all the test sediments was not significantly different from either the laboratory control or background site. Analysis of the dry weight data, growth data, showed mean dry weights ranging from 0.220 mg/individual for mysids maintained in sediment from location S1SD-05 to 0.327 mg/individual for mysids maintained in sediments from locations S1SD-01 and S1SD-03. Statistical analysis of the growth data showed that mysids maintained in sediments from either the "S1" or "S9" project sites were not significantly different from either the laboratory control or the background sediment sample.

3.5 *Hyalella azteca* 10-Day Sediment Assays

Data from the 10-day exposure amphipod sediment assay are summarized in Table 6. After 10 days exposure, there was 86.3% survival in the laboratory control replicates. Surviving control amphipods had a mean dry weight of 0.060 mg per individual. Temperature data presented on the data sheets reflects temperatures at the laboratory bench in 25 mL surrogate test vessels used to measure dissolved oxygen and pH values. Incubator temperature logs document that test temperatures were within the ranges specified by the protocol. Survival data indicate that the organisms were healthy and not stressed by handling. Survival in the background sediment provided with this series of assays, BG1SD-01 was 61.3% and surviving amphipods had a mean dry weight of 0.029 mg/individual. Analysis of the data showed that survival in the background sample was significantly lower than observed in the laboratory control. A review of growth data, dry weights, showed that amphipods maintained in the background sediment were significantly different, smaller, than those maintained in the laboratory control sediment.

Review of survival data showed that amphipods exposed to sediments from the 5 locations within the "S2" and "S3" project areas had mean survival rates ranging from 51.3% at location S2SD-03 to 90% at location S3SD-05. There was a significant difference in survival between *H. azteca* exposed to sediments from sites S2SD-01, S2SD-02, S2SD-03, S2SD-04, S2SD-05, S3SD-02 and BG1SD-01, and *H. azteca* maintained in the control sediment. Analysis of the dry weight data for growth showed mean dry weights ranging from 0.029 mg/individual for amphipods maintained in sediment from site S2SD-02 to 0.099 mg/individual for amphipods maintained in sediment from site S3SD-03. Statistical analysis of the growth data showed that amphipods maintained in sediments from sites S2SD-02 and BG1SD-01 were significantly different from that observed the laboratory control.

3.6 *Eisenia foetida* Survival Assays

Review of survival at the end of the 14-day exposure period showed there was 84% survival in the laboratory control soil. Protocol indicate that survival in the laboratory control should be ≥90%. Survival in individual laboratory control replicates ranged from 72 to 96% (Table 7). Survival in the three background soil samples provided with this series of assays, "BG1SS-01", "BG2SS-01 and "BG3SS-01", was 0%, 68% and 16%, respectively. Review of the assay and its protocol showed that the organism loading rate was higher than specified by the protocol. It is possible that the increased loading may have resulted in an increase in metabolic waste products which could have impacted survival. The increased loading rates were used to provide additional tissue that would be used in subsequent tissue analysis.

After 7 days exposure to the soils, test chambers were emptied and the number of live organisms determined. Data from this point in the assay showed survival ranging from 0% for organisms exposed to soils from sites BG1SS-01 and S1SS-05 to 77% for organisms maintained in soil from site S1SS-05. Survival in the laboratory control soil was 89.7%. Observations made during the assay showed that worms exposed to soils from sites BG1SS-01 and S1SS-05 exhibited significant stress when added to the soils. In both cases, the worms actively attempted to avoid the soils by climbing up the sides to the test chambers. After 30 minutes worms in all other soils had burrowed below the soil surface and were not visible. Worms in soils from BG1SS-01 and S1SS-05 had not started burrowing after the initial 30 minute period. General observations made during temperature monitoring indicated that a number of worms in these two soils were dead within 24 hours of starting the test.

Data collected at the end of the assay, 14 days exposure, showed worm survival ranging from 0.0% for worms exposed to soils from locations "S1SS-05" to 57% survival for worms maintained in soils from location S1SS-04. Analysis of the data set showed a statistically significant difference in survival between worms maintained in the soils from the project site and the laboratory control soil. A statistical comparison of survival between the "BG2SS-01" reference site and soils from the "S1" project locations showed that worm survival in the S1SS-01 soil was not significantly different from the background soil. Survival in soils, "S1SS-05" and "S1SS-07" was significantly lower than in the "BG2SS-01" background soil. Due to their low survival, comparisons were not made against the "BG1SS" and "BG3SS-01" background soils.

3.7 Summary

Data collected from this series of assays have showed that waters, sediments and soils collected from the Naval Air Station, Key West project sites have a range of toxicities that vary with test species. The overlying waters from within the project sites exhibited low levels acute toxicity to the inland silverside, *Menidia beryllina*, though not enough to be considered a significant impact with the exception of waters from S2SW-02. The development of mussel larvae and fertilization of the sea urchin were not significantly impacted by exposure to overlying waters from any of the project sites. Sediments from sites "S1" and "S9" had no significant effects on either the survival or growth of the mysid, *Mysidopsis bahia*. The soils from the majority of the sites in "S2" and "S3" had a significant effect on both the survival and growth of the amphipod, *H. azteca*. The survival of the earthworm, *Eisenia foetida*, appears to have been significantly impacted by the soils from all of the locations within the "S1" project sites.

The areas of greatest impact to the test organisms appear to have been in response to surface water, sediments and soils from the background sites. In the assays with *M. beryllina, M. edulis, H. azteca,* and *E. foetida*, the lowest survival and growth rates occurred in either sediments or surface water form these areas. The only tests which did not show significant negative responses were the sea urchin sperm motility assay mysid sediment assays.

4.0 LITERATURE CITED

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TABLE 1. Summary of Sample Collection Information. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Collection Date	Collection Time	Arrival Date	Arrival Time	Arrival Temp.
S1SD-01	01/22/96	1300	01/23/96	1000	5
S1SW-02	01/22/96	1300	01/23/96	1000	5
S1SD-02	01/22/96	1400	01/23/96	1000	5
S1SW-02	01/22/96	1400	01/23/96	1000	5
S9SW-01	01/23/96	1030	01/24/96	0930	6
S9SD-01	01/23/96	1030	01/24/96	0930	6
S9SW-02	01/23/96	1100	01/24/96	0930	6
S9SD-02	01/23/96	1100	01/24/96	0930	6
S9SW-03	01/23/96	1430	01/24/96	0930	6
S9SD-03	01/23/96	1430	01/24/96	0930	6
S9SW-04	01/23/96	1245	01/24/96	0930	6
S9SD-04	01/23/96	1245	01/24/96	0930	6
S9SW-05	01/23/96	1320	01/24/96	0930	6
S9SD-05	01/23/96	1320	01/24/96	0930	6
S1SD-04	01/24/96	1010	01/25/96	0930	NA
S1SD-05	01/24/96	1045	01/25/96	0930	NA
S1SD-03	01/24/96	1150	01/25/96	0930	NA
S1SW-04	01/24/96	1010	01/25/96	0930	NA
S1SW-05	01/24/96	1045	01/25/96	0930	NA
S1SW-03	01/24/96	1150	01/25/96	0930	NA
S2SD-01	01/24/96	1415	01/25/96	0930	NA
S2SW-01	01/24/96	1415	01/25/96	0930	NA
S2SD-05	01/24/96	1445	01/25/96	0930	NA
S2SW-05	01/24/96	1445	01/25/96	0930	NA
S2SD-02	01/25/96	0900	01/26/96	0945	4
S2SW-02	01/25/96	0900	01/26/96	0945	4
S2SW-03	01/25/96	0925	01/26/96	0945	4
S2SD-03	01/25/96	0925	01/26/96	0945	4
S2SD-04	01/25/96	1005	01/26/96	0945	4
S2SW-04	01/25/96	1005	01/26/96	0945	4
S3SD-01	01/25/96	1215	01/26/96	0945	4
S3SW-01	01/25/96	1215	01/26/96	0945	4
S3SD-02	01/25/96	1240	01/26/96	0945	4
S3SW-02	01/25/96	1240	01/26/96	0945	4
S3SD-03	01/25/96	1420	01/26/96	0945	4
S3SW-3	01/25/96	1420	01/26/96	0945	4

TABLE 1. Summary of Sample Collection Information. Naval Air Station Key West Toxicity Evaluation. January 1996 (Continued).

Site	Collection Date	Collection Time	Arrival Date	Arrival Time	Arrival Temp.
S3SW-04	01/25/96	1430	01/26/96	0945	4
S3SD-04	01/25/96	1430	01/26/96	0945	4
S3SW-05	01/25/96	1515	01/26/96	0945	4
S3SD-05	01/25/96	1515	01/26/96	0945	4
BG1SW-01	01/26/96	0945	01/27/96	1045	1
BG3SS-01	01/26/96	0945	01/27/96	1045	1
BG3SW-01	01/26/96	1145	01/27/96	1045	1
BG3SD-01	01/26/96	1145	01/27/96	1045	1
BG2SW-01	01/26/96	1145	01/27/96	1045	1
BG1SS-01	01/26/96	1340	01/27/96	1045	1
BG1SD-01	01/26/96	1340	01/29/96	NA	NA
BG2SS-01	01/26/96	1340	01/29/96	NA	NA
BG2SD-01	01/26/96	0945	01/29/96	NA	NA
S2SW-05	01/31/96	0940	02/01/96	1015	NA
S2SW-01	01/31/96	0950	02/01/96	1015	NA
S1SS-04	01/31/96	0840	02/01/96	1015	NA
S1SS-05	01/31/96	0900	02/01/96	1015	NA
S1SS-07	01/31/96	0920	02/01/96	1015	NA
S1SW-04	02/01/96	1257	02/02/96	0930	NA
S1SW-05	02/01/96	1255	02/02/96	0930	NA

NOTES:

NA = Data not available.

TABLE 2. Summary of Survival Data from the Acute, 96-Hour, Exposure Assays Conducted with the Silverside, *Menidia beryllina*, Exposed to Surface Water Samples from the Naval Air Station Key West Project Sites. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Date Collected	Date Received	Assay Start	Percent Survival Rep A	Rep B	Rep C	Rep D	Rep E	Rep F	Mean
Control - 25‰ Salinity			1/24	100	100	100	100	100	100	100.0
S1SW-01	1/22	1/23	1/24	80	80					80.0
S1SW-02	1/22	1/23	1/24	100	50					75.0
S9SW-01	1/23	1/24	1/24	90	100					95.0
S9SW-02	1/23	1/24	1/24	90	60					75.0
S9SW-03	1/23	1/24	1/24	70	100					85.0
S9SW-04	1/23	1/24	1/24	90	90					90.0
S9SW-05	1/23	1/24	1/24	80	100					90.0
Control - 25‰ Salinity			1/27	90	90					90.0
BG2SW-01	1/26	1/27	1/27	40	10					25.0***
BG3SW-01	1/26	1/27	1/27	10	30					20.0***
Control - 5‰ Salinity			1/27	70	70					70.0
BG1SW-01	1/26	1/27	1/27	90	30					60.0
Control - 10‰ Salinity			1/27	90	100					95.0
S2SW-02	1/25	1/26	1/27	60	70					65.0***
S2SW-03	1/25	1/26	1/27	90	50					70.0
S2SW-04	1/25	1/26	1/27	90	50					70.0
S3SW-01	1/25	1/26	1/27	80	80					80.0
S3SW-02	1/25	1/26	1/27	70	100					85.0
S3SW-03	1/25	1/26	1/27	90	80					85.0
S3SW-04	1/25	1/26	1/27	80	100					90.0
S3SW-05	1/25	1/26	1/27	90	100					95.0
Control - 20‰ Salinity			2/02	100	100	100	100			100.0
S2SW-01	1/31	2/01	2/02	100	100					100.0
S2SW-05	1/30	2/01	2/02	100	100					100.0
Control - 30‰ Salinity			2/02	100	100	100	100			100.0
S1SW-04	2/01	2/02	2/02	90	90					90.0
S1SW-05	2/01	2/02	2/02	80	70					75.0

NOTE:
*** = Significant difference in survival between treatment and laboratory control.

TABLE 3. Summary of Development Data from the 48-Hour Exposure Larval Development Assays Conducted with the Mytilid, *Mytilus edulis*, Exposed to Surface Water Samples from the Naval Air Station Key West Project Sites. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Date Collected	Date Rec.	Assay Start	REP A	REP B	REP C	REP D	MEAN
				% Larvae with Normal Development				
Laboratory Control			01/25	97.9	96.9	95.5	95.6	96.5
S1SW-01	01/22	01/23	01/25	100.0	94.9	95.7	94.4	96.2
S1SW-02	01/22	01/23	01/25	84.5	95.7	98.9	98.4	94.4
S9SW-01	01/23	01/24	01/25	100.0	97.8	91.5	96.1	96.3
S9SW-02	01/23	01/24	01/25	96.0	92.2	93.7	96.6	94.6
S9SW-03	01/23	01/24	01/25	97.3	94.9	96.8	96.3	96.3
S9SW-04	01/23	01/24	01/25	94.0	94.0	95.5	94.3	94.5
S9SW-05	01/23	01/24	01/25	83.8	87.6	88.1	92.3	88.0
Laboratory Control			01/26	91.9	92.9	92.3	92.3	92.4
S1SW-03	01/24	01/25	01/26	90.4	93.8	94.5	95.3	93.5
S1SW-04	01/24	01/25	01/26	93.4	93.6	95.1	94.7	94.2
S1SW-05	01/24	01/25	01/26	92.4	95.6	91.5	92.3	93.0
Laboratory Control			01/27	82.3	93.6	95.9	94.2	91.5
BG2SW-01	01/26	01/27	01/27	21.4	14.6	92.0	1.9	11.8***
BG3SW-01	01/26	01/27	01/27	92.4	93.1	96.6	96.4	94.6

NOTE:

*** = Significant difference in normal development between treatment and laboratory control.

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S9SD-03	Lab Salt	12/9/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	18.3	6.9	7.93	30.3	23	18.6	7.2	7.99	30.4	23	18.6	7.3	8.00	30.6	23	18.6	7.2	8.00	32.2	25
1	19.7	7.1	8.07	30.9	24	19.6	7.2	8.03	31.8	24	19.6	7.3	8.03	31.8	25	19.6	7.3	8.05	33.6	26
2	18.6	7.0	8.05	31.8	25	18.4	6.8	7.94	31.6	25	18.5	7.0	8.01	31.8	25	18.6	7.1	7.92	34.0	26
3	18.1	7.7	7.88	31.8	31	17.9	7.4	8.03	32.1	27	18.1	7.6	8.04	32.8	27	17.9	7.6	7.91	35.1	28
4	18.4	6.6	8.04	31400	26	18.5	6.8	7.87	32600	27	18.6	6.6	7.96	32600	29	18.5	6.8	8.02	32500	30
5	16.9	7.2	8.06	31900	27	17.1	7.0	7.88	32600	27	17.2	6.9	7.87	33400	27	17.0	6.5	7.90	32600	30
6	18.1	7.1	7.87	40.3	32	18.2	7.0	7.84	36.9	30	18.5	6.7	7.90	35.3	30	18.6	6.8	8.08	34.4	28
7	18.6	6.5	7.98	35.4	26	18.5	7.5	8.07	35.6	26	18.7	7.5	8.09	37.7	28	18.6	7.5	8.08	43.0	33
8	19.3	6.6	7.85	36.3	27	19.1	7.5	8.04	37.1	27	19.2	7.6	8.05	38.4	28	19.3	7.7	8.05	43.0	32
9	17.9	5.5	7.82	34.1	30	17.9	7.0	8.06	35.2	30	17.9	7.2	8.11	37.1	32	17.9	7.2	8.09	41.4	36
10	19.4	7.1	8.05	36.1	28	19.3	7.2	7.95	37.3	28	19.4	7.1	8.02	38.5	30	19.5	7.2	8.01	43.4	35

14 15 10 12

m. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT: Lab Salt	START DATE:
5563	S1SD-01	1/26 ~~[illegible]~~	1/29/96

	DAY	REP A					REP B					REP C					REP D				
		TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
1/29	0	18.3	8.0	7.93	31.0	27	18.9	8.2	7.88	31.5	27	18.4	6.9	7.74	34.2	27	18.8	7.0	8.01	36.6	28
	1	19.6	7.4	8.06	31.8	24	19.7	7.4	7.92	34.4	25	19.6	7.4	8.00	34.9	25	19.6	7.4	8.15	36.9	27
1/31	2	19.0	7.4	8.05	34.8	27	19.1	7.5	8.02	34.9	27	19.0	7.3	8.04	35.2	27	18.9	7.3	8.14	37.9	29
	3	18.1	7.9	8.09	35.0	28	18.3	7.9	8.04	35.1	29	18.2	7.8	8.08	35.9	29	18.3	7.8	8.18	38.5	32
2/2	4	18.7	7.4	8.11	35.00	27	18.7	7.1	8.12	35.00	28	18.7	7.0	8.12	36.00	29	18.6	6.9	8.20	39.00	31
2/3	5	17.8	7.3	8.12	35500	28	17.9	7.1	8.14	36500	28	17.4	7.1	8.12	36.00	29	17.0	7.8	8.18	39600	30
2/4	6	18.6	7.4	8.09	37.2	29	18.9	6.6	8.06	38.1	30	18.8	6.6	8.03	39.3	33	18.6	7.2	8.18	44.1	38
2/5	7	18.5	6.5	8.01	38.5	30	18.4	5.9	7.99	38.5	30	18.5	7.4	8.21	40.0	30	18.8	6.0	8.10	46.4	36
2/6	8	19.5	7.7	8.15	39.1	30	19.6	7.6	8.15	38.5	29	19.4	7.6	8.18	40.2	30	19.3	7.6	8.18	44.0	35
2/7	9	18.0	7.2	8.18	37.6	30	18.1	7.2	8.18	37.8	30	18.1	7.2	8.23	39.0	33	17.9	7.2	8.23	43.2	35
2/8	10	19.7	7.0	8.12	39.5	30	19.7	7.0	7.99	39.4	30	19.6	7.1	8.19	41.8	31	19.6	7.1	8.18	45.5	35
		12					16					14					14				

m. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S9SD-04	Lab Salt	1/29/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	18.1	8.4	7.95	35.1	28	18.0	8.6	7.96	34.3	27	18.2	8.6	7.97	34.7	27	18.3	8.6	7.95	36.0	28
1	19.8	7.6	8.01	33.6	27	19.3	7.5	8.03	34.4	27	19.5	7.5	8.02	34.4	27	19.3	7.4	8.02	35.5	28
2	18.4	7.5	8.00	34.1	28	18.6	7.5	8.01	34.9	30	18.6	7.4	8.02	34.9	27	18.4	7.4	8.02	37.3	30
3	17.9	7.7	8.02	36.9	31	18.2	7.8	8.03	35.7	30	18.4	7.8	8.03	36.0	29	18.1	7.9	8.00	39.1	29
4	18.1	7.0	8.03	38000	30	18.2	7.0	8.05	36000	29	18.4	7.1	8.03	38500	30	18.3	7.1	8.02	41600	33
5	16.7	7.9	8.08	33400	30	17.2	7.7	8.11	34000	31	17.4	7.8	8.10	37800	31	17.2	7.6	8.08	42000	32
6	18.1	7.5	8.06	41.1	32	18.4	7.5	8.10	39.0	33	18.4	7.5	8.09	40.5	34	18.1	7.5	7.92	47.3	40
7	18.1	7.5	8.01	42.2	34	18.3	7.6	8.03	40.7	26	18.4	7.6	8.04	42.6	33	18.4	7.6	7.99	50.6	41
8	18.8	7.6	8.00	42.4	33	18.8	7.8	8.03	36.7	30	19.0	7.8	8.01	41.2	31	18.9	7.8	7.98	45.7	35
9	17.6	7.1	8.03	40.0	30	17.6	7.2	8.06	38.1	34	17.6	7.3	8.05	39.5	35	17.6	7.3	8.03	44.9	40
10	19.3	7.2	7.97	42.0	35	19.1	7.2	7.99	40.7	31	19.1	7.2	7.98	41.1	33	19.2	5.8	7.78	46.2	38

16 16 15 15

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S9SD-01	LabSalt	1/29/96

	DAY	REP A					REP B					REP C					REP D				
		TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
29	0	18.1	8.7	7.95	34.5	27	18.4	8.6	7.90	34.4	27	18.3	8.6	7.95	35.1	27	18.4	8.5	7.94	36.4	29
	1	19.5	7.3	8.01	32.7	24	19.6	7.3	8.01	34.1	25	19.5	7.3	8.01	35.3	26	19.2	7.2	8.01	36.3	27
13	2	18.6	7.4	8.02	34.4	28	18.6	7.4	8.00	34.4	26	18.4	7.3	8.00	35.0	26	18.2	7.4	8.00	37.6	30
	3	18.1	7.8	8.04	34.8	29	17.9	7.8	7.98	34.8	29	17.9	7.8	8.03	35.4	31	17.9	7.9	8.02	39.1	32
12	4	17.9	7.1	8.06	36800	30	17.7	7.0	8.06	35.00	30	17.9	7.0	8.06	37400	31	17.9	7.1	8.04	40800	33
13	5	17.1	7.3	8.11	35600	30	17.2	7.4	8.05	36800	30	17.1	7.4	8.03	38200	31	17.3	7.5	8.06	41800	33
14	6	18.3	7.3	7.96	38.2	28	18.3	7.3	7.89	39.1	31	18.3	7.4	7.98	42.3	35	18.2	7.3	7.96	46.5	40
15	7	18.1	7.6	8.05	39.0	30	18.2	7.7	8.05	39.2	30	18.4	7.7	8.04	42.0	32	18.2	7.0	7.86	48.6	38
16	8	19.1	7.6	8.05	39.9	31	19.2	7.7	8.01	39.9	30	19.1	7.8	7.98	42.6	32	19.1	7.8	8.01	44.2	30
17	9	17.6	7.3	8.08	37.8	34	17.5	7.3	8.06	37.6	33	17.5	7.3	8.03	40.2	30	17.5	7.3	8.03	43.9	40
18	10	19.2	7.0	7.96	39.8	31	19.2	7.2	8.00	40.9	31	19.0	7.2	7.99	41.9	34	19.0	7.3	7.96	47.1	39

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M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	SISD-03	LabSalt	1/29/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	17.7	8.8	7.80	30.3	25	18.3	8.4	7.61	31.3	24	18.9	8.4	7.53	31.5	24	18.9	8.3	7.50	31.9	24
1	19.4	7.2	7.85	31.5	24	19.3	7.3	7.83	32.0	24	19.6	7.3	7.72	32.6	24	19.6	7.3	7.66	32.2	24
2	19.0	7.3	7.83	33.2	26	18.9	7.4	7.81	33.0	26	18.9	7.4	7.72	32.8	26	18.9	7.3	7.63	33.1	26
3	18.6	7.6	7.86	35.8	27	18.5	7.6	7.81	35.6	27	18.5	7.7	7.66	35.9	28	18.6	7.8	7.60	34.3	28
4	18.2	7.2	7.87	34200	26	18.5	7.2	7.85	34000	27	18.9	7.1	7.76	35400	29	19.1	7.1	7.65	36000	30
5	18.4	7.6	7.88	37800	27	18.3	7.4	7.85	36400	27	18.3	7.6	7.84	35400	29	18.3	7.3	7.68	36400	30
6	18.1	7.4	7.88	37.1	30	18.2	7.5	7.87	37.8	32	18.3	7.5	7.76	37.4	31	18.4	7.4	7.67	38.3	33
7	18.1	7.6	7.84	38.0	30	18.2	7.0	7.61	38.6	30	18.4	7.1	7.57	38.1	30	18.6	7.1	7.55	41.2	32
8	18.9	7.6	7.86	38.7	30	18.9	7.8	7.80	39.8	30	19.1	7.8	7.73	39.3	30	19.1	7.6	7.62	40.4	30
9	18.1	7.0	7.85	37.8	33	18.1	7.2	7.83	37.8	33	18.4	7.3	7.69	37.8	33	18.4	7.2	7.61	39.1	34
10	19.3	7.2	7.79	40.5	30	19.2	7.2	7.75	40.0	30	19.3	6.9	7.59	38.0	30	19.3	6.8	7.53	40.4	32
	15					11					16					10				

m. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S9SD-05	Lab Salt	1/29/96

	DAY	REP A					REP B					REP C					REP D				
		TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
29	0	17.7	8.6	7.88	34.0	27	18.1	8.6	7.93	34.1	27	18.4	8.7	7.95	34.1	27	18.6	8.6	7.96	32.8	26
	1	19.3	7.2	7.97	33.1	24	19.6	7.3	8.08	34.9	26	19.6	7.3	8.00	34.5	26	19.4	7.3	8.07	33.3	26
31	2	18.7	7.3	7.76	34.9	27	18.6	7.4	7.95	35.2	27	18.6	7.4	8.00	35.4	29	18.5	7.5	8.01	34.2	28
	3	18.4	7.4	7.71	35.5	29	18.4	7.3	7.97	35.8	29	18.3	7.3	8.00	35.4	30	18.2	7.6	8.02	34.7	30
2	4	18.4	7.2	7.88	36200	30	18.7	7.2	7.98	36800	30	18.6	7.1	8.02	34200	30	18.6	7.1	8.02	38.0	30
3	5	18.1	7.4	7.81	37700	29	18.0	7.3	7.98	37800	29	17.9	7.4	8.03	38800	30	17.6	7.5	8.07	39.00	30
4	6	18.3	7.3	7.77	38.7	34	18.4	7.5	7.97	38.3	34	18.5	7.8	8.05	39.7	35	18.4	7.5	8.04	42.0	35
5	7	18.1	6.9	7.78	38.9	30	18.3	7.5	7.98	40.6	31	18.4	7.5	8.02	42.3	33	18.5	6.8	7.88	44.3	34
6	8	18.9	7.7	7.94	39.1	30	18.9	7.5	7.98	40.2	30	19.0	7.6	7.98	40.8	31	19.0	7.7	7.96	42.2	32
	9	7.9	7.0	7.90	37.6	33	18.0	7.2	8.01	38.3	33	18.1	7.2	8.02	39.3	35	18.0	7.3	7.99	40.8	36
8	10	19.3	6.6	7.69	40.8	31	19.1	7.0	7.97	40.3	31	19.2	7.1	7.98	40.7	33	19.3	7.1	7.87	44.1	35

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M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	Control	LabSalt	1/29/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	18.4	8.8	7.29	32.8	26	18.3	8.6	7.74	34.5	28	18.5	8.6	7.82	34.7	28	18.9	8.5	7.83	35.8	28
1	19.9	7.4	7.71	35.0	25	19.8	7.2	7.80	36.1	27	19.8	7.2	7.87	36.7	28	19.6	7.2	7.83	37.4	28
2	19.6	7.4	7.34	33.5	27	19.3	7.4	7.63	36.1	25	19.4	7.3	7.76	37.2	31	19.2	7.2	7.80	38.0	30
3	19.7	7.9	7.72	34.7	27	19.5	7.9	7.80	38	28	19.6	7.8	7.82	38.1	32	19.3	7.7	7.83	39.0	32
4	18.9	7.4	7.51	35000	27	19.0	7.4	7.73	36000	28	19.1	7.1	7.90	36000	32	19.7	7.0	7.90	37100	32
5	19.0	7.6	7.31	38300	27	19.0	7.3	7.81	39200	30	19.0	7.2	7.81	39200	31	19.0	7.5	7.89	42100	32
6	18.9	7.4	7.90	38300	30	18.7	7.5	7.91	41800	26	18.7	7.4	7.89	43300	35	18.8	7.4	7.92	45700	37
7	18.0	7.4	7.68	39.0	32	18.2	7.4	7.85	43.6	34	18.1	7.4	7.91	45.3	35	18.4	7.2	7.88	48.1	39
8	19.5	7.3	7.46	39.4	30	19.3	7.4	7.77	42.1	33	19.3	7.5	7.83	43.8	35	19.3	7.2	7.75	45.8	35
9	18.8	7.1	7.68	37.2	32	18.7	7.0	7.79	41.5	36	18.8	7.0	7.85	43.9	38	18.6	7.0	7.81	45.2	38
10	19.8	6.7	7.39	39.0	30	19.8	6.6	7.56	43.0	34	19.8	6.8	7.71	44.4	35	19.6	6.8	7.72	45.9	36
		14					13					11					14			

15 organisms added to each replicate RH 1/29

- AMM, HARD, & ALK PULLED AT START OF ASSAY EB/1/29/96

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	59SD-02	Lab Salt	1/29/96

	DAY	REP A					REP B					REP C					REP D				
		TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
1/24	0	18.0	8.5	7.87	30.4	25	18.4	8.5	7.84	30.7	24	18.5	8.4	7.81	35.0	28	18.6	8.4	7.83	35.9	28
	1	19.6	7.2	7.83	32.2	24	19.5	7.1	7.81	32.1	24	19.6	7.1	7.84	36.0	27	19.6	7.1	7.81	37.0	28
1/31	2	19.3	7.3	7.84	32.2	26	19.0	7.1	7.81	32.5	26	19.1	7.1	7.78	35.7	27	18.9	7.1	7.78	37.1	28
	3	19.1	7.4	7.85	32.7	28	18.9	7.7	7.80	32.6	28	19.1	7.7	7.76	37.1	32	18.9	7.7	7.77	38.8	32
2/12	4	18.6	7.0	7.94	35.00	27	18.6	7.0	7.89	33.800	27	18.6	7.0	7.89	36.300	30	19.1	6.8	7.80	39.600	32
2/13	5	18.7	7.2	7.92	34.400	30	18.5	7.0	7.85	36.400	30	18.6	6.8	7.87	40.600	32	18.6	7.0	7.84	40.700	31
2/14	6	18.5	7.3	7.92	36.3	28	18.4	7.0	7.86	38.3	30	18.4	7.0	7.80	42.6	34	18.6	7.0	7.78	44.9	38
2/15	7	18.3	7.0	7.89	36.8	29	18.1	6.7	7.81	38.2	30	18.2	6.5	7.75	43.1	34	18.5	6.5	7.75	44.3	36
2/16	8	19.0	7.6	7.86	37.7	30	19.0	7.5	7.83	38.4	30	19.1	7.4	7.78	43.0	33	19.0	7.4	7.80	43.6	35
2/17	9	18.6	6.9	7.83	36.0	32	18.4	6.8	7.83	37.8	33	18.5	6.9	7.76	41.5	36	18.6	6.7	7.75	42.9	37
2/18	10	19.5	6.5	7.67	39.2	30	19.3	6.6	7.66	38.8	30	19.4	6.6	7.65	42.9	35	19.4	6.5	7.65	44.6	35

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~~*Arbacia punctulata*~~ 2 Hour Chronic

STUDY	CLIENT	SAMPLE/DILUENT	DATE
55603	Brown + Root		1.28.96

SALINITY ADJUSTMENT RECORD: mL EFFLUENT + mL BRINE = % ACTUAL PERCENTAGE

EFFLUENT CONCENTRATION (%)	WATER QUALITIES D.O. (mg/L)	pH (SU)	SPEC COND (µMHOS)	SALINITY (PPT)	TRC (mg/L)
"AS RECEIVED"					
Lab Salt	8.5	7.38	30800	25	
BG 2SW-01 (100 ml / 45 ml)	7.9	7.89	35400	27	
BG 3SW-01 (mg / 110 ml / 45 ml)	7.8	7.83	35300	27	
~~10% BSC susp. part.~~					
~~25% BSC~~					
~~50% BSC~~					
100% BSC	7.6	7.86	32900	25	

SPERM DILUTIONS:

HEMACYTOMETER COUNT, E: 90 X 10^4 = SPM SOLUTION E = 9×10^5

SPERM CONCENTRATIONS:
SOLUTION E X 40 = SOLUTION A = 3.6×10^7 SPM
SOLUTION E X 20 = SOLUTION B = 1.8×10^7 SPM
SOLUTION E X 5 = SOLUTION C = 4.5×10^6 SPM

FINAL COUNTS:

FINAL SPERM COUNT: 7.2×10^7
FINAL EGG COUNT: 300

TEST TIMES:

SPERM COLLECTED: 1119
EGGS COLLECTED: 1123
SPERM ADDED: 1217
EGGS ADDED: 1315
FIXATIVE ADDED: 1355

~~*Arbacia punctulata*~~ 2 Hour Chronic

STUDY	CLIENT	SAMPLE/DILUENT	DATE
5563	Brown + Root		1·26·96

SALINITY ADJUSTMENT RECORD: ml EFFLUENT + ml BRINE = % ACTUAL PERCENTAGE

ml DILUENT + ml SPRING = % ACTUAL PERCENTAGE

EFFLUENT CONCENTRATION (%)	D.O. (mg/L)	pH (SU)	SPEC COND (µMHOS)	SALINITY (PPT)	TRC (mg/L)
"AS RECEIVED" EFFL.					
"AS RECEIVED" DILN.					
lab	7.9	7.43	35400	28	
SISW -03	6.6	7.39	43700	36	
SISW -04	6.5	7.43	39600	33	
SISW -05	7.1	7.36	41900	34	

SPERM DILUTIONS:

HEMACYTOMETER COUNT, E: 58.5 X 10^4 = SPM SOLUTION E = 5.85×10^5

SPERM CONCENTRATIONS:

SOLUTION E X 40 = SOLUTION A = 2.34×10^7 SPM
SOLUTION E X 20 = SOLUTION B = 1.17×10^7 SPM
SOLUTION E X 5 = SOLUTION C = 2.93×10^6 SPM

FINAL COUNTS:

FINAL SPERM COUNT: 4.68×10^7
FINAL EGG COUNT: 2800

TEST TIMES:

SPERM COLLECTED: 1125
EGGS COLLECTED: 1120
SPERM ADDED: 1221
EGGS ADDED: 1326
FIXATIVE ADDED: 1425

~~*Arbacia punctulata* 2 Hour Chronic~~ VBC 1/24/96

STUDY	CLIENT	SAMPLE/DILUENT	DATE
5563	Brown + Root		1/24/96

SALINITY ADJUSTMENT RECORD: ml EFFLUENT + ml BRINE = % ACTUAL PERCENTAGE

ml DILUENT + ml SPRING = % ACTUAL PERCENTAGE

EFFLUENT CONCENTRATION (%)	D.O. (mg/L)	pH (SU)	SPEC COND (µMHOS)	SALINITY (PPT)	TRC (mg/L)
"AS RECEIVED" EFFL.					
~~"AS RECEIVED" DILN.~~ lab					
S9SW-01					
S9SW-02					
S9SW-03					
S9SW-04					
S9SW-05					
S1SW-01					
S1SW-02					

See documentation form for water qualities

SPERM DILUTIONS:

HEMACYTOMETER COUNT, E: 121 X 10^4 = SPM SOLUTION E = 1.21×10^6

SPERM CONCENTRATIONS:
SOLUTION E X 40 = SOLUTION A = 4.84×10^7 SPM
SOLUTION E X 20 = SOLUTION B = 2.42×10^7 SPM
SOLUTION E X 5 = SOLUTION C = 6.05×10^6 SPM

FINAL COUNTS:

FINAL SPERM COUNT: (A) 4.84×10^7
FINAL EGG COUNT: 2100

TEST TIMES:

SPERM COLLECTED: 1350
EGGS COLLECTED: 1345
SPERM ADDED: 1440
EGGS ADDED: 1542
FIXATIVE ADDED: 1700

DOCUMENTATION FORM #1

STUDY No.: 5363 STUDY DIRECTOR: F. Giordano

PROJECT TITLE: Brown & Root

GENERATED BY: [illegible] DATE: 1.24.96

The following information is

- [X] Miscellaneous Documentation
- [ ] A Deviation from the Protocol
- [ ] A Deviation from SOP _____

water qualities

as rec'd eff	pH	spec con	salinity (ppt)	~~TRC~~ D.O.
S9SW-01	7.54	45600	33	6.7
S9SW-02	7.67	43800	34	6.7
S9SW-03	7.67	44200	34	6.7
S9SW-04	7.65	45400	34	6.7
S9SW-05	7.65	45800	33	6.7
S1SW-01	7.67	47100	33	6.9
S1SW-02	7.37	48300	34	6.5

APPROVED BY: _____ DATE: _____

Mytilus edulis Embryo/Larval Assay

STUDY	CLIENT	SAMPLE/DILUENT	DATE	

Conc (%) Site	REPLICATE VIAL			
	A Normal/Abnormal	B Normal/Abnormal	C Normal/Abnormal	D Normal/Abnormal
Lab	238/5	186/6	193/9	174/8
Lab	153/33	219/15	185/8	195/12
Lab	136/12	183/14	155/13	203/17
S1SW-01	89/0	94/5	154/7	101/6
S1SW-02	87/16	132/6	92/1	123/2
S1SW-03	113/12	165/11	208/12	203/10
S1SW-04	155/11	162/6	154/8	125/7
S1SW-05	122/10	130/6	108/10	126/10
BG2SW-01	42/154	32/187	10/99	4/211
BG3SW-01	122/10	94/7	115/4	108/4
S9SW-01	109/0	131/3	129/12	174/7
S9SW-02	143/6	201/17	179/12	115/4
S9SW-03	142/4	167/9	121/4	156/6
S9SW-04	158/10	172/11	128/6	148/9
S9SW-05	109/~~20~~ 21	211/30	119/16	96/8

Mytilus edulis 48 Hour Development Assay

SITE	REP 1	% Normal REP 2	REP 3	REP 4	MEAN
LAB	0.979	0.969	0.955	0.956	
LAB	0.823	0.936	0.959	0.942	
LAB	0.919	0.929	0.923	0.923	0.934
S1SW-01	1.000	0.949	0.957	0.944	0.962
S1SW-02	0.845	0.957	0.989	0.984	0.944
S1SW-03	0.904	0.938	0.945	0.953	0.935
S1SW-04	0.934	0.936	0.951	0.947	0.942
S1SW-05	0.924	0.956	0.915	0.926	0.930
BG2SW-01	0.214	0.146	0.092	0.019	0.118
BG3SW-01	0.924	0.931	0.966	0.964	0.946
S9SW-01	1.000	0.978	0.915	0.961	0.963
S9SW-02	0.960	0.922	0.937	0.966	0.946
S9SW-03	0.973	0.949	0.968	0.963	0.963
S9SW-04	0.940	0.940	0.955	0.943	0.945
S9SW-05	0.838	0.876	0.881	0.923	0.880

~~*Arbacia punctulata*~~ 2 Hour Chronic

STUDY	CLIENT	SAMPLE/DILUENT	DATE
5563	Brown + Root		2·1·96

EFFLUENT CONCENTRATION (%)	REPLICATE VIAL		
	1	2	3
	UNFERT/TOTAL	UNFERT/TOTAL	UNFERT/TOTAL
lab	18/106	7/108	30/124
SISW-03	68/100	5/105	43/100
SISW-04	8/117	2/102	14/102
SISW-05	29/104	16/100	21/105

~~*Arbacia punctulata*~~ 2 Hour Chronic

STUDY	CLIENT	SAMPLE/DILUENT	DATE
5563	Brown + Root		2·1·96

EFFLUENT CONCENTRATION (%)	REPLICATE VIAL		
	1	2	3
	UNFERT/TOTAL	UNFERT/TOTAL	UNFERT/TOTAL
LabSalt	8/108	7/113	4/112
BG 2SW-01	9/106	5/110	12/111
BG 3SW-01	16/107	6/110	12/105
BSC susp. part.	21/106	16/101	22/112

~~*Arbacia punctulata* 2 Hour Chronic~~ 0-32 1/24/96

STUDY	CLIENT	SAMPLE/DILUENT	DATE
5563	Brown & Root		1.30.96

EFFLUENT CONCENTRATION (%)	REPLICATE VIAL		
	1	2	3
	UNFERT/TOTAL	UNFERT/TOTAL	UNFERT/TOTAL
lab	0/100	~~[illegible]~~ 0/100	0/100
S9SW-01	0/100	2/101	NR 1/30/96 ~~3/104~~ 0/100
S9SW-02	0/100	0/100	NR 1/30/96 ~~2/104~~ 0/100
S9SW-03	0/100	0/100	0/100
S9SW-04	0/100	1/101	0/100
S9SW-05	0/100	0/100	1/101
S1SW-01	0/100	0/101	3/104
S1SW-02	0/100	0/100	2/104

S. fransiscana (Sea Urchin) Sperm Motility (Fertilization) Assay

SITE	% Eggs Fertilized REP 1	REP 2	REP 3	MEAN
LAB	0.830	0.935	0.758	0.841
S1SW-03	0.320	0.952	0.570	0.614
S1SW-04	0.932	0.980	0.863	0.925
S1SW-05	0.721	0.840	0.800	0.787
LAB	0.926	0.938	0.964	0.943
BG2SW-01	0.915	0.955	0.892	0.921
BG3SW-01	0.850	0.945	0.804	0.866
LAB	1.000	1.000	0.990	0.997
S9SW-01	1.000	1.000	1.000	1.000
S9SW-02	1.000	1.000	1.000	1.000
S9SW-03	1.000	1.000	1.000	1.000
S9SW-04	1.000	0.990	1.000	0.997
S9SW-05	1.000	1.000	0.990	0.997
S1SW-01	1.000	1.000	0.971	0.990
S1SW-02	1.000	1.000	0.981	0.994

Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	525D-03	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	18.9	8.8	8.21	2610	20	18.4	8.8	8.19	2860	20	18.5	8.8	8.16	3330	20	18.4	8.8	8.21	3750	20	JR	1/30
1	18.2	9.3	8.30	3000	20	17.8	9.1	8.25	2070	20	18.0	9.3	8.22	3380	20	17.9	9.0	8.26	4030	20	—	2/3
2	17.2	9.0	8.28	3040	20	16.9	9.3	8.23	3420	20	16.6	9.3	8.17	3420	20	16.7	9.3	8.23	4360	20	JR	2/5
3	18.6	8.9	8.30	3030	20	18.0	9.0	8.27	3300	20	18.1	9.0	8.22	3480	20	18.1	8.9	8.29	3910	20	LHB	2/2
4	17.4	8.5	8.39	3260	20	17.0	8.3	8.36	3410	20	17.2	8.5	8.31	3690	20	17.3	8.5	8.27	4220	20	—	2/3
5	18.0	9.1	8.49	3380	20	17.4	9.0	8.44	3680	20	17.6	9.0	8.31	4020	20	17.8	8.7	8.21	4820	20	—	2/4
6	18.0	9.0	8.33	3500	20	17.3	9.2	8.30	3610	20	17.5	9.2	8.28	4200	20	17.5	9.2	8.34	4210	20	LH	2/5
7	18.1	9.0	8.34	3.1	20	17.6	9.0	8.28	3.0	20	17.7	9.0	8.13	3.4	20	17.6	9.0	8.35	3.7	20	EB	2/6
8	17.9	9.0	8.38	3.0	20	17.4	9.0	8.35	2.0	20	17.4	9.1	8.26	3.0	20	17.4	9.0	8.36	3810	20	LH	2/7
9	18.9	8.6	8.34	3.0	20	18.2	8.8	8.33	2.9	20	18.3	8.7	8.26	3.4	20	18.4	8.7	8.36	3.7	20	EB	2/8
10	18.6	8.7	8.40	2.9	20	18.1	9.0	8.38	2.9	20	18.4	9.1	8.32	3.3	20	18.4	9.0	8.40	3.6	20	EB	2/9
11	18.6	8.6	8.33	3840	20	17.9	8.6	8.41	3510	20	18.0	8.7	8.37	3030	20	18.1	8.6	8.39	2850	20	—	2/.
12					6					17					12					6	JR	2/11
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S2SD-04	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	
0	18.7	8.8	8.17	3560	20	18.5	8.8	8.17	3870	20	18.7	8.8	8.21	4190	20	18.9	8.9	8.24	4600	20	[illegible]
1	17.9	9.8	8.28	3640	20	17.7	9.7	8.25	3480	20	18.0	9.0	8.27	4350	20	18.1	9.0	8.36	4830	20	[illegible]
2	16.6	9.4	8.28	3880	20	16.6	9.1	8.26	4000	20	16.9	9.3	8.26	4400	20	16.9	9.3	8.26	5010	20	[illegible]
3	18.2	9.0	8.28	3960	20	18.0	8.9	8.27	4020	20	18.1	8.9	8.26	4420	20	18.3	8.9	8.28	4710	20	[illegible]
4	17.2	8.7	8.32	4140	20	17.0	8.7	8.32	4440	20	17.1	8.8	8.31	4580	20	17.2	8.9	8.31	5040	20	[illegible]
5	17.9	8.8	8.33	4310	20	17.5	9.2	8.37	4320	20	17.7	9.0	8.38	4840	20	17.9	9.0	8.37	5400	20	[illegible]
6	17.5	9.2	8.31	4410	20	17.4	9.2	8.37	4520	20	17.5	9.2	8.27	5040	20	17.7	9.2	8.31	4680	20	LH
7	17.8	9.1	8.31	3.8	20	17.6	9.2	8.30	3.7	20	17.9	9.2	8.29	4.1	20	18.0	9.2	8.31	4.4	20	SB
8	17.6	9.1	8.36	3859	20	17.4	9.2	8.34	3.8	20	17.2	9.2	8.32	4.0	20	17.6	9.2	8.34	4.0	20	LH
9	18.5	8.8	8.31	3.8	20	18.2	8.8	8.31	3.8	20	18.5	8.9	8.30	4.2	20	18.6	8.8	8.33	4.5	20	SB
10	18.4	9.0	8.36	3.8	20	18.2	9.1	8.34	3.7	20	18.4	9.1	8.33	4.1	20	18.5	9.1	8.35	4.4	20	SB
11	18.1	8.7	8.43	3760	20	17.9	8.7	8.39	3340	20	18.0	8.7	8.37	3990	20	18.0	8.7	8.37	3440	20	[illegible]
12					16					11					15					12	[illegible]
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	525D-01	mtr	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	17.3	8.6	8.12	2750	20	18.6	8.4	8.19	3290	20	19.0	8.5	8.16	3080	20	18.9	8.6	8.17	3010	20	[illegible]	1/30
1	18.9	8.7	8.07	2730	20	17.9	9.0	8.41	3250	20	18.1	9.0	8.24	3250	20	18.1	9.2	8.24	3350	20	[illegible]	1/3
2	17.7	8.8	7.15	2820	20	17.2	8.9	8.15	3380	20	17.4	9.0	8.16	3330	20	17.3	9.1	8.12	3640	20	[illegible]	2/1
3	19.0	8.4	8.06	2810	20	18.4	8.7	8.23	3270	20	18.6	8.8	8.23	3250	20	18.4	8.6	8.24	3530	20	[illegible]	2/2
4	17.7	8.7	7.64	2930	20	18.0	8.5	8.08	3080	20	18.2	8.6	8.18	3400	20	18.1	8.7	8.21	3320	20	—	2/3
5	18.4	8.7	8.55	3030	20	17.6	8.8	8.20	3560	20	18.1	8.7	8.42	3620	20	17.9	8.8	8.36	3500	20	—	2/4
6	18.3	7.5	7.93	3030	20	17.6	9.0	8.28	3090	20	17.9	9.0	8.38	3380	20	17.9	9.0	8.38	3380	20	[illegible]	2/5
7	18.3	7.9	7.67	2.6	20	17.6	8.8	8.25	3.1	20	17.9	8.9	8.29	3.2	20	17.8	8.9	8.31	3.0	20	[illegible]	2/6
8	18.1	7.7	8.05	2.80	20	17.8	9.0	8.36	3.160	20	18.1	9.0	8.33	3.140	20	17.8	9.0	8.34	3.060	20	[illegible]	2/7
9	19.2	8.5	7.97	2.7	20	18.5	8.9	8.32	3.0	20	18.8	8.8	8.28	3.1	20	18.6	8.5	8.30	3.2	20	[illegible]	2/8
10	18.7	9.0	7.89	2.7	20	18.3	9.0	8.35	2.8	20	18.9	9.1	8.32	3.0	20	18.9	9.0	8.34	3.1	20	[illegible]	2/9
11	18.2	8.3	7.8	2660	20	18.3	8.5	8.31	2920	20	18.2	8.5	8.35	3110	20	18.3	8.5	8.35	3225	20	—	2/
12					12					9					10					14	[illegible]	2/12
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CR, Hard, stain pulled on overflying H_2O at test start. [illegible]

Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S2SD-02	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	17.1	8.1	8.08	3360	20	18.5	8.3	8.13	3350	20	18.4	8.4	8.15	4140	20	18.6	8.6	8.22	3830	20	[illegible]	1/30
1	18.4	9.0	8.22	3530	20	17.9	8.9	8.22	3520	20	17.9	9.1	8.21	4340	20	18.2	9.2	8.28	4120	20	[illegible]	1/31
2	17.6	9.0	8.12	3560	20	16.9	9.3	8.14	3590	20	17.4	9.3	8.12	4530	20	17.1	9.2	8.23	4320	20	[illegible]	2/1
3	19.0	8.8	8.21	3870	20	18.4	8.6	8.21	3590	20	18.2	8.8	8.21	4420	20	18.2	8.9	8.28	3940	20	[illegible]	2/2
4	18.1	8.4	8.21	4050	20	18.3	8.5	7.26	3530	20	17.5	8.7	8.19	4680	20	17.6	8.7	8.31	4332	20	[illegible]	2/3
5	18.5	8.7	8.36	4250	20	17.7	8.7	8.37	3940	20	17.7	8.7	8.30	5040	20	17.8	8.7	8.40	4790	20	[illegible]	2/4
6	18.2	8.9	8.24	4350	20	17.4	8.9	8.36	4080	20	17.3	8.4	8.11	5350	20	17.8	8.8	8.27	4380	20	LH	2/5
7	18.1	8.3	8.23	3.5	20	17.6	8.8	8.21	3.5	20	17.6	9.0	8.25	4.2	20	18.1	9.0	8.26	3.8	20	[illegible]	2/6
8	17.9	8.8	8.29	3.50	20	17.6	9.0	8.27	3.40	20	17.5	9.0	8.27	4.30	20	17.6	9.0	8.31	3.50	20	LH	2/7
9	19.1	8.5	8.24	3.6	20	18.4	8.5	8.25	3.4	20	18.4	8.6	8.25	4.0	20	18.6	8.6	8.28	3.7	20	EB	2/8
10	18.6	8.6	8.31	3.5	20	18.1	8.8	8.31	3.3	20	18.2	9.0	8.29	4.1	20	18.9	9.0	8.34	3.6	20	[illegible]	2/9
11	18.4	8.4	8.32	3370	20	17.9	8.0	8.32	3420	20	18.1	8.5	8.28	4180	20	18.6	8.6	8.33	3770	20	[illegible]	2/10
12					14					14					9					15	[illegible]	2/11
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S3SD-02	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	18.6	8.8	8.25	1970	20	18.6	8.9	8.27	2130	20	18.6	8.9	8.29	2080	20	18.4	8.9	8.31	1996	20	JC	1/30
1	18.0	9.0	8.35	2140	20	18.0	9.0	8.33	2170	20	17.9	9.0	8.33	2120	20	17.9	8.9	8.34	2120	20	—	1/31
2	15.9	9.6	8.33	2040	20	15.6	9.6	8.34	2200	20	15.5	9.6	8.36	2220	20	15.7	9.7	8.36	2150	20	JC	2/1
3	18.4	9.0	8.38	2040	20	18.3	8.9	8.35	2230	20	18.3	8.9	8.36	2080	20	18.1	8.9	8.37	2010	20	[illegible]	2/2
4	16.8	9.3	8.45	2090	20	16.9	9.1	8.42	2270	20	16.9	9.0	8.43	2140	20	16.6	9.0	8.44	2160	20	—	2/3
5	17.6	8.7	8.47	2090	20	17.6	9.0	8.48	2250	20	17.5	8.9	8.49	2190	20	17.2	9.0	8.50	2340	20	—	2/4
6	17.7	9.3	8.42	2220	20	17.7	9.2	8.38	2360	20	17.4	9.1	8.40	2270	20	17.4	9.2	8.41	2180	20	LH	2/5
7	18.1	9.1	8.38	1.9	20	17.8	9.0	8.38	2.1	20	17.6	9.0	8.38	1.9	20	17.4	9.0	8.40	2.0	20	EB	2/6
8	16.9	9.2	8.45	1.8	20	16.8	9.2	8.43	2030	20	16.8	9.2	8.43	1880	20	16.9	9.2	8.43	2080	20	LH	2/7
9	18.9	8.8	8.43	2.0	20	18.7	8.8	8.39	2.0	20	18.6	8.7	8.40	2.0	20	18.4	8.7	8.41	1.9	20	EB	2/8
10	18.9	9.0	8.45	1.9	20	18.9	9.0	8.41	2.0	20	18.6	8.9	8.43	2.0	20	18.4	9.0	8.44	2.0	20	EB	2/9
11	17.7	8.7	8.49	1970	20	18.3	8.6	8.46	1970	20	18.1	8.7	8.47	1870	20	18.1	8.7	8.47	1940	20	—	2/10
12					14					18					5					20	EB	2/11
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S35D-03	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	
0	18.8	8.9	8.21	1437	20	18.6	8.7	8.24	1655	20	18.6	9.8	8.28	1696	20	18.6	9.0	8.30	2150	20	[illegible] 1/3
1	18.5	9.0	8.31	1640	20	18.2	8.8	8.26	1740	20	18.1	8.6	8.24	1780	20	17.8	8.7	8.30	2100	20	" 1/3
2	15.7	9.8	8.32	1592	20	15.7	9.0	8.23	1696	20	15.5	9.4	8.19	1850	20	15.6	9.2	8.37	2220	20	[illegible] 2/1
3	18.7	8.6	8.29	1650	20	18.6	8.5	8.25	1810	20	18.3	8.5	8.26	1840	20	18.0	8.9	8.33	2200	20	[illegible] 3/1
4	16.9	9.3	8.44	1720	20	16.9	9.2	8.35	1850	20	16.6	9.0	8.23	1900	20	16.5	9.0	8.41	2360	20	" 2/3
5	17.9	9.0	8.48	1940	20	18.0	8.7	8.40	1930	20	17.8	8.6	8.32	1940	20	17.5	8.3	8.45	2710	20	" 2/4
6	18.1	9.2	8.35	1930	20	18.1	8.8	8.35	1960	20	17.8	7.8	8.24	2110	20	17.5	9.0	8.46	2440	20	LH 2/5
7	18.4	8.9	8.33	1.8	20	18.3	8.8	8.28	1.9	20	17.9	8.8	8.41	1.9	20	17.4	9.0	8.47	2.1	20	EB 2/[illegible]
8	17.2	9.0	8.43	1.90	20	17.0	8.9	8.39	1.90	20	16.8	9.0	8.47	1.90	20	16.8	9.0	8.53	2.30	20	LH 2/7
9	18.9	8.6	8.39	1.9	20	18.6	8.6	8.36	1.8	20	18.6	8.7	8.46	1.9	20	18.3	8.7	8.50	2.1	20	EB 2/8
10	18.9	8.6	8.39	1.8	20	18.9	8.8	8.38	1.8	20	18.5	8.8	8.47	1.9	20	18.5	8.9	8.51	2.0	20	EB 2/[illegible]
11	18.4	8.2	8.46	1740	20	18.4	8.2	8.43	1780	20	17.9	8.5	8.47	1870	20	18.1	8.6	8.54	2000	20	" [illegible]
12					20					13					21					14	" [illegible]
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S 350 - 04	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	19.3	8.6	8.15	1550	20	19.1	8.5	8.12	2170	20	19.1	8.6	8.20	2060	20	18.9	8.7	8.27	2320	20	[illegible]	1/30
1	18.4	9.6	8.31	1510	20	18.3	8.5	8.19	2140	20	18.2	8.3	8.24	2090	20	17.9	8.5	8.26	2470	20	[illegible]	1/31
2	16.4	9.0	8.36	1429	20	16.2	8.9	8.19	2180	20	16.0	9.0	8.23	2110	20	16.0	8.9	8.15	2400	20	[illegible]	2/1
3	18.9	8.6	8.38	1520	20	18.6	8.6	8.21	2330	20	18.6	8.7	8.26	2130	20	18.2	8.7	8.31	2420	20	[illegible]	2/2
4	16.5	9.2	8.39	1570	20	16.6	9.0	8.20	2560	20	16.5	8.9	8.27	2190	20	16.2	8.8	8.23	2480	20	[illegible]	2/3
5	17.9	8.5	8.54	1630	20	17.9	8.6	8.33	2450	20	17.8	8.6	8.35	2270	20	17.5	8.6	8.32	2760	20	[illegible]	2/4
6	18.2	8.9	8.39	1650	20	17.9	8.8	8.21	2420	20	18.0	8.7	8.28	2350	20	17.7	8.7	8.40	2430	20	LH	2/5
7	18.4	8.8	8.31	1.5	20	18.2	8.5	8.15	2.2	20	18.4	8.6	8.27	2.2	20	17.6	8.8	8.44	2.3	20	EB	2/6
8	17.2	8.9	8.39	1440	20	17.0	8.8	8.24	2380	20	17.1	8.7	8.33	2280	20	16.8	8.7	8.48	2310	20	LH	2/7
9	18.9	8.5	8.33	1.5	20	18.8	8.3	8.25	2.3	20	18.9	8.4	8.32	2.0	20	18.5	8.7	8.46	2.2	20	EB	2/8
10	18.9	8.6	8.35	1.5	20	18.8	8.7	8.22	2.1	20	18.9	8.7	8.30	2.1	20	18.4	8.8	8.45	2.2	20	EB	2/9
11	18.2	8.3	8.49	1470	20	18.1	8.3	8.26	2030	20	18.0	8.0	8.29	2010	20	18.1	8.0	8.42	2150	20	[illegible]	2/11
12					19					18					13					13	LH CHS	2/12
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	D 4/1/26 S35X-05	mHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	
0	19.3	8.7	8.19	1258	20	19.1	8.7	8.16	1427	20	19.1	8.7	8.21	1559	20	19.0	8.7	8.30	1669	20	1/3
1	18.2	8.6	8.30	1460	20	18.1	8.6	8.25	1510	20	18.0	8.6	8.25	1610	20	18.1	8.7	8.33	1740	20	1/3
2	16.2	9.0	8.25	1388	20	16.0	9.1	8.30	1499	20	16.0	9.2	8.23	1639	20	15.9	9.3	8.32	1883	20	2/1
3	18.9	8.6	8.35	1420	20	18.6	8.5	8.23	1620	20	18.3	8.6	8.25	1600	20	18.3	8.8	8.35	1720	20	2/2
4	16.4	8.9	8.33	1500	20	16.2	8.7	8.32	1650	20	16.2	8.6	8.31	1660	20	16.3	8.7	8.34	1780	20	2/3
5	18.0	8.6	8.42	1550	20	17.9	8.6	8.36	1690	20	17.9	8.7	8.38	1760	20	18.0	8.7	8.46	1970	20	2/4
6	18.2	8.6	8.36	1620	20	17.9	8.6	8.19	1740	20	17.8	8.3	8.28	1770	20	17.9	8.8	8.41	1750	20	LH 2/5
7	18.4	8.6	8.27	1.6	20	18.1	8.6	8.26	1.6	20	18.1	8.6	8.23	1.7	20	17.8	8.8	8.45	1.8	20	EB 2/
8	17.2	8.7	8.34	1480	20	16.9	8.7	8.34	1550	20	16.7	8.7	8.30	1600	20	16.8	8.7	8.51	1720	20	LH 2/
9	18.9	8.5	8.31	1.6	20	18.6	8.4	8.35	1.8	20	18.7	8.4	8.29	1.6	20	18.6	8.7	8.46	1.7	20	EB 2/
10	18.7	8.7	8.39	1.6	20	18.8	8.8	8.34	1.6	20	18.6	8.6	8.29	1.7	20	18.4	8.7	8.47	1.8	20	EB 2/
11	18.3	8.3		1470	20	17.9	8.3	8.36	1510	20	17.9	9.3	8.34	1520	20	18.0	8.2	8.45	1660	20	1/
12					16					18					18					20	LH 2/
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Hyallela DRY WEIGHTS

CLIENT: Brown + Root				TEST DATES: 1/30 -2/10/96		
STUDY #: 5563				SPECIES: H. azteca		
CONC	REP	TARE WT (G)	FISH + FOIL (G)	NET WT (MG)	# FISH	MEAN WT (MG)
CONTROL	A	0.01101	.01254 ~~.01042~~	1.53	18	0.085
	B	0.00948	.01054	1.06	17	0.062
	C	0.01001	.01098	0.98	16	0.061
	D	0.01014	.01070	0.56	18	0.031
BG15D-01	A	0.01002	.001061	0.59	17	0.035
	B	0.01186	.01194	0.08	11	0.007
	C	0.01082	.01105	0.23	16	0.014
	D	0.01285	.01314	0.29	5	0.058
525D-01	A	0.00930	.00935	0.05	12	.004
	B	0.01008	.01023	0.15	9	0.017
	C	0.00865	.00945	0.80	10	0.08
	D	0.00995	.01106	1.11	14	0.079
525D-02	A	0.01124	.01196	0.72	14	0.051
	B	0.00914	.00933	0.19	14	0.014
	C	0.01006	.01038	0.32	9	0.036
	D	0.01009	.01033	0.24	15	0.016
525D-03	A	0.01073	.01110	0.37	6	0.062
	B	0.00988	.01041	0.53	17	0.031
	C	0.01107	.01116	0.09	12	0.008
	D	0.01023	.01055	0.32	6	0.053
525D-04	A	0.00899	.01648	1.49	16	0.093
	B	0.00958	.01089	1.31	11	0.119
	C	0.00973	.00999	0.26	15	0.017
	D	0.00994	.01043	0.49	12	0.041
DATE:		2/13/96	2.14.96			
TIME:		1543	2:45			
INIT:		EB	~			

Hyallela : DRY WEIGHTS

CLIENT: Brown + Root	TEST DATES: 1/30 - 2/10/96
STUDY #: 5563	SPECIES: H. azteca

CONC	REP	TARE WT (G)	FISH + FOIL (G)	NET WT (MG)	# FISH	MEAN WT (MG)
525D-05	A	0.00968	.01058 ~~.01289~~	0.90	12	0.075
	B	0.01103	.01180 ~~.01160~~	0.77	9	0.086
	C	0.01040	.01129 ~~.01208~~	0.89	16	0.056
	D	0.01059	.01150 ~~.01122~~	0.91	16	0.057
535D-01	A	0.00954	.01127 ~~.01272~~	1.73	17	0.102
	B	0.01117	.01227	1.10	18	0.061
	C	0.01106	.01182	0.76	11	0.069
	D	0.01096	.01222	1.26	12	0.105
535D-02	A	0.00930	.01074	1.44	14	0.103
	B	0.01080	.01160	0.80	18	0.044
	C	0.00939	.01038	0.99	8	0.124
	D	0.01018	.01137	1.19	10	0.119
535D-03	A	0.01045	.01272	2.27	20	0.114
	B	0.01091	.01245	1.54	13	0.118
	C	0.01084	.01260	1.76	21	0.084
	D	0.01141	.01250	1.09	14	0.078
535D-04	A	0.00839	.00967	1.28	19	0.067
	B	0.01101	.01305	2.04	18	0.113
	C	0.01043	.01140	0.97	13	0.075
	D	0.00994	.01044	0.50	13	0.038
535D-05	A	0.01113	.01280	1.67	16	0.104
	B	0.01005	.01160	1.55	18	0.086
	C	0.01091	.01208	1.17	18	0.065
	D	0.00968	.01122	1.54	20	0.077
DATE:		2/13/96	2.14.96			
TIME:		1543	2:45			
INIT:		GB	~			

Hyallela azteca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S2SD-05	mHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	18.8	8.9	8.25	2900	20	18.4	8.8	8.30	2840	20	18.6	8.8	8.29	3340	20	18.9	8.9	8.23	3660	20	[illegible]	1/30
1	17.6	9.9	8.43	3050	20	17.4	8.8	8.34	2920	20	17.7	9.0	8.35	3480	20	17.9	8.9	8.36	3530	20	[illegible]	1/31
2	16.10	9.3	8.35	3120	20	15.9	9.4	8.35	2990	20	16.0	9.3	8.24	3220	20	16.1	9.0	8.16	3670	20	[illegible]	2/1
3	18.1	8.9	8.40	3040	20	17.9	9.0	8.38	3070	20	18.7	9.0	8.37	3380	20	18.1	8.6	8.30	3670	20	[illegible]	2/2
4	16.7	8.8	8.43	3110	20	17.2	8.7	8.44	3260	20	16.9	8.8	8.40	3500	20	16.7	8.8	8.39	3960	20	[illegible]	2/3
5	17.7	9.0	8.52	3250	20	17.6	9.0	8.50	3350	20	17.9	9.1	8.42	3660	20	17.8	9.0	8.38	4320	20	[illegible]	2/4
6	17.5	9.0	8.33	3430	20	17.4	9.0	8.38	3450	20	17.6	9.2	8.39	3730	20	17.5	9.2	8.40	4010	20	LH	2/5
7	17.6	9.0	8.41	3.1	20	17.6	9.0	8.41	3.0	20	18.0	9.0	8.41	3.2	20	18.0	9.0	8.44	3.6	20	EB	2/6
8	17.1	9.1	8.45	2900	20	17.3	9.1	8.44	2990	20	17.0	9.1	8.44	2990	20	17.1	9.2	8.46	3460	20	LH	2/7
9	18.4	8.8	8.42	3.1	20	18.3	8.8	8.41	3.0	20	18.6	8.8	8.41	3.2	20	18.6	8.7	8.44	3.5	20	EB	2/8
10	18.4	8.8	8.44	3.0	20	18.2	9.0	8.43	2.9	20	18.4	9.1	8.43	3.1	20	18.4	9.2	8.45	3.5	20	EB	2/9
11	17.6	8.5	8.49	2710	20	17.7	8.6	8.47	2980	20	18.0	8.6	8.37	3120	20	17.7	8.6	8.44	3570	20	[illegible]	2/10
12					15					19					16					14	[illegible]	2/11
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S3 SD-01	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	18.7	8.5	8.25	1740	20	18.6	8.7	8.22	2250	20	18.6	8.8	8.26	2370	20	18.4	8.8	8.28	2320	20	[illegible]	1/3
1	17.4	8.7	8.41	1930	20	17.3	8.9	8.28	2140	20	17.4	9.0	8.31	2470	20	17.6	9.0	8.37	2390	20	[illegible]	1/31
2	15.5	9.8	8.34	1922	20	15.5	9.7	8.30	2150	20	15.5	9.7	8.31	2360	20	15.9	9.8	8.29	2530	20	[illegible]	2/1
3	18.1	8.9	8.40	1870	20	17.9	9.0	8.34	2160	20	18.0	9.0	8.35	2330	20	17.6	9.0	8.36	2410	20	[illegible]	2/2
4	16.9	9.0	8.53	2040	20	16.4	8.9	8.41	2090	20	16.2	8.9	8.37	2390	20	16.0	8.8	8.35	2660	20	[illegible]	2/3
5	17.6	9.0	8.54	2150	20	17.4	9.1	8.50	2310	20	17.6	9.1	8.48	2490	20	17.3	8.6	8.37	2530	20	[illegible]	2/4
6	17.5	9.3	8.39	2100	20	17.4	9.2	8.36	2290	20	17.6	9.3	8.37	2570	20	17.4	9.3	8.40	2600	20	LH	2/5
7	17.6	9.0	8.41	1.9	20	17.6	9.1	8.36	2.1	20	17.9	9.2	8.36	2.3	20	17.6	9.2	8.42	2.3	20	EB	2/6
8	16.8	9.1	8.49	1880	20	16.7	9.1	8.41	2050	20	16.7	9.2	8.42	2370	20	16.7	9.3	8.46	2334	20	LH	2/7
9	18.4	8.8	8.43	2.0	20	18.1	8.9	8.38	2.1	20	18.4	8.8	8.38	2.2	20	18.3	8.8	8.42	2.3	20	EB	2/8
10	18.4	9.0	8.46	1.9	20	18.1	9.0	8.39	2.2	20	18.3	9.1	8.41	2.3	20	18.3	9.1	8.44	2.2	20	EB	2/9
11	17.7	8.5	8.57	1910	20	17.6	8.6	8.48	2130	20	17.6	8.6	8.47	2110	20	17.7	8.6	8.40	2230	20	[illegible]	[illegible]
12					17					18					11					12	[illegible]	[illegible]
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Hyallela azetca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	Control	MHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.	
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV		
0	19.1	8.5	7.75	323	20	19.2	8.6	7.64	299	20	19.1	8.7	7.63	328	20	18.9	8.8	7.41	314	20	JC	1/30
1	18.1	8.6	9.07	422	20	18.3	8.7	7.87	3.4	20	18.1	8.7	7.73	313	20	17.8	8.7	7.71	2.05	20	—	1/31
2	15.7	9.4	8.07	340	20	15.7	9.5	7.74	292	20	15.8	9.4	7.65	322	20	15.6	9.4	7.68	406	20	JC	2/1
3	16.4	8.9	8.06	337	20	16.8	8.7	7.98	313	20	18.6	8.7	7.80	327	20	17.9	8.7	7.78	356	20	LH	2/2
4	16.4	8.7	8.65	360	20	16.4	8.5	8.46	312	20	16.2	8.5	8.28	329	20	16.1	9.0	8.13	380	20	—	2/3
5	17.8	8.6	8.63	460	20	17.4	8.6	8.41	488	20	17.9	8.6	8.21	396	20	17.4	8.5	8.11	453	20	—	2/4
6	17.9	8.9	7.90	428	20	18.0	8.7	7.81	348	20	17.9	8.7	7.72	358	20	17.5	8.7	7.71	413	20	LH	2/5
7	18.3	8.8	8.11	450	20	18.3	8.5	7.82	339	20	18.1	8.5	7.70	345	20	17.6	8.6	7.71	415	20	EB	2/6
8	16.9	9.0	8.16	417	20	16.9	8.9	8.01	345	20	16.7	8.7	7.87	346	20	16.7	8.7	7.85	429	20	LH	2/7
9	18.6	8.6	8.17	0.6	20	19.1	8.5	7.93	0.5	20	18.9	8.4	7.81	0.4	20	18.6	8.4	7.82	0.5	20	EB	2/8
10	18.7	9.0	8.20	0.5	20	18.9	8.9	7.92	0.4	20	18.7	8.8	7.82	0.4	20	18.5	8.8	7.86	0.5	20	EB	2/9
11	18.0	8.4	8.62	467	20	18.1	8.2	8.43	378	20	17.9	8.2	8.09	384	20	17.9	8.2	8.07	453	20	—	2/10
12					18					17					16					18	LH	2/12
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Hyallela azteca CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	BG 1SD-01	UHR	1/30/96

DAY	REP A					REP B					REP C					REP D					INIT.
	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	TEMP	D.O.	pH	S.C.	SURV	
0	19.3	8.6	7.93	1212	20	19.3	8.6	8.31	1715	20	19.3	8.7	8.38	1247	20	19.4	8.9	8.37	1631	20	UH 1/3
1	18.1	8.8	8.04	1416	20	18.0	8.7	8.34	1874	20	17.9	8.7	8.40	1952	20	18.0	8.7	8.43	1866	20	" 1/3
2	15.5	9.4	8.17	1572	20	15.0	9.4	8.33	1971	20	15.4	9.6	8.38	2020	20	15.5	9.4	8.36	1932	20	" 2/1
3	18.1	8.9	8.32	1812	20	18.1	8.6	8.37	2180	20	18.2	8.8	8.41	2230	20	18.1	8.8	8.43	2180	20	UH 2/5
4	16.3	8.5	8.17	1830	20	16.4	8.4	8.31	2190	20	16.4	8.3	8.35	228	20	16.2	8.7	8.43	2270	20	" 2/3
5	17.9	8.8	8.24	1990	20	17.9	8.7	8.39	2390	20	17.7	8.7	8.48	2500	20	17.8	8.8	8.54	2520	20	" 2/4
6	17.9	8.9	8.29	2000	20	17.8	9.0	8.41	2460	20	17.7	9.0	8.43	2000	20	17.9	9.2	8.44	2600	20	UH 2/5
7	18.2	8.7	8.31	1.9	20	18.1	8.9	8.37	2.2	20	18.2	8.9	8.41	2.2	20	18.1	8.9	8.41	2.3	20	EB 2/6
8	16.4	8.8	8.36	1858	20	16.4	8.9	8.44	2150	20	16.2	9.0	8.48	2410	20	16.4	9.0	8.48	2210	20	UH 2/7
9	18.9	8.5	8.35	1.9	20	18.9	8.6	8.44 8.40	2.0	20	19.0	8.6	8.44	2.3	20	18.9	8.7	8.44	2.3	20	EB 2/8
10	18.7	8.7	8.11	1.9	20	18.9	8.5	8.38	2.1	20	18.9	8.8	8.43	2.3	20	18.6	8.9	8.45	2.3	20	EB 2/9
11	17.7	8.5	8.23	1793	20	17.9	8.5	8.32	2080	20	17.8	8.5	8.43	2280	20	17.6	8.6	8.49	2270	20	" 2/10
12					17					11					16					5	UH 2/12
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LARVAL FISH DRY WEIGHTS

CLIENT: Brown + Root	TEST DATES: 1/29 - 2/8/96
STUDY #: 5563	SPECIES: M. bahia - 1

CONC	REP	TARE WT (G)	FISH + FOIL (G)	NET WT (MG)	# FISH	MEAN WT (MG)
S1SD-01	A	0.00929	0.01277	3.48	12	0.290
	B	0.00861	0.01286	4.25	16	0.266
	C	0.00869	0.01374	5.05	14	0.361
	D	0.00974	0.01523	5.49	14	0.392
S9SD-03	A	0.01088	0.01509	4.21	14	0.301
	B	0.01049	0.01582	5.33	15	0.355
	C	0.01044	0.01422	3.78	10	0.378
	D	0.00942	0.01269	3.27	12	0.272
S1SD-02	A	0.00882	0.01304	4.22	15	0.281
	B	0.01077	0.01483	4.06	14	0.290
	C	0.00951	0.01318	3.67	12	0.306
	D	0.01028	0.01386	3.58	15	0.239
S1SD-05	A	0.00894	0.09300	4.06	14	0.290
	B	0.00906	0.01215	3.09	15	0.206
	C	0.00968	0.01176	2.08	11	0.189
	D	0.00985	0.01249	2.64	13	0.203
S1SD-04	A	0.01005	0.01389	3.84	14	0.274
	B	0.00874	0.01224	3.50	13	0.269
	C	0.00993	0.01341	3.48	13	0.268
	D	0.01000	0.01251	2.51	13	0.193
BG35D-01	A	0.00895	0.01423	5.28	13	0.406
	B	0.00941	0.01329	3.88	15	0.259
	C	0.01020	0.01340	3.20	13	0.246
	D	0.01078	0.01460	3.82	13	0.294
DATE:		2/9	2/9	2/9	2/9	2/9
TIME:		0950	1525			
INIT:		EB	LH	LH	LH	LH

LARVAL FISH DRY WEIGHTS

CLIENT: Brown + Root	TEST DATES: 1/29-2/8/96
STUDY #: 5563	SPECIES: m. bahia - 1

CONC	REP	TARE WT (G)	FISH + FOIL (G)	NET WT (MG)	# FISH	MEAN WT (MG)
CONTROL	A	0.00803	0.01132	3.29	14	0.235
	B	0.01028	0.01327	2.99	13	0.230
	C	0.00867	0.01141	2.74	11	0.249
	D	0.00973	0.01382	4.09	14	0.292
59SD-02	A	0.00837	0.01224	3.87	14	0.276
	B	0.00909	0.01303	3.94	12	0.328
	C	~~0.00889~~ ~~0.01067~~ 23	0.01350	4.64	13	0.357
	D	0.01061	0.01481	4.20	16	0.262
51SD-03	A	0.00829	0.01189	3.60	15	0.240
	B	0.00854	0.01086	2.32	11	0.211
	C	0.00878	0.01226	3.48	16	0.218
	D	0.00956	0.01237	2.81	10	0.281
59SD-05	A	0.00904	0.01247	3.43	14	0.245
	B	0.00987	0.01383	3.96	14	0.283
	C	0.00965	0.01342	3.77	12	0.314
	D	0.01041	0.01327	2.86	11	0.260
59SD-04	A	0.00885	0.01286	4.01	16	0.251
	B	0.00997	0.01399	4.02	16	0.251
	C	0.00936	0.01307	3.71	15	0.247
	D	0.01040	0.01334	2.94	15	0.196
59SD-01	A	0.00923	0.01263	3.40	12	0.283
	B	0.00956	0.01309	3.53	13	0.272
	C	0.01052	0.01354	3.02	12	0.252
	D	0.00999	0.01357	3.58	14	0.256
DATE:		2/9	2/9	2/9	2/9	2/9
TIME:		0950	1525			
INIT:		EB	LH	LH	LH	LH

LARVAL FISH DRY WEIGHTS

CLIENT:	Brown + Root	TEST DATES:	1/30 - 2/9/96
STUDY #:	5563-2	SPECIES:	M. bahia

CONC	REP	TARE WT (G)	FISH + FOIL (G)	NET WT (MG)	# FISH	MEAN WT (MG)
control	A	0.00906	0.01176	2.70	19	0.142
	B	0.00976	0.01372	3.96	18	0.220
	C	0.00966	0.01270	3.04	20	0.152
	D	0.01078	0.01452	3.74	20	0.187
BG2SD-01	A	0.01019	0.01250	2.31	17	0.136
	B	0.00937	0.01269	3.32	19	0.175
	C	0.00775	0.01092	3.17	20	0.158
	D	0.01143	0.01406	2.63	17	0.155
	A					
	B					
	C					
	D					
	A					
	B					
	C					
	D					
	A					
	B					
	C					
	D					
	A					
	B					
	C					
	D					
DATE:		2/9	2/9	2/9	2/9	2/9
TIME:		1010	1510			
INIT:		LH	LH	LH	LH	LH

STUDY 5563: Mysidopsis bahia Survival

SITE	Rep A	Rep B	Rep C	Rep D	MEAN
Control	93.3%	86.7%	73.3%	93.3%	86.7%
BG3SD-01	86.7%	100.0%	86.7%	86.7%	90.0%
S9SD-01	80.0%	86.7%	80.0%	93.3%	85.0%
S9SD-02	93.3%	80.0%	86.7%	100.0%	90.0%
S9SD-03	100.0%	73.3%	100.0%	66.7%	85.0%
S9SD-04	100.0%	100.0%	100.0%	100.0%	100.0%
S9SD-05	93.3%	93.3%	80.0%	73.3%	85.0%
S1SD-01	80.0%	100.0%	93.3%	93.3%	91.7%
S1SD-02	100.0%	93.3%	80.0%	100.0%	93.3%
S1SD-03	93.3%	100.0%	66.7%	80.0%	85.0%
S1SD-04	93.3%	86.7%	86.7%	86.7%	88.3%
S1SD-05	93.3%	100.0%	73.3%	86.7%	88.3%

STUDY 5563: Mysidopsis bahia Growth Analysis

SITE	Rep A	Rep B	Rep C	Rep D	MEAN
Control	0.235	0.230	0.249	0.292	0.252
BG3SD-01	0.406	0.259	0.246	0.294	0.301
S9SD-01	0.283	0.272	0.252	0.256	0.266
S9SD-02	0.276	0.328	0.357	0.262	0.306
S9SD-03	0.240	0.211	0.218	0.281	0.238
S9SD-04	0.251	0.251	0.247	0.196	0.236
S9SD-05	0.245	0.283	0.314	0.260	0.276
S1SD-01	0.290	0.266	0.361	0.392	0.327
S1SD-02	0.281	0.290	0.306	0.239	0.279
S1SD-03	0.301	0.355	0.378	0.272	0.327
S1SD-04	0.274	0.269	0.268	0.193	0.251
S1SD-05	0.290	0.206	0.189	0.193	0.220

STUDY 5563: Mysidopsis bahia Growth Analysis

SITE	Rep A	Rep B	Rep C	Rep D	MEAN
Control	0.142	0.220	0.152	0.187	0.175
BG2SD-01	0.136	0.175	0.158	0.155	0.156

STUDY 5563: Mysidopsis bahia Survival

SITE	Rep A	Rep B	Rep C	Rep D	MEAN
Control	95.0%	90.0%	100.0%	100.0%	96.3%
BG2SD-10	85.0%	95.0%	100.0%	85.0%	91.3%

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	Control	Lab Salt	1/30/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	19.3	7.4	7.69	33000	27	19.0	7.4	7.80	33000	27	19.1	7.4	7.83	33000	26	18.9	7.4	7.85	33000	26
1	18.1	7.[illegible]	7.51	33.7	25	17.7	7.5	7.[illegible]	34.5	26	18.1	7.5	7.89	32.3	27	18.0	7.4	7.91	34.3	27
2	16.8	8.1	7.94	34.2	28	16.8	8.1	7.73	34.1	28	16.9	7.9	7.82	33.2	28	17.1	7.9	7.84	34.0	28
3	18.6	7.5	7.16	34500	25	18.4	7.4	7.58	34500	26	18.6	7.2	7.70	35100	26	18.6	7.1	7.72	35000	27
4	17.8	7.3	7.27	35200	30	18.0	7.2	7.60	34900	30	18.1	7.2	7.78	36100	29	18.0	7.2	7.79	35700	29
5	16.4	7.6	8.03	36.2	30	17.1	7.7	8.03	33.3	28	17.6	7.5	8.04	33.4	30	17.7	7.5	8.11	35.1	29
6	17.6	7.8	7.70	35.0	28	17.4	7.6	7.87	36.9	29	17.8	7.4	7.90	36.2	28	17.5	7.6	7.91	35.8	27
7	18.8	7.6	7.59	35.1	28	18.4	7.4	7.78	36.7	28	18.6	7.2	7.74	36.1	27	18.4	73	7.77	37.9	26
8	18.1	7.3	7.80	36.5	29	17.9	7.2	7.84	36.8	30	18.1	7.2	7.84	36.5	30	17.9	7.2	7.85	36.0	30
9	18.9	6.9	7.26	34.7	26	18.5	6.6	7.54	36.6	28	18.6	6.7	7.67	36.1	28	18.4	6.8	7.71	35.7	28
10	18.6	7.3	7.66	36.2	28	18.5	7.2	7.72	36.8	29	18.4	7.1	7.76	36.5	29	18.4	7.1	7.78	35.7	29
	19					18					20					20				

20 mysids / rep

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	BG25D-01	Lab Salt	1/30/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	19.1	7.2	7.82	34700 ~~33900~~	27	19.1	7.1	7.79	34600 ~~33600~~	27	19.1	7.0	7.77	34700 ~~33900~~	27	18.9	7.0	7.81	35000 ~~33900~~	27
1	17.8	7.3	7.91	34.4	27	17.9	7.3	7.89	35.0	28	17.8	7.2	7.86	34.8	28	17.6	7.0	7.87	35.2	28
2	16.8	7.8	7.88	34.0	28	16.9	7.8	7.87	34.4	29	16.5	7.7	7.90	33.7	29	16.9	7.8	7.82	34.7	30
3	18.4	7.4	7.82	35000	26	18.3	7.4	7.82	35400	26	18.4	6.8	7.80	35400	28	18.2	6.7	7.76	36000	27
4	17.9	7.2	7.85	34500	27	18.0	7.1	7.85	35400	28	18.1	6.8	7.81	35700	28	17.7	7.1	7.77	36600	29
5	16.7	7.5	8.06	35.0	30	17.2	7.5	8.05	35.6	31	17.4	7.5	8.02	35.9	30	17.6	7.5	7.98	37.1	31
6	17.9	7.8	7.95	36.2	27	17.9	7.6	7.93	36.9	28	18.1	7.6	7.91	37.0	28	18.2	7.6	7.86	38.7	30
7	18.2	7.4	7.83	36.7	26	18.4	7.3	7.79	36.8	27	18.4	7.4	7.81	36.3	27	18.2	7.3	7.81	35.5	28
8	17.8	7.1	7.89	36.5	30	17.9	7.1	7.89	37.1	30	17.8	7.1	7.89	37.9	30	17.6	7.0	7.88	38.6	32
9	18.3	6.8	7.73	35.7	28	18.4	6.8	7.74	35.7	28	18.3	6.8	7.75	36.2	28	18.2	6.8	7.79	38.0	30
10	18.3	7.1	7.81	36.2	29	18.4	7.0	7.82	36.5	28	18.4	7.0	7.82	36.5	28	18.3	7.0	7.83	38.4	30
	17					19					20					17				

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S1SD-04	Lab Salt	1/29/96

DAY	REP A					REP B					REP C					REP D					
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	
0	18.1	7.2	7.99	35.0	25	18.6	7.3	8.01	35.9	25	18.5	7.1	7.89	36.5	28	18.6	6.9	7.85	37.0	29	Z
1	19.3	7.3	8.03	33.8	27	19.2	7.3	8.04	35.1	28	19.3	7.3	8.03	36.6	29	19.3	7.3	8.04	37.1	30	[illegible]
2	19.1	7.3	8.02	35.4	28	18.1	7.3	8.05	35.7	28	18.1	7.3	8.05	37.4	30	18.1	7.3	8.08	37.9	31	[illegible]
3	17.4	7.8	8.08	35.9	29	17.4	7.9	7.94	36.4	30	17.4	7.8	8.03	38.5	32	17.4	7.7	7.96	39.2	33	[illegible]
4	18.0	7.9	8.07	33400	28	17.9	7.6	8.05	37200	30	17.9	7.4	8.05	39500	31	18.1	7.4	8.07	40400	32	[illegible]
5	16.9	7.6	8.04	35000	28	16.7	7.5	7.93	36000	30	16.5	7.4	8.07	39800	32	16.4	7.4	8.05	41300	34	[illegible]
6	18.0	7.5	8.12	39.6	30	18.1	7.5	8.02	40.3	32	17.9	7.3	7.94	44.0	35	17.9	7.2	7.90	46.1	40	[illegible]
7	18.4	7.4	8.03	40.7	30	18.5	7.5	8.08	42.9	31	18.4	7.5	8.09	47.0	37	18.5	7.5	8.08	50.1	40	[illegible]
8	19.1	7.5	7.94	41.0	32	18.9	7.5	8.04	44.6	35	18.9	7.6	8.04	50.4	40	19.3	7.6	8.09	47.1	37	[illegible]
9	17.3	7.2	8.11	37.1	33	17.2	7.2	8.09	38.4	34	17.3	7.3	8.08	41.6	37	17.2	7.3	8.10	45.0	40	[illegible]
10	19.1	7.3	8.03	38.9	31	19.1	7.5	8.00	41.3	33	19.1	7.3	7.99	45.2	36	19.4	7.2	7.98	48.8	39	[illegible]

14 13 13 13

m. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	BG-3SD-01	LabSalt	1/29/96

	DAY	REP A					REP B					REP C					REP D				
		TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
29	0	17.9	6.8	7.92	35.9	29	18.1	7.2	7.86	36.0	28	18.4	7.3	7.96	37.1	29	18.6	7.3	7.95	37.7	30
	1	19.3	7.2	8.01	34.3	27	19.2	7.2	8.02	36.0	28	19.3	7.2	8.02	37.3	29	19.1	7.3	8.01	38.1	30
1/31	2	18.2	7.5	8.09	36.7	29	18.2	7.4	8.06	37.2	30	18.3	7.4	8.05	38.4	31	18.1	7.4	8.04	39.0	32
	3	17.3	7.6	8.05	37.2	31	17.2	7.7	8.06	37.3	31	17.8	7.8	8.06	40.1	33	17.2	7.8	8.05	40.3	34
10	4	17.9	7.5	8.09	34.600	30	18.0	7.5	8.07	37.500	30	18.1	7.6	8.05	40.000	31	18.1	7.5	7.98	41.400	32
12	5	16.4	8.0	8.11	37.500	31	16.4	7.9	8.13	41.200	33	16.4	7.8	8.11	39.300	33	16.4	8.0	7.97	40.700	34
14	6	17.9	7.6	8.14	41.2	34	17.8	7.7	8.11	42.3	35	17.7	7.5	8.05	45.6	38	17.7		7.86	46.3	42
15	7	18.4	7.5	8.11	43.0	34	18.4	7.5	8.06	44.6	35	18.4	7.6	8.02	48.8	40	18.3	7.6	8.04	51.8	41
16	8	19.1	7.6	8.03	44.1	35	19.0	7.6	7.95	47.7	37	19.1	7.6	7.87	52.2	42	19.1	7.5	8.00	50.2	40
17	9	16.9	7.2	8.11	38.7	34	16.9	7.2	8.06	39.2	35	16.9	7.2	8.04	41.8	37	16.7	7.2	8.05	45.1	41
18	10	19.2	7.3	8.01	41.1	34	19.1	7.4	7.98	42.9	35	19.3	7.4	7.96	46.2	37	19.3	7.4	7.96	48.4	40
		13					15					13					13				

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S1SD-C2	Lab ~~FAT~~ Salt	1/29/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	18.3	7.2	8.05	31.5	25	18.4	6.5	7.94	31.8	25	18.6	6.2	7.78	31.8	25	19.3	5.6	7.66	35.5	26
1	19.6	7.2	8.10	30.7	24	19.6	7.3	8.07	32.5	25	19.7	7.3	7.99	33.0	26	19.6	7.3	7.93	34.5	27
2	18.6	6.9	8.03	32.8	26	18.6	6.9	8.04	32.1	25	18.6	7.1	8.02	32.5	25	18.4	7.2	7.86	35.2	27
3	17.8	7.8	8.09	32.5	27	18.0	7.9	7.98	33.0	27	17.8	7.6	7.96	33.3	27	17.4	7.7	8.09	36.1	29
4	18.5	7.5	8.11	32700	25	18.4	7.4	8.07	33300	26	18.4	7.2	7.96	33800	26	18.4	7.2	8.03	37500	29
5	16.8	6.6	8.16	33200	29	16.8	6.9	8.16	32500	30	16.8	7.1	7.81	34300	31	16.9	7.0	7.98	38300	32
6	18.1	7.3	8.10	35.0	29	18.2	6.4	7.84	35.4	29	18.3	6.3	7.99	37.0	30	18.1	7.4	8.06	42.1	36
7	18.6	7.5	8.17	37.7	27	18.2	5.6	7.89	35.6	26	18.4	7.3	8.09	37.0	27	18.5	7.4	7.98	44.7	35
8	19.1	7.8	8.14	38.0	28	19.1	6.4	7.88	36.5	27	19.1	7.6	8.05	38.1	28	19.1	7.6	8.06	43.2	32
9	17.8	7.1	8.18	36.5	32	17.8	7.2	7.91	35.3	30	17.8	6.4	8.10	36.8	32	17.6	7.1	8.10	42.0	37
10	19.2	7.0	8.12	38.1	30	19.1	7.2	8.15	37.2	29	19.3	7.3	8.07	38.1	30	19.3	7.3	8.06	41.9	35
	15					14					12					15				

M. bahia

CHRONIC EXPOSURE SEDIMENT ASSAY

STUDY #	SAMPLE ID:	DILUENT:	START DATE:
5563	S1SD-05	Lab Salt	1/29/96

DAY	REP A					REP B					REP C					REP D				
	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL	TEMP	D.O.	pH	S.C.	SAL
0	18.5	7.2	7.89	31.5	27	18.6	6.8	7.88	35.3	29	18.6	7.2	7.93	36.6	27	18.7	7.1	7.92	37.0	25
1	19.4	7.1	7.98	31.2	24	19.3	7.1	7.97	35.4	28	19.3	7.2	8.01	36.3	28	19.4	7.3	7.96	37.3	29
2	18.1	7.0	7.92	32.4	26	18.3	7.0	7.96	35.0	27	18.2	7.1	8.00	36.6	30	18.3	7.3	7.98	38.8	30
3	17.1	7.6	8.09	36.6	27	17.4	7.8	7.82	35.7	29	17.6	7.6	7.99	37.6	30	17.6	7.6	8.03	39.1	32
4	18.3	7.2	8.06	36.100	27	18.3	7.1	8.00	37.500	28	18.1	7.0	8.00	40.000	29	18.2	7.0	8.01	40.400	31
5	16.4	7.7	8.11	37.900	30	16.4	7.0	7.93	38.700	31	16.8	7.0	7.96	41.500	33	16.3	7.1	8.05	42.700	33
6	18.1	7.3	8.02	36.1	29	17.8	6.9	7.85	39.0	33	18.1	7.3	7.94	42.8	35	18.1	7.3	8.02	44.9	36
7	18.3	7.5	8.07	37.4	27	18.4	7.5	8.04	42.9	30	18.3	6.8	7.87	44.1	35	18.4	6.8	7.86	48.0	40
8	18.8	7.6	8.04	36.9	28	18.9	7.6	8.01	41.0	30	19.0	7.7	8.00	42.5	33	19.1	7.7	8.00	45.3	35
9	17.4	7.2	8.11	35.7	32	17.4	7.2	8.05	39.3	35	17.6	7.3	8.04	41.7	37	17.5	7.3	8.02	44.1	39
10	19.1	7.3	8.04	38.0	30	19.1	7.4	7.96	40.9	33	19.1	7.4	7.94	42.9	35	19.4	7.3	7.93	46.7	38

19 15 11 13

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Brown + Root

TEST SUBSTANCE: TEST TYPE: SCREEN___ DEFINITIVE___

pH MEASUREMENTS: INSTRUMENT NUMBER: pH probe #7

STUDY INITIATION DATE: 2/1/96 TEST SPECIES: Earthworm

TEST VESSEL	NOMINAL	REP	pH VALUES IN SU 0 Days	~~14~~ 28 Days
CONTROL	0	A	6.06	6.82
		B		
		C		
		D		
control	0	~~E A~~	6.06	6.82
		~~F B~~		
		~~G C~~		
		~~H D~~		
	BG1SS-01	A	8.08	—
		B		
		C		
		D		
	BG2SS-01	A	7.88	8.23
		B		
		C		
		D		
	BG3SS-01	A	7.30	7.65
		B		
		C		
		D		
	S1SS-4	A	7.60	7.96
		B		
		C		
		D		
	S1SS-5	A	8.10	—
		B		
		C		
		D		
RECORDED BY:			LH	LH
DATE:			1/31/96	2/29

NOTES:

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Brown Root

TEST SUBSTANCE: _____ TEST TYPE: SCREEN___ DEFINITIVE___

pH MEASUREMENTS: INSTRUMENT NUMBER: _____

STUDY INITIATION DATE: _____ TEST SPECIES: _____

TEST VESSEL	NOMINAL	REP	pH VALUES IN SU	
			0 Days	~~28~~ 14 Days
~~CONTROL~~ LH 2/1	~~0~~ SISS - 7	A	8.24	7.57
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
RECORDED BY:			LH	LH
DATE:			2/1	2/29

NOTES: _____

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Brown + Root

TEST SUBSTANCE: TEST TYPE: SCREEN___ DEFINITIVE___

SURVIVAL DATA:

STUDY INITIATION DATE: TEST SPECIES: Earthworm

TEST VESSEL	NOMINAL	REP	NUMBER ALIVE 0 Hr	7 Days	14 Days	
CONTROL	0	A	25	20	~~16~~ 19 LH	
		B	25	24	18	
		C	25	25	26	
		D	25	21	19	
control	0	~~E~~ A	25	25	24	
		~~F~~ B	25	18	18	
		~~G~~ C	25	24	24	
		~~H~~ D	25	14		
	BG1SS-01	A	25 ①	0	—	① majority of worms on soil surface, inactive
		B	25 ①	0	—	
		C	25 ①	0	—	
		D	25 ①	0	—	
	BG2SS-01	A	25	22	~~18~~ 20	LH 2/15
		B	25	19	19	
		C	25	24	17	
		D	25	20	12	
	BG3SS-01	A	25	11	3	
		B	25	15	5	
		C	25	10	4	
		D	25	13	4	
	SISS-4	A	25	23	17	
		B	25	20	12 ~~10~~ LH	
		C	25	15	14	
		D	25	19	14	
	SISS-5	A	25 *	—	—	**
		B	25 *	—	—	
		C	25 *	—	—	
		D	25 *	—	—	
RECORDED BY:			LH	LH	LH	
DATE:			~~2/3~~ 2/1	2/8	2/15	

NOTES: * worms are not burrowing into soil layer an hour after being added; all other sediments worms have burrowed

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Bowin + Root

TEST SUBSTANCE: _____ TEST TYPE: SCREEN___ DEFINITIVE___

SURVIVAL DATA:

STUDY INITIATION DATE: _____ **TEST SPECIES:** _____

TEST VESSEL	NOMINAL	REP	NUMBER ALIVE 0 Hr	7 Days	14 Days
~~CONTROL~~ LH 2/1	~~0~~ SISS - 7	A	25	18	12
		B	25	16	14
		C	25	14	9
		D	40 *	12	11
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
RECORDED BY:			LH	LH	LH
DATE:			2/1	2/8	2/15

NOTES: * Due to unusually small size extra worms were added to this replicate

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: B+ Root

TEST SUBSTANCE: _____ TEST TYPE: SCREEN___ DEFINITIVE___

PERCENT MOISTURE DATA:

STUDY INITIATION DATE: _____ **TEST SPECIES:** Earthworm

TEST VESSEL	NOMINAL	REP	PERCENTAGE % 0 Days	~~28~~ ~~14~~ Days
CONTROL	0	A	28%	28.1
		B		
		C		
		D		
(control)	0	E A	28%	28.1
		F B		
		G C		
		H D		
	BG1SS-01	A	23.6	—
		B		
		C		
		D		
	BG2SS-01	A	21.5	25.6%
		B		
		C		
		D		
	BG3SS-01	A	42.9%	57.9%
		B		
		C		
		D		
	SIS-4	A	15.3%	29.2
		B	①	
		C		
		D		
	SISS-5	A	19.1%	—
		B	①	
		C		
		D		
RECORDED BY:			1/31/2011	
DATE:			LH	

NOTES: ① 75 mL DI H2O added to each replicate to help increase the moisture

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Brown Root

TEST SUBSTANCE: TEST TYPE: SCREEN___ DEFINITIVE___

PERCENT MOISTURE DATA:

STUDY INITIATION DATE: **TEST SPECIES:**

TEST VESSEL	NOMINAL	REP	PERCENTAGE % 0 Days	~~28~~ 14 Days
~~CONTROL~~ all	~~0~~ S 155 - 7	A	18.5 %	29.1 %
		B	⊙	
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
		A		
		B		
		C		
		D		
RECORDED BY:				
DATE:				

NOTES: © 15 ml DI H2O added to each replicate to help increase the % moisture

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	50.000	50.000	3.209
Within (Error)	6	93.500	15.583	
Total	7	143.500		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	BG1SD-01	12.250	12.250	1.791	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	BG1SD-01	12.250	12.250	1.791	

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	BG1SD-01	4	5.424	31.4	5.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.002	0.002	3.835
Within (Error)	6	0.003	0.001	
Total	7	0.005		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	BG1SD-01	0.029	0.029	1.958	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	BG1SD-01	0.029	0.029	1.958	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	BG1SD-01	4	0.031	51.9	0.031

UNEQUAL VARIANCE t-TEST Ho:Control<Treatme...

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.001	0.001	2.844
Within (Error)	6	0.002	0.000	
Total	7	0.003		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-05	0.083	0.083	-1.686	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-05	0.083	0.083	-1.686	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-05	4	0.027	44.8	-0.023

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.000	0.000	0.436
Within (Error)	6	0.002	0.000	
Total	7	0.002		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-05	0.069	0.069	-0.660	

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-05	0.069	0.069	-0.660	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-05	4	0.026	43.1	-0.009

NEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	15.125	15.125	2.283
Within (Error)	6	39.750	6.625	
Total	7	54.875		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-01	14.500	14.500	1.511	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-01	14.500	14.500	1.511	

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-01	4	3.537	20.5	2.750

UNEQUAL VARIANCE t-TEST Ho:Control<Treatme...

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

OURCE	DF	SS	MS	F
Between	1	0.001	0.001	2.409
Within (Error)	6	0.003	0.000	
Total	7	0.004		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-01	0.084	0.084	-1.552	

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-01	0.084	0.084	-1.552	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-01	4	0.031	51.3	-0.024

IEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	45.125	45.125	4.385
Within (Error)	6	61.750	10.292	
Total	7	106.875		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-02	12.500	12.500	2.094	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-02	12.500	12.500	2.094	

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-02	4	4.408	25.6	4.750

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.003	0.003	3.094
Within (Error)	6	0.006	0.001	
Total	7	0.008		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-02	0.098	0.098	-1.759	

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-02	0.098	0.098	-1.759	

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-02	4	0.042	69.8	-0.038

NEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.125	0.125	0.014
Within (Error)	6	52.750	8.792	
Total	7	52.875		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-03	17.000	17.000	0.119	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-03	17.000	17.000	0.119	

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-03	4	4.074	23.6	0.250

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.000	0.000	0.504
Within (Error)	6	0.004	0.001	
Total	7	0.005		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-04	0.073	0.073	-0.710	

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-04	0.073	0.073	-0.710	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-04	4	0.037	61.8	-0.014

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	1.125	1.125	0.628
Within (Error)	6	10.750	1.792	
Total	7	11.875		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-05	18.000	18.000	-0.792	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S3SD-05	18.000	18.000	-0.792	

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-05	4	1.839	10.7	-0.750

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.000	0.000	0.090
Within (Error)	6	0.008	0.001	
Total	7	0.008		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-04	0.067	0.067	-0.300	

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-04	0.067	0.067	-0.300	

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-04	4	0.050	84.1	-0.008

NEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	32.000	32.000	5.120
Within (Error)	6	37.500	6.250	
Total	7	69.500		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-05	13.250	13.250	2.263	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-05	13.250	13.250	2.263	

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-05	4	3.435	19.9	4.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.001	0.001	1.683
Within (Error)	6	0.003	0.001	
Total	7	0.004		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-03	0.039	0.039	1.297	

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-03	0.039	0.039	1.297	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-03	4	0.032	53.3	0.021

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	28.125	28.125	8.544
Within (Error)	6	19.750	3.292	
Total	7	47.875		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-04	13.500	13.500	2.923	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-04	13.500	13.500	2.923	*

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-04	4	2.493	14.5	3.750

UNEQUAL VARIANCE t-TEST Ho:Control<Treatme...

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.002	0.002	4.656
Within (Error)	6	0.002	0.000	
Total	7	0.004		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-02	0.029	0.029	2.158	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-02	0.029	0.029	2.158	*

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-02	4	0.027	46.0	0.031

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	98.000	98.000	6.720
Within (Error)	6	87.500	14.583	
Total	7	185.500		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-03	10.250	10.250	2.592	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-03	10.250	10.250	2.592	*

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-03	4	5.247	30.4	7.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatme

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	36.125	36.125	8.758
Within (Error)	6	24.750	4.125	
Total	7	60.875		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-02	13.000	13.000	2.959	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-02	13.000	13.000	2.959	*

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-02	4	2.791	16.2	4.250

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

	NUM OF	Minimum Sig Diff	% of	DIFFERENCE

1	CONTROL	4			
2	S2SD-02	4	3.380	19.6	4.250

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

ANOVA TABLE

OURCE	DF	SS	MS	F
Between	1	72.000	72.000	24.686
Within (Error)	6	17.500	2.917	
Total	7	89.500		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-01	11.250	11.250	4.968	*

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	17.250	17.250		
2	S2SD-01	11.250	11.250	4.968	*

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-01	4	2.347	13.6	6.000

NEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.000	0.000	0.413
Within (Error)	6	0.006	0.001	
Total	7	0.007		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-01	0.045	0.045	0.643	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S2SD-01	0.045	0.045	0.643	

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S2SD-01	4	0.045	74.6	0.015

JNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			

TABLE 4. Summary of Fertilization Success Rates for Sea Urchin, *Strongylocentrotus franciscana*, Sperm Exposed to Surface Water Samples from the Naval Air Station Key West Project Sites. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Date Collected	Date Rec.	Assay Start	REP A	REP B	REP C	MEAN
				% Eggs Fertilized			
Laboratory Control			01/24	100.0	100.0	99.0	99.7
S9SW-01	01/23	01/24	01/24	100.0	100.0	100.0	100.0
S9SW-02	01/23	01/24	01/24	100.0	100.0	100.0	100.0
S9SW-03	01/23	01/24	01/24	100.0	100.0	100.0	100.0
S9SW-04	01/23	01/24	01/24	100.0	99.0	100.0	99.7
S9SW-05	01/23	01/24	01/24	100.0	100.0	99.0	99.7
S1SW-01	01/22	01/23	01/24	100.0	100.0	97.1	99.0
S1SW-02	01/22	01/23	01/24	100.0	100.0	98.1	99.4
Laboratory Control			01/26	83.0	93.5	75.8	84.1
S1SW-03	01/24	01/25	01/26	32.0	95.2	57.0	61.4
S1SW-04	01/24	01/25	01/26	93.2	98.0	86.3	92.5
S1SW-05	01/24	01/25	01/26	72.1	84.0	80.0	78.7
Laboratory Control			01/28	92.6	93.8	96.4	94.3
BG2SW-01	01/26	01/27	01/28	91.5	95.5	89.2	92.1
BG3SW-01	01/26	01/27	01/28	85.0	94.5	80.4	86.6

TABLE 5. Summary of Survival and Growth (Dry Weight) Data for the Mysid Shrimp, *Mysidopsis bahia*, 10-Day Exposue to Sediments from the Naval Air Station Key West Project Sites. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Date Collected	Date Rec.	Assay Start	REP A	REP B	REP C	REP D	MEAN
				Shrimp Survival (%) @ 240 Hours				
Laboratory Control			01/29	93.3	86.7	73.3	93.3	86.7
S9SD-01	01/23	01/24	01/29	80.0	86.7	80.0	93.3	85.0
S9SD-02	01/23	01/24	01/29	93.3	80.0	86.7	100.0	90.0
S9SD-03	01/23	01/24	01/29	100.0	73.3	100.0	66.7	85.0
S9SD-04	01/23	01/24	01/29	100.0	100.0	100.0	100.0	100.0
S9SD-05	01/23	01/24	01/29	93.3	93.3	80.0	73.3	85.0
S1SD-01	01/22	01/23	01/29	80.0	100.0	93.3	93.3	91.7
S1SD-02	01/22	01/23	01/29	100.0	93.3	80.0	100.0	93.3
S1SD-03	01/24	01/25	01/29	93.3	100.0	66.7	80.0	85.0
S1SD-04	01/24	01/25	01/29	93.3	86.7	86.7	86.7	88.3
S1SD-05	01/24	01/25	01/29	93.3	100.0	73.3	86.7	88.3
BG3SD-01	01/26	01/27	01/29	86.7	100.0	86.7	86.7	90.0
Laboratory Control			01/30	95.0	90.0	100.0	100.0	96.3
BG2SD-01	01/26	01/29	01/30	85.0	95.0	100.0	85.0	91.3
				Shrimp Mean Dry Weight (mg)				
Control			01/29	0.235	0.230	0.249	0.292	0.252
S9SD-01	01/23	01/24	01/29	0.283	0.272	0.252	0.256	0.266
S9SD-02	01/23	01/24	01/29	0.276	0.328	0.357	0.262	0.306
S9SD-03	01/23	01/24	01/29	0.240	0.211	0.218	0.281	0.238
S9SD-04	01/23	01/24	01/29	0.251	0.251	0.247	0.196	0.236
S9SD-05	01/23	01/24	01/29	0.245	0.283	0.314	0.260	0.276
S1SD-01	01/22	01/23	01/29	0.290	0.266	0.361	0.392	0.327
S1SD-02	01/22	01/23	01/29	0.281	0.290	0.306	0.239	0.279
S1SD-03	01/24	01/25	01/29	0.301	0.355	0.378	0.272	0.327
S1SD-04	01/24	01/25	01/29	0.274	0.269	0.268	0.193	0.251
S1SD-05	01/24	01/25	01/29	0.290	0.206	0.189	0.193	0.220
BG3SD-01	01/26	01/27	01/29	0.406	0.259	0.246	0.294	0.301
Laboratory Control			01/30	0.142	0.220	0.152	0.187	0.175
BG2SD-01	01/26	01/29	01/30	0.136	0.175	0.158	0.155	0.156

TABLE 6. Summary of Survival and Growth (Dry Weight) Data for the Amphipod, *Hyalella azteca*, Exposed to Sediments from the Naval Air Station Key West Project Sites. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Date Collected	Date Rec.	Assay Start	REP A	REP B	REP C	REP D	MEAN
				Amphipod Survival (%) @ 240 Hours				
Laboratory Control			01/30	90.0	85.0	80.0	90.0	86.3
BG1SD-01	01/26	01/27	01/30	85.0	55.0	80.0	25.0	61.3***
S2SD-01	01/24	01/25	01/30	60.0	45.0	50.0	70.0	56.3***
S2SD-02	01/25	01/26	01/30	70.0	70.0	45.0	75.0	65.0***
S2SD-03	01/25	01/26	01/30	30.0	85.0	60.0	30.0	51.3***
S2SD-04	01/25	01/26	01/30	80.0	55.0	75.0	60.0	67.5***
S2SD-05	01/24	01/25	01/30	60.0	45.0	80.0	80.0	66.3***
S3SD-01	01/25	01/26	01/30	85.0	90.0	55.0	60.0	72.5
S3SD-02	01/25	01/26	01/30	70.0	90.0	40.0	50.0	62.5***
S3SD-03	01/25	01/26	01/30	100.0	65.0	100.0	70.0	83.8
S3SD-04	01/25	01/26	01/30	95.0	90.0	65.0	65.0	78.8
S3SD-05	01/25	01/26	01/30	80.0	90.0	90.0	100.0	90.0
				Amphipod Mean Dry Weight (mg)				
Laboratory Control			01/30	0.085	0.062	0.061	0.031	0.060
BG1SD-01	01/26	01/27	01/30	0.035	0.007	0.014	0.058	0.029***
S2SD-01	01/24	01/26	01/30	0.004	0.017	0.080	0.079	0.045
S2SD-02	01/25	01/27	01/30	0.051	0.014	0.036	0.016	0.029***
S2SD-03	01/25	01/26	01/30	0.062	0.031	0.001	0.053	0.037
S2SD-04	01/25	01/26	01/30	0.093	0.119	0.017	0.041	0.068
S2SD-05	01/24	01/25	01/30	0.075	0.086	0.056	0.057	0.069
S3SD-01	01/25	01/26	01/30	0.102	0.061	0.069	0.105	0.084
S3SD-02	01/25	01/26	01/30	0.103	0.044	0.124	0.119	0.098
S3SD-03	01/25	01/26	01/30	0.114	0.118	0.084	0.078	0.099
S3SD-04	01/25	01/26	01/30	0.067	0.113	0.075	0.038	0.073
S3SD-05	01/25	01/26	01/30	0.104	0.086	0.065	0.077	0.083

NOTES:

*** = Significant difference in survival or growth between treatment and control

TABLE 7. **Summary of Survival Data for the Earthworm *Eisenia foetida* Exposed to Soils from the Naval Air Station Key West Project Sites. Naval Air Station Key West Toxicity Evaluation. January 1996.**

Site	Date Collected	Date Rec.	Assay Start	REP A	REP B	REP C	REP D	MEAN
				Worm Survival (%) @ 168 Hours				
Laboratory Control				80	96	100	84	
				100	72	96	-	89.7
BG1SS-01	01/26	01/27	02/01	0	0	0	0	0.0
BG2SS-01	01/26	01/29	02/01	88	76	96	80	85.0
BG3SS-01	01/26	01/27	02/01	44	60	40	52	49.0
S1SS-04	01/31	02/01	02/01	92	80	60	76	77.0
S1SS-05	01/31	02/01	02/01	0	0	0	0	0.0
S1SS-07	01/31	02/01	02/01	72	64	56	48	60.0
				Worm Survival (%) @ 336 Hours				
Laboratory Control				76	80	96	76	
				96	72	96	-	84.6
BG1SS-01	01/26	01/27	02/01	0	0	0	0	0.0
BG2SS-01	01/26	01/29	02/01	80	76	68	48	68.0
BG3SS-01	01/26	01/27	02/01	12	20	16	16	16.0
S1SS-04	01/31	02/01	02/01	68	48	56	56	57.0
S1SS-05	01/31	02/01	02/01	0	0	0	0	0.0
S1SS-07	01/31	02/01	02/01	48	56	36	44	46.0

TABLE 8. Summary of General Water Quality Data for Surface Water Samples at Start of Assays. Naval Air Station Key West Toxicity Evaluation. January 1996.

Site	Date Collected	Date Rec.	Assay Start	pH	Sal.	Hard.	Alk.	NH_3	TSS	TS
S1SW-01	1/22	1/23	1/24	7.73	28	4383	182	3.16	238	37500
S1SW-02	1/22	1/23	1/24	7.40	29	5322	155	<0.10	178	50400
S1SW-03	2/01	2/02	2/02	7.48	27	4972	90.8	<0.10	144	39500
S1SW-04	2/01	2/02	2/02	7.72	34	4280	162	<0.10	154	35700
S1SW-05	2/01	2/02	2/02	7.50	34	5045	105	<0.10	156	35800
S2SW-01	1/31	2/01	2/02	7.83	12	2225	149	<0.10	6510	18100
S2SW-02	1/25	1/26	1/27	7.76	13	1650	155	<0.10	145	13100
S2SW-03	1/25	1/26	1/27	7.89	12	1713	152	3.07	81	12700
S2SW-04	1/25	1/26	1/27	7.89	12	1900	143	0.91	361	12800
S2SW-05	1/30	2/01	2/02	7.89	12	1496	147	<0.10	120	12900
S3SW-01	1/25	1/26	1/27	7.79	10	1516	203	1.26	147	10200
S3SW-02	1/25	1/26	1/27	7.76	10	1505	196	1.41	54	9710
S3SW-03	1/25	1/26	1/27	8.39	10	1327	192	<0.10	115	11400
S3SW-04	1/25	1/26	1/27	7.61	10	1527	215	<0.10	88	9940
S3SW-05	1/25	1/26	1/27	7.45	9	1260	237	<0.10	38	6010
S9SW-01	1/23	1/24	1/24	7.68	28	5302	118	<0.10	136	49600
S9SW-02	1/23	1/24	1/24	7.71	34	4856	119	<0.10	142	35800
S9SW-03	1/23	1/24	1/24	7.72	28	5030	83.5	<0.10	124	38000
S9SW-04	1/23	1/24	1/24	7.73	33	4623	78.2	1.07	126	35200
S9SW-05	1/23	1/24	1/24	7.74	33	1596	105	0.46	160	35400
BG1SW-01	1/26	1/27	1/27	7.85	5	816	54.1	0.82	208	41500
BG2SW-01	1/26	1/27	1/27	7.83	38	5852	199	<0.10	260	9560
BG3SW-01	1/26	1/27	1/27	7.72	37	5491	83.2	6.65	144	41300

NOTE:

pH = pH in Standard Units (SU)
Hard. = Hadness in mg/L CaCO3
NH_3 = Ammonia in mg/L
TS = Total Solids in mg/L
Sal. = Salinity in ‰
Alk. = Alkalinity in mg/L $CaCO_3$
TSS = Total Suspended Solids in mg/L

APPENDIX A

RAW DATA
STATISTICAL SUPPORT

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	625.000	625.000	1.471
Within (Error)	2	850.000	425.000	
Total	3	1475.000		

Critical F value = 18.50 (0.05,1,2)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	95.000	95.000		
2	S2SW-03	70.000	70.000	1.213	

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	95.000	95.000		
2	S2SW-03	70.000	70.000	1.213	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatr

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	2			
2	S2SW-03	2	60.197	63.4	25.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	2			
2	S2SW-03	2	130.162	137.0	25.000

STUDY 5561; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	900.000	900.000	18.000
Within (Error)	2	100.000	50.000	
Total	3	1000.000		

Critical F value = 18.50 (0.05,1,2)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	LAB CONTROL	95.000	95.000		
2	S2SW-02	65.000	65.000	4.243	*

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	LAB CONTROL	95.000	95.000		
2	S2SW-02	65.000	65.000	4.243	*

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatm

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	2			
2	S2SW-02	2	20.648	21.7	30.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	2			
2	S2SW-02	2	20.648	21.7	30.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	100.000	100.000	0.111
Within (Error)	2	1800.000	900.000	
Total	3	1900.000		

Critical F value = 18.50 (0.05,1,2)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Trea

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	70.000	70.000		
2	BG1SW-01	60.000	60.000	0.333	

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	70.000	70.000		
2	BG1SW-01	60.000	60.000	0.333	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatm

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	2			
2	BG1SW-01	2	87.600	125.1	10.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	2			
2	BG1SW-01	2	189.414	270.6	10.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	4900.000	4900.000	49.000
Within (Error)	2	200.000	100.000	
Total	3	5100.000		

Critical F value = 18.50 (0.05,1,2)
Since F > Critical F REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	LAB CONTROL	90.000	90.000		
2	BG3SW-01	20.000	20.000	7.000	*

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	LAB CONTROL	90.000	90.000		
2	BG3SW-01	20.000	20.000	7.000	*

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatm

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	2			
2	BG3SW-01	2	29.200	32.4	70.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	2			
2	BG3SW-01	2	63.138	70.2	70.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	4225.000	4225.000	18.778
Within (Error)	2	450.000	225.000	
Total	3	4675.000		

Critical F value = 18.50 (0.05,1,2)
Since F > Critical F REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Trea

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	90.000	90.000		
2	BG2SW-01	25.000	25.000	4.333	*

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	90.000	90.000		
2	BG2SW-01	25.000	25.000	4.333	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	2			
2	BG2SW-01	2	43.800	48.7	65.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	2			
2	BG2SW-01	2	94.707	105.2	65.000

STUDY 5562; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	337.500	337.500	4.500
Within (Error)	6	450.000	75.000	
Total	7	787.500		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Trea

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	100.000	100.000		
2	S9SW-03	85.000	85.000	2.121	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	100.000	100.000		
2	S9SW-03	85.000	85.000	1.000	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatr

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	6			
2	S9SW-03	2	13.740	13.7	15.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	6			
2	S9SW-03	2	94.707	94.7	15.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	937.500	937.500	12.500
Within (Error)	6	450.000	75.000	
Total	7	1387.500		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	LAB CONTROL	100.000	100.000		
2	S9SW-02	75.000	75.000	3.536	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	LAB CONTROL	100.000	100.000		
2	S9SW-02	75.000	75.000	1.667	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatm

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	6			
2	S9SW-02	2	13.740	13.7	25.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	LAB CONTROL	6			
2	S9SW-02	2	94.707	94.7	25.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	937.500	937.500	4.500
Within (Error)	6	1250.000	208.333	
Total	7	2187.500		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Trea

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	100.000	100.000		
2	S1SW-02	75.000	75.000	2.121	*

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	S
1	LAB CONTROL	100.000	100.000		
2	S1SW-02	75.000	75.000	1.000	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	6			
2	S1SW-02	2	22.901	22.9	25.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatmen

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTRO
1	LAB CONTROL	6			
2	S1SW-02	2	157.845	157.8	25.000

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563R	SAMPLE RECEIVED 2/1/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED	
CLIENT Brown+ Root	TEST ORGANISM M. bahia		
SAMPLE Key West NAS	ORGANISM SUPPLIER ESE		
DILUENT Lab Seat	ORGANISM BATCH/AGE 011496MM		

	TRC	TS/S	AMM	TOC	ALK	HARD	SAL	PH	S/C	OTHER (SPECIFY)
EFF	n/a									
DIL	n/a									

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	TEMPERATURE (°C) 0	24	48	72	96	S/C 0	SAL 0
Lab	A	10	10	10	10	10	7.5	6.4	5.4	5.5	5.2	7.73	6.76	7.36	7.20	7.26	25.6	25.5	25.5	25.5	24.8	30.0	20
	B	10	10	10	10	10	7.5	6.0	5.9	5.7	5.4	7.73	7.14	7.56	7.40	7.21							
	C	10	10	10	10	10	7.5	6.0	6.0	5.8	5.6	7.73	7.21	7.58	7.47	7.25						30.0	20
	D	10	10	10	10	10	7.5	6.1	6.0	6.0	5.6	7.73	7.25	7.61	7.52	7.26							
-1 525W -01	A	10	10	10	10	10	6.3	5.8	6.3	5.9	5.4	7.83	7.78	8.03	7.89	7.61						20.0	12
	B	10	10	10	10	10	6.3	5.9	6.5	5.9	5.8	7.83	7.93	8.05	7.93	7.62							
-2 525W -05	A	10	10	10	10	10	7.3	5.8	6.6	6.4	5.9	7.89	7.95	8.11	7.99	7.79						19.7	12
	B	10	10	10	10	10	7.3	5.8	6.5	6.4	5.4	7.89	7.98	8.04	7.94	7.81							
DATE		2/2	2/2	2/4	2/5	2/6	2/2	2/3	2/4	2/5	2/6	2/2	2/3	2/4	2/5	2/6	2/2	2/3	2/4	2/5		2/2	2/2
TIME		1625	1200	1130	1650	1600																	
INITIALS		[illegible]	[illegible]	[illegible]	[illegible]	KMB	NSR	[illegible]	[illegible]	[illegible]	KMB	NSR	[illegible]	[illegible]	[illegible]	KMB	NSR	[illegible]	[illegible]	[illegible]		NSR	NSR
FED?		✓	✓		✓																		

ACUTE BIOASSAY DATA SUMMARY

STUDY	5563	SAMPLE RECEIVED	2-2-96
CLIENT	Biergy & Cost	TEST ORGANISM	M. beryllina
SAMPLE	NAS	ORGANISM SUPPLIER	ESE
DILUENT	lab salt	ORGANISM BATCH/AGE	011496 mix

"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED

	TRC	TS'S	AMM	TOC	ALK	HARD	SAL	PH	S/C	OTHER (SPECIFY)
EFF	n/a	—	—	—	—	—	—	—	—	—
DIL	n/a	—	—	—	—	—	—	—	—	—

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	TEMPERATURE (°C) 0	24	48	72	96	S/C 0	SAL 0
Lab	A	10	7	7	7	7	7.1	6.2	6.2	6.3	5.2	7.96	7.72	7.69	7.54	7.24	25.6	25.5	25.5	25.5	24.8	41.1	30
	B	10	8	8	8	8	7.1	6.0	6.0	6.2	5.5	7.96	7.74	7.72	7.63	7.26							
↓	C	10	9	7	7	7	7.1	6.0	6.0	6.0	5.6	7.96	7.73	7.74	7.62	7.30						41.1	30
	D	10	7	6	4	4	7.1	5.9	6.0	6.0	5.8	7.96	7.73	7.76	7.66	7.28							
SISW-04	A	10	9	9	9	9	6.0	5.8	5.9	5.9	5.9	7.72	7.74	8.04	7.92	7.61						48.2	34
	B	10	9	9	9	9	6.0	5.7	6.1	5.8	5.0	7.72	7.84	8.06	7.95	7.71							
SISW-05	A	10	8	8	8	8	7.5	5.8	6.0	5.7	4.8	7.50	7.86	7.95	7.88	7.83						49.8	34
	B	10	8	7	7	7	7.5	5.8	5.9	5.7	5.2	7.50	7.83	7.93	7.88	7.81							
DATE		2/2	2/3	2/4	2/5	2/6	2/2	2/3	2/4	2/5	2/6	2/2	2/3	2/4	2/5	2/6	2/2	2/3	2/4	2/5	2/6	2/2	2/2
TIME		1635	1200	1700	1645	1615																	
INITIALS		NBC	w	mb	d	KMB	NBC	w	mb	d	KMB	NBC	w	mb	d	KMB	NBC	w	mb	d	KMB	"	NBC
FED?		✓	✓	✓	✓																		

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563	SAMPLE RECEIVED 1/27/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED											
CLIENT Brown & Root	TEST ORGANISM M. beryllina		TRC	TS'S	AMM	TOC	ALK	HARD	SAL	PH	SC	OTHER (SPECIFY)	
SAMPLE Keywest NAS	ORGANISM SUPPLIER ABS	EFF	n/a										
DILUENT Lab Sea H	ORGANISM BATCH/AGE	DIL	n/a										

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	TEMPERATURE (°C) 0	24	48	72	96	S/C x1000 0	SAL 0	
-9 BG2SW-01	A	10	5	5	5	4	7.1	6.3	6.2	7.5	7.0	7.83	7.75	7.85	7.91	7.76	25.5	25.5	25.5	25.5		55.0	4	38
	B	10	4	4	2	1	7.1	6.1	6.3	7.5	7.0	7.83	7.76	7.88	7.91	7.76						55.0	6	38
-10 BG3SW-4	A	10	1	1	1	1	6.9	6.0	6.4	7.1	7.1	7.72	7.75	7.90	7.95	7.79						53.4	38	37
	B	10	5	5	3	3	6.9	5.6	6.4 (W)	6.0	7.0	7.72	7.77	7.92	7.96	7.79						53.4	38	37
~~-11~~	~~A~~																						37	1/27 LH
	~~B~~	LH 1/27																					37	
DATE		1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/27	
TIME		1330	1440	1619	1450	2330																		
INITIALS		LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	LH	
FED?																								

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563	SAMPLE RECEIVED 1/27/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED	
CLIENT Brown Root	TEST ORGANISM M. beryllina		
SAMPLE BG1SW-01	ORGANISM SUPPLIER SSI	EFF	
DILUENT MHR	ORGANISM BATCH/AGE	DIL	

	TRC	TSS	AMM	TOC	ALK	HARD	SAL	PH	SC	OTHER (SPECIFY)
EFF	NR									
DIL										

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	SURVIVAL 24	SURVIVAL 48	SURVIVAL 72	SURVIVAL 96	DISSOLVED OXYGEN (MG/L) 0	DO 24	DO 48	DO 72	DO 96	PH (SU) 0	PH 24	PH 48	PH 72	PH 96	TEMPERATURE (°C) 0	TEMP 24	TEMP 48	TEMP 72	TEMP 96	S/C 0	SAL 0
Lab	A	10	10	10	10	7	8.4	7.8	7.2	7.2	7.1	7.77	6.36	7.29	7.12	7.16	24.6	24.5	24.5	24.5	24.1	304	5
	B	10	10	10	10	7	8.4	7.0	7.3	7.2	7.1	7.77	6.39	7.40	7.31	7.20						304	5
-1	A	10	10	10	10	39	6.0	7.0	7.3	7.2	6.6	7.85	7.03	8.09	8.12	7.59						9870	5
BG1SW-01	B	10	10	10	10	3	6.0	7.1	7.3	7.2	6.6	7.85	7.49	8.21	8.22	7.98						9870	5
DATE		1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31		1/27
TIME		1:55	2:30	1630	1710	2:30																	
INITIALS		LH	~	GB	GB	~	LH	~	GB	GB	~	LH	~	GB	GB	~	LH	~	GB	GB	~		LH
FED?																							

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563	SAMPLE RECEIVED 1/26/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED											
CLIENT Brown & Root	TEST ORGANISM M. bahia		TRC	TS/S	AMM	TOC	ALK	HARD	SAL	PH	S/C	OTHER (SPECIFY)	
SAMPLE Key West LAS	ORGANISM SUPPLIER ABS	EFF	n/a										
DILUENT Lab Salt	ORGANISM BATCH/AGE	DIL	n/a										

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	TEMPERATURE (°C) 0	24	48	72	96	S/C 0	SAL 0
-1	A	10	10	10	8	6	6.4	6.0	6.0	6.7	7.4	7.76	7.00	8.08	8.12	7.92	25.5	25.5	25.5	25.5	25.5	19.9	13
S25W-02	B	10	10	10	9	7	6.4	6.1	6.1	6.7	7.4	7.76	7.55	8.07	8.13	7.91						19.9	13
-2	A	10	10	10	10	9	7.7	6.0	6.1	6.8	7.3	7.89	7.76	8.09	8.14	7.92						19.9	12
S25W-03	B	10	10	8	8	5	7.7	6.1	6.2	7.0	7.2	7.89	7.87	8.12	8.17	7.93						19.9	12
-3	A	10	10	10	9	9	5.8	6.2	6.2	6.9	6.9	7.89	7.92	8.11	8.16	7.94						20.2	12
S25W-04	B	10	10	10	6	5	5.8	6.0	6.3	6.9	6.9	7.89	7.94	8.14	8.18	7.98						20.2	12
-4	A	10	10	10	9	8	7.7	6.2	6.4	6.9	7.1	7.79	8.02	8.22	8.26	8.06						16.1	10
S35W-01	B	10	10	9	8	8	7.7	6.3	6.4	7.2	7.1	7.79	8.03	8.23	8.29	8.08						16.1	10
-5	A	10	10	9	8	7	5.3	6.4	6.5	7.0	7.1	7.76	8.03	8.21	8.26	8.08						15.6	10
S35W-02	B	10	10	10	10	10	5.3	6.3	6.5	7.1	7.4	7.76	8.03	8.20	8.26	8.07						15.6	10
-6	A	10	10	10	10	9	8.1	6.2	6.1	6.8	7.5	8.39	8.11	8.21	8.24	8.06						18.9	12
S35W-03	B	10	10	10	9	8	8.1	6.0	6.2	6.8	7.3	8.39	8.16	8.22	8.25	8.05						18.9	12
-7	A	10	10	10	10	8	7.2	6.0	6.2	7.1	7.4	7.61	8.09	8.25	8.30	8.11						16.4	10
S35W-04	B	10	10	10	10	10	7.2	6.0	6.0	7.2	7.4	7.61	8.07	8.26	8.32	8.14						16.4	10
-8	A	10	10	10	9	9	6.7	6.1	6.3	7.2	7.3	7.45	8.07	8.27	8.33	8.15						15.8	9.8
S35W-05	B	10	10	10	10	10	6.7	6.3	6.2	7.0	7.4	7.45	8.06	8.27	8.32	8.15						15.8	9.8
DATE		1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/27
TIME		1:00	1:40	1:40	1:50	2:30																	
INITIALS		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FED?																							

ACUTE BIOASSAY DATA SUMMARY

STUDY 85563	SAMPLE RECEIVED 1/26/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED
CLIENT Brown & Root	TEST ORGANISM M. berylina	
SAMPLE Key West NAS	ORGANISM SUPPLIER ABS	
DILUENT Lab Salt	ORGANISM BATCH/AGE	

	TRC	TS/S	AMM	TOC	ALK	HARD	SAL	PH	S/C	OTHER (SPECIFY)
EFF	n/a									
DIL	n/a									

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	TEMPERATURE (°C) 0	24	48	72	96	S/C 0	SAL 0	
Lab	A	10	10	10	8	8.9	7.3	7.2	6.1	6.6	6.2	7.85	7.49	7.58	7.62	7.64	25.5	25.5	25.5	25.5	25.5	35.0	25	
	B	10	10	9	9	9	7.3	7.3	6.1	6.6	6.3	7.85	7.81	7.68	7.73	7.68						35.0	25	
	C	10	10	9	8	7	7.3	7.3	6.1	6.7	6.3	7.85	7.82	7.71	7.77	7.68						35.0	25	
	D	10	10	9	7	7	8.2	7.4	6.4	7.4	6.4	7.53	7.81	7.71	7.92	7.71						15.1	25	10
	E	10	10	10	9	9	8.2	7.4	6.3	7.4	6.3	7.53	8.00	7.64	7.80	7.66						15.1	25	10
	F	10	10	10	10	10	8.2	7.5	6.3	7.3	6.3	7.53	7.82	7.58	7.73	7.60						15.1	25	10
																							LH 1/27	
DATE		1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/28	1/29	1/30	1/31	1/27	1/27	
TIME		1:30	2:00	1616	1440	2:30																		
INITIALS		LH	~	SB	NBR	~	LH	~	SB	NBR	~	LH	~	SB	NBR	~	LH	~	SB	NBR	~	LH	LH	
FED?																								

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563	SAMPLE RECEIVED 1/25/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED
CLIENT Brown Root	TEST ORGANISM C. bergillina	
SAMPLE Keyluted NAS Outfall	ORGANISM SUPPLIER SSI	
DILUENT Lab Salt	ORGANISM BATCH/AGE	

	TRC	TS'S	AMM	TOC	ALK	HARD	SAL	PH	S'C	OTHER (SPECIFY)
EFF	n/a									
DIL	n/a	—								

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	SURVIVAL 24	SURVIVAL 48	SURVIVAL 72	SURVIVAL 96	DISSOLVED OXYGEN (MG/L) 0	DO 24	DO 48	DO 72	DO 96	PH (SU) 0	PH 24	PH 48	PH 72	PH 96	Incubator TEMPERATURE (°C) 0	TEMP 24	TEMP 48	TEMP 72	TEMP 96	S/C µmhos 0	SAL 0
Lab	A	10	10	9	9	5	7.1	6.3	6.2	7.0	6.5	7.69	7.49	7.64	7.57	7.56	25.5	25.5	25.5	25.5	25.5	341	27
	B	10	10	10	10	3	7.1	6.2	6.0	6.5	6.4	7.69	7.64	7.69	7.72	7.67						341	27
	C	10	8	7	4	2	7.1*	7.0	6.6	7.4	7.1	7.69	7.67	7.80	7.76	7.82						341	27
	D	10	10	10	10	10	7.1*	6.9	6.4	7.3	7.0	7.69	7.71	7.78	7.85	7.82						341	27
DATE		1/25	1/26	1/27	1/28	1/29	1/25	1/26	1/27	1/28	1/29	1/25	1/26	1/27	1/28	1/29	1/25	1/26	1/27	1/28	1/29	1/25	1/25
TIME		1625	1530	0120	2030	1445																	
INITIALS		JL	JL	LH	V	GB	JL	JL	LH	V	GB	JL	JL	LH	V	GB	JL	JL	LH	V	GB	JL	JL
FED?																							

* Aerated beginning Day 0.

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563	SAMPLE RECEIVED 1/25/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED	
CLIENT Brown+Root	TEST ORGANISM M. beryllina		
SAMPLE Key West NAS	ORGANISM SUPPLIER 351		
DILUENT Lab Salt	ORGANISM BATCH/AGE		

	TRC	TS/S	AMM	TOC	ALK	HARD	SAL	PH	S/C	OTHER (SPECIFY)
EFF	N/a	—								
DIL	n/a	—	—	—	—	—	—			

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	Incubator TEMPERATURE (°C) 0	24	48	72	96	S/C X1000 0	SAL 0
-1	A	10	9	9	9	5	6.7	6.1	5.9	6.5	6.5	7.48	7.65	7.78	7.82	7.82	25.5	25.5	25.5	25.5	25.5	47.3	27
S1SW03	B	10	10	10	10	5	6.7	6.1	6.0	6.4	6.2	7.48	7.67	7.80	7.82	7.85						47.3	27
-2	A	10	10	10	10	9	6.6	6.6	6.7	7.0	7.0	7.38	8.04	8.12	7.88	8.06						45.2	34
S1SW04	B	10	7	7	7	4	6.6	6.7	6.7	7.0	6.9	7.38	8.04	8.12	7.96	8.14						45.2	34
-3	A	10	9	9	8	8	4.3	5.7	5.9	6.4	6.3	7.35	7.70	7.93	7.97	7.97						44.4	34
S1SW05	B	10	9	9	8	7	4.3	5.4	6.0	6.4	6.3	7.35	7.71	7.87	8.19	7.95						44.4	34
-4	A	10	10	10	10	5	4.1	6.5	6.2	6.2	6.3	7.63	7.96	8.09	8.18	8.14						24.0	18
S2SW01	B	10	9	10	10	7	4.1	6.4	6.2	6.2	6.2	7.63	7.94	8.06	8.18	8.12						24.0	18
-5	A	10	10	10	10	5	4.8	6.2	5.9	6.4	6.2	8.00	7.99	8.11	8.22	8.16						17.5	13
S2SW05	B	10	10	10	10	5	6.8	6.2	5.9	6.3	6.2	8.00	8.00	8.09	8.19	8.15						17.5	13
DATE		1/25	1/26	1/27	1/28	1/29	1/25	1/26	1/27	1/28	1/29	1/25	1/26	1/27	1/28	1/29	1/25	1/26	1/27	1/28	1/29	1/25	1/25
TIME		1628	1530	0955	~	1445																	
INITIALS		[illegible]	[illegible]	LH	2:30	GB	[illegible]	[illegible]	LH	~	GB	[illegible]	[illegible]	LH	~	GB	[illegible]	[illegible]	LH	~	GB	[illegible]	[illegible]
FED?																							

ACUTE BIOASSAY DATA SUMMARY

STUDY 55663	SAMPLE RECEIVED 1/23-24/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED
CLIENT Brown+Root	TEST ORGANISM M. beryllina	
SAMPLE –	ORGANISM SUPPLIER ABC	
DILUENT LabSalt	ORGANISM BATCH/AGE 011096 HB 1 day old	

	TRC	TS/S	AMM	TOC	ALK	HARD	SAL	PH	S/C	OTHER (SPECIFY)
EFF	N/a									
DIL	N/a									

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	TEMPERATURE (°C) Incubator 0	24	48	72	96	S/C µmhos/cm 0	SAL 0
Lab	A	10	10	10	10	10	7.1	5.3	5.9	5.9	6.5	7.67	7.16	7.35	7.51	7.30	25.5	25.5	25.5	25.5	25.5	34.6	25
	B	10	10	10	10	10	7.1	5.1	5.8	5.7	6.2	7.67	7.33	7.44	7.60	7.56						34.6	25
	C	10	10	10	10	10	7.1	5.1	5.6	5.8	6.0	7.67	7.36	7.48	7.65	7.68						34.6	25
	D	10	10	10	10	10	7.1	5.1	5.6	5.8	6.1	7.67	7.38	7.51	7.68	7.72						34.0	25
	E	10	10	10	10	10	7.1	4.9	5.7	5.7	6.2	7.67	7.40	7.54	7.69	7.73						34.0	25
	F	10	10	10	10	10	7.1	5.2	5.7	5.8	6.2	7.67	7.42	7.54	7.69	7.73						34.0	25
DATE		1/24	1/25	1/26	1/27	1/28	1/24	1/25	1/26	1/27	1/28	1/24	1/25	1/26	1/27	1/28	1/24	1/25	1/26	1/27	1/28	1/24	1/24
TIME		1130	1500	1140	0950	2:30																	
INITIALS		[illegible]	[illegible]	[illegible]	HH	[illegible]	[illegible]	[illegible]	[illegible]	HH	[illegible]	[illegible]	[illegible]	[illegible]	HH	[illegible]	[illegible]	[illegible]	[illegible]	HH	[illegible]	[illegible]	[illegible]
FED?																							

ACUTE BIOASSAY DATA SUMMARY

STUDY 5563	SAMPLE RECEIVED 1/23-24/96	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES TO BE SAMPLED
CLIENT Brown + Root	TEST ORGANISM M. beryllina	
SAMPLE NAS Key West	ORGANISM SUPPLIER ARO	
DILUENT lab Salt	ORGANISM BATCH/AGE D11096 MB 11 days	

	TRC	TSS	AMM	TOC	ALK	HARD	SAL	PH	SC	OTHER (SPECIFY)
EFF	N/A	—	—	—	—	—	—	—	—	
DIL	N/A	—	—	—	—	—	—	—	—	

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): ML EFFLUENT + ML BRINE = % ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	DISSOLVED OXYGEN (MG/L) 0	24	48	72	96	PH (SU) 0	24	48	72	96	Incubator TEMPERATURE (°C) 0	24	48	72	96	S/C 0	SAL 0
-1	A	10	9	9	9	8	7.5	5.0	5.4	5.6	6.3	7.73	7.78	7.94	8.07	8.01	25.5	25.5	25.5	25.5	25.5	44.3	28
S1SW-01	B	10	9	8	8	8	7.5	4.9	5.1	5.5	6.3	7.73	7.81	7.97	8.05	8.07						44.3	28
-2	A	10	10	10	10	10	6.2	4.7	5.1	5.3	6.3	7.40	7.71	7.89	8.01	8.04						45.0	29
S1SW-02	B	10	5	5	5	5	6.2	4.8	5.3	5.6	6.2	7.40	7.75	7.95	8.05	8.07						45.0	29
-3	A	10	9	9	9	9	5.8	4.9	5.4	5.5	6.2	7.68	7.68	7.83	7.95	8.02						44.9	28
S9SW-01	B	10	10	10	10	10	5.8	4.9	5.2	5.5	6.1	7.68	7.70	7.83	7.93	7.97						44.9	28
-4	A	10	9	9	9	9	5.9	4.2	5.0	5.4	6.2	7.71	7.67	7.77	7.91	7.98						44.6	34
S9SW-02	B	10	9	8	8	6	5.9	4.6	5.1	5.6	6.1	7.71	7.70	7.83	7.93	7.98						44.6	34
-5	A	10	7	7	7	7	6.5	4.7	5.4	5.8	6.0	7.72	7.70	7.82	7.94	8.00						44.8	28
S9SW-03	B	10	10	10	10	10	6.5	4.9	5.5	5.7	6.0	7.72	7.72	7.82	7.91	8.00						44.8	28
-6	A	10	9	9	9	9	6.0	5.0	5.3	5.9	6.0	7.73	7.74	7.81	7.92	7.99						44.1	33
S9SW-04	B	10	9	9	9	9	6.0	4.6	5.1	5.7	6.1	7.73	7.73	7.82	7.91	8.00						44.1	33
-7	A	10	9	9	9	8	6.2	4.4	5.1	5.7	6.2	7.74	7.72	7.80	7.91	7.99						43.6	33
S9SW-05	B	10	10	10	10	10	6.2	4.8	5.1	5.6	6.2	7.74	7.72	7.82	7.90	8.00						43.6	33
	A																						
	B																						
DATE		1/24	1/25	1/26	1/27	1/28	1/24	1/26	1/26	1/27	1/28	1/24	1/25	1/26	1/27	1/28	1/24	1/25	1/26	1/27	1/28	1/24	1/24
TIME		1300	1400	1400	0855	2:30																	
INITIALS		[illegible]	[illegible]	[illegible]	LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	[illegible]	[illegible]	[illegible]	[illegible]	LH	[illegible]		[illegible]
FED?																							

DOCUMENTATION FORM

STUDY No.: 5563 STUDY DIRECTOR: _____

PROJECT TITLE: P + R. E.

GENERATED BY: JM3 DATE: 1/25/96

The following information is
- ☐ Miscellaneous Documentation
- ☐ A Deviation from the Protocol
- ☐ A Deviation from SOP _____

	Mysid	Menidia	Oyster	Urchin	Amphipod
S1SD-01	X				
-02	X				
-03	X				
-04	X				
-05	X				
S1SW-01		X	X	X	
-02		X	X	X	
-03		X	X	X	
-04		X	X	X	
-05		X	X	X	
S2SD-01	~~X~~				X
S2SD-05	~~X~~				X
S2SW-01		X	~~X~~	~~X~~	
S2SW-05		X	~~X~~	~~X~~	
S9SD-01	X				
-02	X				
-03	X				
-04	X				
-05	X				
S9SW-01		X		X	
-02		X		X	
-03		X		X	
-04		X		X	
-05		X		X	

APPROVED BY: _____ DATE: _____

DOCUMENTATION FORM

STUDY No.: _____ STUDY DIRECTOR: _____

PROJECT TITLE: _____

GENERATED BY: _____ DATE: _____

The following information is

- ☐ Miscellaneous Documentation
- ☐ A Deviation from the Protocol
- ☐ A Deviation from SOP _____

B63SW01

B62SW01

APPROVED BY: _____ DATE: _____

ORGANISMS LENGTHS AND WET WEIGHTS

STUDY #: 5563 CLIENT: Growth Root

SPECIES: M. bernellina ARO011096 SLB ASSAY: 96.4D

Standard Length and Weight of 20 (#) Control Organisms at the Start (Start / End) of Test

REP				
	WEIGHT (g)	LENGTH (mm)	WEIGHT (g)	LENGTH (mm)
1	0.0036	7.7	0.0021	6.8
2	0.0044	8.2	0.0032	7.8
3	0.0033	7.7	0.0034	8.0
4	0.0034	7.7	0.0038	7.7
5	0.0051	8.3	0.0044	8.2
6	0.0026	7.0	0.0033	8.2
7	0.0027	7.6	0.0036	8.3
8	0.0036	7.6	0.0033	8.9
9	0.0032	7.8	0.0022	6.8
10	0.0033	7.8	0.0029	6.8
MEAN			$\bar{x}$ = 0.0034	$\bar{x}$ = 7.7

TEST SOLUTION VOLUME: 200 mL

LOADING RATE: 0.17 g/L

Signature: Natalie [illegible] Date: 1/24/96

Form: ACUTEL&W

ORGANISMS LENGTHS AND WET WEIGHTS

STUDY #: 5563 CLIENT: Brown + Root

SPECIES: C. bengalensis ASSAY: 96 HS

Standard Length and Weight of 20 (#) Control Organisms at the Start (Start / End) of Test

REP				
	WEIGHT (g)	LENGTH (mm)	WEIGHT (g)	LENGTH (mm)
1	0.0009	5.4	0.0006	4.7
2	0.0007	3.7	0.0044	8.1
3	0.0006	4.7	0.0013	6.7
4	0.0030	7.0	0.0014	7.7
5	0.0023	7.1	0.0020	7.3
6	0.0018	6.3	0.0014	7.3
7	0.0009	6.3	0.0009	6.4
8	0.0067	9.6	0.0001	5.3
9	0.0015	7.3	0.0008	5.3
10	0.0057	8.8	0.0016	7.2
MEAN				

TEST SOLUTION VOLUME: 200 mL

LOADING RATE: g/L

Signature: [illegible] Date: 1/25/96

Form: ACUTEL&W

COC #

Envirosystems

CHAIN OF CUSTODY RECORD

Page 1 of 1

RL 2/1/96

~~General Engineering Laboratories, Inc.~~
~~2040 Savage Road~~
~~Charleston, South Carolina 29414~~
~~P.O. Box 30712~~
~~Charleston, South Carolina 29417~~
~~(803) 556-8171~~

Client Name/Facility Name

Collected by/Company: Rachel Layman, BRE

SAMPLE ANALYSIS REQUIRED (x) - use remarks area to specify specific compounds or methods

Use F or P in the boxes to indicate whether sample was filtered and/or preserved

SAMPLE ID	DATE	TIME	WELL	SOIL	COMP	GRAB	# OF CONTAINERS	pH, conductivity	TOC/DOC	TOX	Chloride, Fluoride, Sulfide	Nitrite/Nitrate	VOC - Specify Method required	METALS - specify	Pesticide	Herbicide	Total Phenol	Acid Extractables	B/N Extractables	PCB's	Cyanide	Coliform - specify type			Remarks
S1SW-04	2/1/96	1257				✓	1			✓															resample 4°C
S1SW-05	2/1/96	1255				✓	1			✓															resample ⊥

Relinquished by:	Date:	Time:	Received by:	Relinquished by:	Date:	Time:	Received by:
Rachel M Layman	2/1/96	1600	Fed Ex # 9230385242				
Relinquished by:	Date:	Time:	Received by lab by:	Date: 2/2/96	Time: 0730	Remarks:	

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	833.333	833.333	66.667
Within (Error)	4	50.000	12.500	
Total	5	883.333		

Critical F value = 7.71 (0.05,1,4)
Since F > Critical F REJECT Ho: All equal

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treat

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	100.000	100.000		
2	S1SW-05	75.000	75.000	8.165	*

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	100.000	100.000		
2	S1SW-05	75.000	75.000	5.000	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatme

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	4			
2	S1SW-05	2	6.527	6.5	25.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	4			
2	S1SW-05	2	31.569	31.6	25.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatme

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	95.000	95.000		
2	S2SW-04	70.000	70.000	1.213	

2 Sample t table value = 2.92 (1 Tailed Value, P=0.05, df=2,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	95.000	95.000		
2	S2SW-04	70.000	70.000	1.213	

2 Sample t table value = 6.31 (1 Tailed Value, P=0.05, df=1,1)

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatmen

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	2			
2	S2SW-04	2	60.197	63.4	25.000

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	2			
2	S2SW-04	2	130.162	137.0	25.000

STUDY 5563; NAS Key West Minnow Survival Analysis
File: NASCLEAN Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	625.000	625.000	1.471
Within (Error)	2	850.000	425.000	
Total	3	1475.000		

Critical F value = 18.50 (0.05,1,2)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	4.500	4.500	0.806
Within (Error)	6	33.500	5.583	
Total	7	38.000		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	CONTROL	17.250	17.250		
2	S3SD-04	15.750	15.750	0.898	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI
1	CONTROL	17.250	17.250		
2	S3SD-04	15.750	15.750	0.898	

2 Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Key West NAS - Hyallela azteca Survival
File: HASurvival Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	CONTROL	4			
2	S3SD-04	4	3.247	18.8	1.500

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROI
1	CONTROL	4			

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	0.003	0.003	6.620
Within (Error)	6	0.003	0.000	
Total	7	0.006		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SI(
1	CONTROL	0.060	0.060		
2	S3SD-03	0.099	0.099	-2.573	

2 Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	CONTROL	0.060	0.060		
2	S3SD-03	0.099	0.099	-2.573	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Key West NAS - Hyallela azteca Growth
File: HAGrowth Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	CONTROL	4			
2	S3SD-03	4	0.029	49.0	-0.039

UNEQUAL VARIANCE t-TEST Ho:Control<Treatm

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL

DOCUMENTATION FORM -3

STUDY No.: 5563 STUDY DIRECTOR:

PROJECT TITLE: B&R Earthworm 28 days

GENERATED BY: [illegible] DATE: 2/1/96

The following information is
- ✓ Miscellaneous Documentation
- ☐ A Deviation from the Protocol
- ☐ A Deviation from SOP

Percent moisture

	SISS-4	SISS-7	SISS-5
Beaker wt. =	69.1	66.6	67.8
wet soil wt. =	33.9	26.2	25.7
dry soil + beaker =	97.8	89.8	88.6
dry soil =	28.7	23.2	20.8
% moisture =	15.3	11.5	19.1

SISS-7 - addition of DI H_2O → 125ml DI H_2O added to the combined soil.

beaker wt g.	93.5
wet soil wt	30.8 g
dry soil wt + beaker	118.6 g
dry soil wt	18.5

For each soil sample 2, 1 liter jars were provided by the client; the jar of soil were dumped into a glass tray and thoroughly mixed - then the sample was divided b/w 4, 1 liter glass jars.

APPROVED BY: DATE:

DOCUMENTATION FORM —1

STUDY No.: 5563 STUDY DIRECTOR:

PROJECT TITLE: BAR Earthworm

GENERATED BY: L. [illegible] DATE: 1/31/96

The following information is
- [x] Miscellaneous Documentation
- [ ] A Deviation from the Protocol
- [ ] A Deviation from SOP

- 4 reps for each sediment
- 28 reps for control - 1 lost - broke
- check moisture + pH of each soil
- check weight of worms
- 15 grams of worms / bottle (~20-30 worms)
- count at 7 days, 14 days, 28 days
- 20°C
- feed at 14 days

% moisture

	Control	BG 1SS-01	BG 2SS 01	BG 3SS-01
Beaker weight:	~~65.9g~~ LH 1/31	68.9g	66.3g	67.6g
soil weight:	~~25.0g~~ 2	25.0g	25.1g	25.4g
dried soil weight + beaker		88.0g	86.0g	82.1
		-68.9	-66.3	-67.6
		19.1g Dry weight	19.7g Dry weight	14.5 Dry Weight
% moisture:		23.6%	21.5%	42.9%

1100 1/31

APPROVED BY: DATE:

ESI SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
P.O. Box 778, One Lafayette Road
Hampton, N.H. 03842
(603) 926-0345

ESI STUDY NUMBER: 5563

SAMPLE RECEIPT DATE: 1/23/96 TIME: 1000

SAMPLE RECEIVED BY: ~~Brent~~ 1/23 E. Nardone

DELIVERED VIA: ☑ FED X ☐ CARRIER ☐ CLIENT ☐ COURIER

SAMPLE CONDITION:

CHAIN OF CUSTODY: ☑ YES ☐ NO

CHAIN OF CUSTODY SIGNED: ☑ YES ☐ NO

CHAIN OF CUSTODY COMPLETE:

SAMPLE DATE: ☑ YES ☐ NO
SAMPLE TIME RECORDED: ☑ YES ☐ NO
SAMPLE TYPE IDENTIFIED: ☑ YES ☐ NO

CUSTODY SEAL IN PLACE: ☑ YES ☐ NO

SHIPPING CONTAINER INTACT: ☑ YES ☐ NO

SAMPLE TEMPERATURE (AT ARRIVAL): 5 °C

COMMENTS: 1x 4oz + 1x 500 ml 2x1g S1SW-01 - Silverside, Oyster, Arbacia
1x 4oz + 1x 500 ml 2x1g S1SW-02 - Silverside, Oyster, Arbacia
1x1L S1SD-01 - Mysid Sediment Tox
1x1L S1SD 02 - Mysid Sediment Tox

COOLER NUMBER: 179

ESI SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
P.O. Box 778, One Lafayette Road
Hampton, N.H. 03842
(603) 926-3345

ESI STUDY NUMBER: 5563 Brown + Root

SAMPLE RECEIPT DATE: 1/24/96 TIME: 1930

SAMPLE RECEIVED BY: JPO

DELIVERED VIA: ☒ FED X ☐ CARRIER ☐ CLIENT ☐ COURIER

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☒ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☒ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:		
SAMPLE DATE:	☒ YES	☐ NO
SAMPLE TIME RECORDED:	☒ YES	☐ NO
SAMPLE TYPE IDENTIFIED:	☒ YES	☐ NO
CUSTODY SEAL IN PLACE:	☒ YES	☐ NO
SHIPPING CONTAINER INTACT:	☒ YES	☐ NO
SAMPLE TEMPERATURE (AT ARRIVAL):	6 °C	

COMMENTS: 10 x 1g
5 x 500 ml gl.
5 x 4oz. gl.
5 x 1000mL gl.

COOLER NUMBER: 225, 178, 106, 158.

DOCUMENTATION FORM

STUDY No.: 5563 STUDY DIRECTOR: _____

PROJECT TITLE: Brown + Root

GENERATED BY: DMB DATE: 2/1/96

The following information is

- [ ] Miscellaneous Documentation
- [ ] A Deviation from the Protocol
- [ ] A Deviation from SOP _____

2/1/96 - 500mL AMBER LABELED AS S2SW-02 IS NOT IN ACCORDANCE WITH CHAIN OF CUSTODY. AMBER LABEL IS AMENDED TO S2SW-01.

APPROVED BY: _____ DATE: _____

CHAIN OF CUS)DY RECORD

ENVIROSYSTEMS, INCORPORATED COC #1

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE 1 OF 1

CLIENT: NAS, Key West	CONTACT: Kevin Walker	PROJECT NAME: NAS, Key West	P.O. #
REPORT TO: Kevin Walker, BRE	ADDRESS: 900 Trail Ridge Road, Aiken, SC 29803		PHONE: 803-649-7963
INVOICE TO: Same as above	ADDRESS:		SAMPLED BY: RL

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
S1SD-01	—	1-22-96	NO	1300	O	—	NO	Mysid shrimp, ~~Silverside, Oyster, and Sea Urchin~~ toxicity test. JRB 1-23-96
S1SW-01	—	1-22-96	NO	1300	O	—	NO	Silverside, Oyster, Sea Urchin toxicity test.
S1SD-02	—	1-22-96	NO	1400	O	—	NO	Mysid shrimp toxicity test
S1SW-02	—	1-22-96	NO	1400	O	—	NO	Silverside, Oyster, Sea Urchin toxicity test

RELINQUISHED BY: Julee Bradley	DATE: 1-22-96	TIME: 1730	RECEIVED BY: Fedex Air Bill # 9230392290	DATE: 1-22-96	TIME: 1730
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY: Elizabeth J. Mendoza	DATE: 1-23-96	TIME: 1000
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:

COMMENTS:

A CHAIN OF CUSTODY IS REQUIR ITH EACH SET OF SAMPLES

ORGANISMS LENGTHS AND WET WEIGHTS

STUDY #: 5563 CLIENT: Brown + Root

SPECIES: M. beryllina ASSAY: ~~96-1453~~ 9645

Standard Length and Weight of 20 (#) Control Organisms at the end (Start / End) of Test

REP				
	WEIGHT (g)	LENGTH (mm)	WEIGHT (g)	LENGTH (mm)
1	0.0013	6.9	0.0012	5.8
2	0.0013	6.7	0.0024	7.4
3	0.0018	6.7	0.0014	7.0
4	0.0016	7.1	0.0011	6.7
5	0.0016 ~~53~~	6.6	0.0016	7.3
6	0.0013	6.6	0.0013	6.6
7	0.0013	6.3	0.0012	6.6
8	0.0012	5.7	0.0016	6.1
9	0.0014	6.7	0.0013	6.0
10	0.0012	5.9	0.0012	6.0
MEAN				

TEST SOLUTION VOLUME: 200 mL

LOADING RATE: _____ g/L

Signature: [signature] Date: 1/31/96

Form: ACUTEL&W

ESI

EnviroSystems, Incorporated

Organism Culture and Acclimation Data

EnviroSystems Inc.
[illegible] Chesterfield Road
[illegible]
[illegible]
[illegible] Fax

I. Organism Information

Species: Mysidopsis bahia

Age: 7-9 day

Client: Brown + Root

Amount: 600

Culturist: ~

Study #: 5263

Date Needed: 1/23/96

II. Culture Maintenance Information

Flow Through _____

Recirc _____

Brood Board _____

Static Renewal ✓

Hatch Date: 1/2/96

Lot #: _____

Brood Origin: ARO

III. Acclimation History

Temperature: 17.6 °C

Salinity: 27 ppt

Hardness: _____ mg/L as $CaCO_3$

pH: 7.41 SU

DO: 7.1 mg/L

Water Type: Natural Salt H2O

SITE WATER ACCLIMATION (If applicable)

Start: _____

End: _____

ESI

EnviroSystems, Incorporated

Organism Culture and Acclimation Data

EnviroSystems, Inc.
[illegible] One Lorraine Road
[illegible]
[illegible]
[illegible] Fax

I. Organism Information

Species: Mysidopsis bahia

Age: 7-9 days

Client: Brown + Root

Amount: 160

Culturist: [illegible]

Study #: 5563

Date Needed: 1/30/96

II. Culture Maintenance Information

Flow Through _____

Recirc ✓

Brood Board _____

Static Renewal _____

Hatch Date: 1/23/96

Lot #: _____

Brood Origin: Ocs

III. Acclimation History

Temperature: 19.5 °C

Salinity: 31 ppt

Hardness: _____ mg/L as $CaCO_3$

pH: 7.67 SU

DO: 5.6 mg/L

Water Type: Natural Salt H2O

SITE WATER ACCLIMATION (If applicable)

Start: _____

End: _____

Aquatic Research Organisms

DATA SHEET

I. Organism History

Species: EISENIA FOETIDA

Source: Lab reared ✓ Hatchery reared____ Field collected____

Hatch date > 90 DAYS Receipt date____

Lot number 090095 FE Strain____

Brood Origination EPA, OREGON / AL

II. Water Quality

Temperature 23 °C Salinity____ ppt DO____

pH____ Hardness____ ppm

III. Culture Conditions

System: PEATMOSS / TOPSOIL

Diet: Flake Food____ Phytoplankton____ Trout Chow____

Brine Shrimp____ Rotifers____ Other WORM FOOD

Prophylactic Treatments:____

Comments:____

IV. Shipping Information

Client: ESI # of Organisms: 600+

Carrier: ESI Date Shipped: 1-23-96

Biologist: Stan Sintshi

1 - 800 - 927 - 1650

PO Box 1271 • One Lafayette Road • Hampton, NH 03842 • (603) 926-1650

Aquatic Research Organisms

DATA SHEET

I. Organism History

Species: HYALELLA AZTECA

Source: Lab reared X Hatchery reared ____ Field collected ____

Hatch date 1/10/96 Receipt date ____

Lot number NA Strain ARC-F3

Brood Origination EPA-OHIO

II. Water Quality

Temperature 23 °C Salinity <1 ppt DO ____

pH 7.8 Hardness 195 ppm

III. Culture Conditions

System: STATIC FW

Diet: Flake Food X Phytoplankton ____ Trout Chow ____

Brine Shrimp ____ Rotifers ____ Other ____

Prophylactic Treatments: ____

Comments: ____

IV. Shipping Information

Client: ESI # of Organisms: 1620+

Carrier: PICK-UP Date Shipped: 1/23/96

Biologist: [signature]

1 - 800 - 927 - 1650

PO Box 1271 • One Lafayette Road • Hampton, NH 03842 • (603) 926-1650

Aquatic Research Organisms

DATA SHEET

I. Organism History

Species: Menidia beryllina

Source: Lab reared ✓ Hatchery reared ____ Field collected ____

Hatch date 1-13-96 Receipt date ____

Lot number 011C96MB Strain ____

Brood Origination ____

II. Water Quality

Temperature 25 °C Salinity ~28 ppt DO ✓

pH 8.0 Hardness ✓ ppm

III. Culture Conditions

System: RECIRC

Diet: Flake Food ✓ Phytoplankton ____ Trout Chow ____

Brine Shrimp ✓ Rotifers ____ Other ____

Prophylactic Treatments: ____

Comments: ____

IV. Shipping Information

Client: EST # of Organisms: 400+

Carrier: UPS Date Shipped: 1-24-96

Biologist: Mark Rosenquist

1 - 800 - 927 - 1650

PO Box 1271 • One Lafayette Road • Hampton, NH 03842 • (603) 926-1650

ESI

EnviroSystems, Incorporated

Organism Culture and Acclimation Data

EnviroSystems, Inc.
P.O. Box 773 One Longview R
Portsmouth, N.H. 03840-0773
603 926-0505
603 926-0521 Fax

I. Organism Information

Species: Mysidopsis bahia

Age: 7-14 day

Client: Brown + Root

Amount: 160

Culturist: R

Study #: 5563

Date Needed: 1/25/96

II. Culture Maintenance Information

Flow Through _____

Recirc _____

Brood Board _____

Static Renewal ✓

Hatch Date: 1/18/96

Lot #: 011496 mm

Brood Origin: ABS

III. Acclimation History

Temperature: 20.4 °C

Salinity: 22 ppt

Hardness: _____ mg/L as $CaCO_3$

pH: 7.37 SU

DO: 6.6 mg/L

Water Type: Natural / Salt H2O

SITE WATER ACCLIMATION (If applicable)

Start: _____

End: _____

ESI

EnviroSystems, Incorporated

Organism Culture and Acclimation Data

EnviroSystems, Inc.
P.O. Box 778 One Lafayette Road
Hampton, NH 03842-0778
603 926-5345
603 926-0291 Fax

I. Organism Information

Species: Menidia beryllina

Age: 7-14 days

Client: Brown + Root

Amount: 20

Culturist: [illegible]

Study #: 5563

Date Needed: 2/1/96

II. Culture Maintenance Information

Flow Through _____

Recirc _____

Brood Board _____

Static Renewal _____

Hatch Date: 1/8/96

Lot #: 01-4-96 MM

Brood Origin: ARS

III. Acclimation History

Temperature: 19.6 °C

Salinity: 30 ppt

Hardness: _____ mg/L as $CaCO_3$

pH: 7.40 SU

DO: 6.5 mg/L

Water Type: Natural Salt H_2O

SITE WATER ACCLIMATION (If applicable)

Start: _____

End: _____

2821 Remington Street
Fort Collins, Colorado 80525

Toll Free 1-800-331-5916
In Colorado (970) 223-2938

AQUATIC BIO SYSTEMS ABS INC.

ORGANISM HISTORY

DATE: [illegible]

SPECIES: Menidia beryllina

AGE: 10 days

LIFE STAGE: Larvae

HATCH DATE: [illegible]

BEGAN FEEDING: Immediately

FOOD: Rotifers, Artemia

Water Chemistry Record:	Mean	Range
TEMPERATURE:	25 [illegible]	[illegible]
SALINITY / CONDUCTIVITY:	21 ppt	[illegible] ppt
TOTAL HARDNESS (as $CaCO_3$):	--	--
TOTAL ALKALINITY (as $CaCO_3$):	[illegible] mg/l	[illegible] mg/l
pH:	[illegible]	[illegible]

Comments:

Facility Supervisor

HARDNESS BY CALCULATION

STUDY NUMBER: 5563
CLIENT: Brown & Root Environmental
SAMPLE DESCRIPTION: Hardness of Surface Waters - Key West NAS Project

SAMPLE DESCRIPTION	SAMPLE DAY	MAGNESIUM (mg/L)	CALCIUM (mg/L)	HARDNESS (mg/L)
S1SW-01	0	881.10	302.30	4383.2
S1SW-02	0	1072.00	363.30	5321.7
S1SW-03	0	1019.00	310.60	4971.8
S1SW-04	0	866.40	285.20	4280.0
S1SW-05	0	1024.00	331.90	5045.6
S2SW-01	0	425.10	190.20	2225.5
S2SW-02	0	323.20	127.90	1650.3
S2SW-03	0	336.40	131.30	1713.2
S2SW-04	0	360.60	166.10	1899.7
S2SW-05	0	292.00	117.60	1496.1
S3SW-01	0	285.30	136.80	1516.5
S3SW-02	0	282.60	136.60	1504.8
S3SW-03	0	255.30	110.50	1327.2
S3SW-04	0	283.80	143.60	1527.3
S3SW-05	0	230.30	125.00	1260.5
BG1SW-01	0	148.50	82.02	816.3
BG2SW-01	0	1193.00	376.20	5852.1
BG3SW-01	0	1126.00	342.20	5491.3

HARDNESS BY CALCULATION

STUDY NUMBER: 5563
CLIENT: Brown & Root Environmental
SAMPLE DESCRIPTION: Hardness of Surface Waters - Key West NAS Project

SAMPLE DESCRIPTION	SAMPLE DAY	MAGNESIUM (mg/L)	CALCIUM (mg/L)	HARDNESS (mg/L)
S9SW-01	0	1087.00	330.80	5302.3
S9SW-02	0	997.60	299.40	4855.7
S9SW-03	0	1028.00	319.20	5030.3
S9SW-04	0	941.50	298.80	4623.2
S9SW-05	0	136.00	415.00	1596.3
S2SW-01	0	425.10	190.20	2225.5
S2SW-02	0	323.20	127.90	1650.3
S2SW-03	0	336.40	131.30	1713.2
S2SW-04	0	360.60	166.10	1899.7
S2SW-05	0	292.00	117.60	1496.1
S3SW-01	0	285.30	136.80	1516.5
S3SW-02	0	282.60	136.60	1504.8
S3SW-03	0	255.30	110.50	1327.2
S3SW-04	0	283.80	143.60	1527.3
S3SW-05	0	230.30	125.00	1260.5
BG1SW-01	0	148.50	82.02	816.3
BG2SW-01	0	1193.00	376.20	5852.1
BG3SW-01	0	1126.00	342.20	5491.3

DOCUMENTATION FORM - 4

STUDY No.: 5563 STUDY DIRECTOR:

PROJECT TITLE: B+R Earthworm

GENERATED BY: L Hawkins DATE: 2/8/96

The following information is
- [x] Miscellaneous Documentation
- [ ] A Deviation from the Protocol
- [ ] A Deviation from SOP

Day 7:

BG355-01 – 30ml DI H_2O added to Rep A, B, C
25ml " " " to Rep D

BG255-01 – 20ml DI H_2O added to Rep A, B, C
10ml " " " to Rep D

APPROVED BY: DATE

ENVIROSYSTEMS, INCORPORATED
PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Brown+Root

TEST SUBSTANCE: _____ TEST TYPE: SCREEN _____ DEFINITIVE _____

GENERAL STUDY SPECIFIC INFORMATION: Earthworm Percent moisture 28 days 2/29/96

	Control	BG2SS-01	BG3SS-01
Beaker wt :	95.2	104.2	98.4
wetsoil+~~beak~~ wt :	86.7	89.6	53.4
drysoil+beaker :	157.5	170.9	120.9
drysoil wt. :	62.3	66.7	22.5
% moisture :	28.1 %	25.6 %	57.9 %

	S1SS-4	S1SS-7
Beaker wt :	107.2	102.7
wetsoil wt :	110.5	88.8
drysoil+beaker :	185.3	165.7
drysoil wt :	78.1	63.0
% moisture	29.2 %	29.1 %

TUDY 5563: Earthworm Survival - NAS Key West
ile: worms Transform: NO TRANSFORM

ANOVA TABLE

(CE	DF	SS	MS	F
etween	1	60.500	60.500	7.118
ithin (Error)	6	51.000	8.500	
otal	7	111.500		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

TUDY 5563: Earthworm Survival - NAS Key West
ile: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

ROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	BG2SS-01	17.000	17.000		
2	S1SS-07	11.500	11.500	2.668	*

ple t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

ROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	BG2SS-01	17.000	17.000		
2	S1SS-07	11.500	11.500	2.668	*

Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

UDY 5563: Earthworm Survival - NAS Key West
le: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

OUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	BG2SS-01	4			
2	S1SS-07	4	4.006	23.6	5.500

IAL VARIANCE t-TEST Ho:Control<Treatment

OUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	BG2SS-01	4			

DOCUMENTATION FORM -2

STUDY No.: 5563 STUDY DIRECTOR:

PROJECT TITLE: Earthworm - B+R (control)

GENERATED BY: [illegible] DATE: 1/31/96

The following information is
- ✓ Miscellaneous Documentation
- ☐ A Deviation from the Protocol
- ☐ A Deviation from SOP

Worm culture Soil: pH = 5.54

% moisture pH Adj = 6.06 1235

Beaker wt = 93.2g

wet soil wt = 25.0g

Dry soil + Beaker = 111.20g

- 93.2

18g Dry weight 28% moisture

weight of 10 worms:	
.4g	1.0
.6	0.8
.6	0.6
.9	0.6
1.0	0.7

mean = 0.72g.

APPROVED BY: DATE:

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	351.125	351.125	54.368
Within (Error)	6	38.750	6.458	
Total	7	389.875		

Critical F value = 5.99 (0.05,1,6)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	BG2SS-01	17.000	17.000		
2	S1SS-01	3.750	3.750	7.373	*

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	BG2SS-01	17.000	17.000		
2	S1SS-01	3.750	3.750	7.373	*

Sample t table value = 2.35 (1 Tailed Value, P=0.05, df=3,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	BG2SS-01	4			
2	S1SS-01	4	3.492	20.5	13.250

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	BG2SS-01	4			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	222.870	222.870	30.457
Within (Error)	9	65.857	7.317	
Total	10	288.727		

Critical F value = 5.12 (0.05,1,9)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	S1SS-07	11.500	11.500	5.519	*

2 mple t table value = 1.83 (1 Tailed Value, P=0.05, df=9,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	S1SS-07	11.500	11.500	6.115	*

2 Sample t table value = 1.86 (1 Tailed Value, P=0.05, df=8,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			
2	S1SS-07	4	3.108	14.9	9.357

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	1107.325	1107.325	188.544
Within (Error)	9	52.857	5.873	
Total	10	1160.182		

Critical F value = 5.12 (0.05,1,9)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	S1SS-05	0.000	0.000	13.731	*

Sample t table value = 1.83 (1 Tailed Value, P=0.05, df=9,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	S1SS-05	0.000	0.000	18.592	*

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			
2	S1SS-05	4	2.784	13.3	20.857

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORMATION

ANOVA TABLE

S RCE	DF	SS	MS	F
Between	1	15.125	15.125	1.788
Within (Error)	6	50.750	8.458	
Total	7	65.875		

Critical F value = 5.99 (0.05,1,6)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	BG2SS-01	17.000	17.000		
2	S1SS-04	14.250	14.250	1.337	

2 mple t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	BG2SS-01	17.000	17.000		
2	S1SS-04	14.250	14.250	1.337	

2 Sample t table value = 2.13 (1 Tailed Value, P=0.05, df=4,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORMATION

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	BG2SS-01	4			
2	S1SS-04	4	3.996	23.5	2.750

U. QUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	BG2SS-01	4			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	723.325	723.325	118.670
Within (Error)	9	54.857	6.095	
Total	10	778.182		

Critical F value = 5.12 (0.05,1,9)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	BG3SS-01	4.000	4.000	10.894	*

Sample t table value = 1.83 (1 Tailed Value, P=0.05, df=9,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	BG3SS-01	4.000	4.000	14.121	*

Sample t table value = 1.89 (1 Tailed Value, P=0.05, df=7,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			
2	BG3SS-01	4	2.837	13.6	16.857

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

ANOVA TABLE

JRCE	DF	SS	MS	F
Between	1	111.120	111.120	15.243
Within (Error)	9	65.607	7.290	
Total	10	176.727		

Critical F value = 5.12 (0.05,1,9)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	S1SS-04	14.250	14.250	3.904	*

ample t table value = 1.83 (1 Tailed Value, P=0.05, df=9,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	S1SS-04	14.250	14.250	4.337	*

2 Sample t table value = 1.86 (1 Tailed Value, P=0.05, df=8,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			
2	S1SS-04	4	3.102	14.9	6.607

QUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

ANOVA TABLE

S CE	DF	SS	MS	F
Between	1	1107.325	1107.325	188.544
Within (Error)	9	52.857	5.873	
Total	10	1160.182		

Critical F value = 5.12 (0.05,1,9)
Since F > Critical F REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

ROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	BG1SS-01	0.000	0.000	13.731	*

Sample t table value = 1.83 (1 Tailed Value, P=0.05, df=9,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

ROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	BG1SS-01	0.000	0.000	18.592	*

Sample t table value = 1.94 (1 Tailed Value, P=0.05, df=6,1)

UDY 5563: Earthworm Survival - NAS Key West
le: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

OUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			
2	BG1SS-01	4	2.784	13.3	20.857

N AL VARIANCE t-TEST Ho:Control<Treatment

OUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	1	37.870	37.870	3.751
Within (Error)	9	90.857	10.095	
Total	10	128.727		

Critical F value = 5.12 (0.05,1,9)
Since F < Critical F FAIL TO REJECT Ho: All equal

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	BG2SS-01	17.000	17.000	1.937	*

2 Sample t table value = 1.83 (1 Tailed Value, P=0.05, df=9,1)

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	LAB CONTROL	20.857	20.857		
2	BG2SS-01	17.000	17.000	1.834	

2 Sample t table value = 2.01 (1 Tailed Value, P=0.05, df=5,1)

STUDY 5563: Earthworm Survival - NAS Key West
File: worms Transform: NO TRANSFORM

EQUAL VARIANCE t-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			
2	BG2SS-01	4	3.651	17.5	3.857

UNEQUAL VARIANCE t-TEST Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	LAB CONTROL	7			

CHAIN OF CUSTODY RECORD

COC#4

ENVIROTECH SYSTEMS, INCORPORATED

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE OF

CLIENT: NAS Key West
CONTACT: Kevin Walker
PROJECT NAME: NAS Key West
P.O. #

REPORT TO: Kevin Walker
ADDRESS: 900 Trail Ridge Road, Aiken, SC 29803
PHONE:

INVOICE TO: Same as above
ADDRESS:
SAMPLED BY:

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
S25D-02		1-25-96	NO	0900	O		NO	Amphipod tox test
S25W-02		1-25-96	NO	0900	O		NO	Silverside tox test
S25W-03		1-25-96	NO	0925	O		NO	Silverside tox test
S25D-03		1-25-96	NO	0925	O		NO	Amphipod
S25D-04		1-25-96	NO	1005	O		NO	Amphipod tox test
S25W-04		1-25-96	NO	1005	O		NO	Silverside tox test
S35D-01		1-25-96	NO	1215	O		NO	Amphipod tox test
S35W-01		1-25-96	NO	1215	O		NO	Silverside tox test
S35D-02		1-25-96	NO	1240	O		NO	Amphipod tox test
S35W-02		1-25-96	NO	1240	O		NO	Silverside tox test
S35D-03		1-25-96	NO	1430	0930 1-25-96 O		NO	Amphipod
S35W-3		1-25-96	NO	1430	0930 1-25-96 O		NO	Silverside

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
Julia Bradley	1-25-96	1730	Fed ex Air Bill #: 9230385146	1-25-96	1730
			[illegible]	1/26/96	0945

COMMENTS:

A CHAIN OF CUSTODY IS REQUIRED WITH EACH SET OF SAMPLES

CHAIN OF CUS. DY RECORD

COC #5

ENVIROSYSTEMS, INCORPORATED

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE OF

CLIENT: NAS Key West
CONTACT: Kevin Walter
PROJECT NAME: NAS Key West
P.O. #

REPORT TO: Kevin Walter
ADDRESS: 900 Trail Ridge Rd Aiken SC
PHONE: 803-649-7963

INVOICE TO: Same as above
ADDRESS:
SAMPLED BY: RL

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
S35W-04		1-25-96	NO	1430	O		NO	Silverside
S35D-04				1430				Amphipod
S35W-05				1515				Silverside
S35D-05				1515				Amphipod

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
Julie Bradley	1-25-96	1730	Fed Ex Air bill #: 923038 5146	1-25-96	1730
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE: 1/26/96	TIME: 0945
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:

COMMENTS:

A CHAIN OF CUSTODY IS REQUIR. ITH EACH SET OF SAMPLES

ESI SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
P.O. Box 778, One Lafayette Road
Hampton, N.H. 03842
(603) 926-3345

ESI STUDY NUMBER: 5563

SAMPLE RECEIPT DATE: 1/26/96 TIME: 0945

SAMPLE RECEIVED BY: M Kim

DELIVERED VIA: ☑ FED X ☐ CARRIER ☐ CLIENT ☐ COURIER

SAMPLE CONDITION:

CHAIN OF CUSTODY: ☑ YES ☐ NO

CHAIN OF CUSTODY SIGNED: ☑ YES ☐ NO

CHAIN OF CUSTODY COMPLETE:

SAMPLE DATE: ☑ YES ☐ NO
SAMPLE TIME RECORDED: ☑ YES ☐ NO
SAMPLE TYPE IDENTIFIED: ☑ YES ☐ NO

CUSTODY SEAL IN PLACE: ☑ YES ☐ NO

SHIPPING CONTAINER INTACT: ☑ YES ☐ NO

SAMPLE TEMPERATURE (AT ARRIVAL): 4 °C

COMMENTS: 1 each of S25D-02 – S25D04 Amphipod
1 each of S35D01 – S35D05 Amphipod
1 each of S25W-02-04 Silverside
1 each of S35W-01 – S35W05 Silverside

COOLER NUMBER: ~~1337~~ 1598226

ESI SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
P.O. Box 778, One Lafayette Road
Hampton, N.H. 03842
(603) 926-0345

ESI STUDY NUMBER: 5563

SAMPLE RECEIPT DATE: 1/27/96 TIME: 1045

SAMPLE RECEIVED BY: ZH

DELIVERED VIA: ☑ FED X ☐ CARRIER ☐ CLIENT ☐ COURIER

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☑ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☑ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:		
SAMPLE DATE:	☑ YES	☐ NO
SAMPLE TIME RECORDED:	☑ YES	☐ NO
SAMPLE TYPE IDENTIFIED:	☑ YES	☐ NO
CUSTODY SEAL IN PLACE:	☑ YES	☐ NO
SHIPPING CONTAINER INTACT:	☑ YES	☐ NO
SAMPLE TEMPERATURE (AT ARRIVAL):	1 °C	

COMMENTS: 3 - silverside
3 - earthworm
1 - mysid
2 seaurchin
2 - oyster

COOLER NUMBER: 171

CHAIN OF CUSTODY RECORD

ENVIROSYSTEMS, INCORPORATED

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE OF

CLIENT: NAS, Key West
CONTACT: Kevin Walter, BRE
PROJECT NAME: NAS Key West
P.O. #
REPORT TO: Kevin Walter, BRE
ADDRESS: 900 Trail Ridge Rd Aiken, SC 29803
PHONE: 803 649-7963
INVOICE TO: Same as above
ADDRESS:
SAMPLED BY:

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
S95W-01		1-23-96	NO	1030	O		NO	Silverside, Oyster, Sea Urchin tox
S95D-01		1-23-96	NO	1030	O		NO	Mysid tox test
S95W-02		1-23-96	NO	1100	O		NO	Silverside, Oyster, Sea Urchin tox
S95D-02		1-23-96	NO	1100	O		NO	Mysid tox test
S95W-03		1-23-96	NO	~~1420~~ 1430	O		NO	Silverside, Oyster, Sea Urchin tox
S95D-03		1-23-96	NO	~~1420~~ 1430	O		NO	Mysid tox test
S95W-04		1-23-96	NO	1245	O		NO	Silverside, Oyster Sea Urchin tox
S95D-04		1-23-96	NO	1245	O		NO	Mysid tox test
S95W-05		1-23-96	NO	1320	O		NO	Silverside, Oyster, Sea Urchin tox
S95D-05		1-23-96	NO	1320	O		NO	Mysid tox test

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
Gelica Bradley	1-23-96	1750	Air bill # 9230385 1315	1-23-96	1750
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE: 1/24/96	TIME: 0930
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:

COMMENTS:

A CHAIN OF CUSTODY IS REQUIRED WITH EACH SET OF SAMPLES

COC #

CHAIN OF CUS DY RECORD

ENVIROSYSTEMS, INCORPORATED

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE 1 OF 1

CLIENT: B&RE	CONTACT: Mike Whitten	PROJECT NAME: NAS Key West	P.O. #
REPORT TO: Kevin Walter	ADDRESS:		PHONE:
INVOICE TO:	ADDRESS:		SAMPLED BY: Rachel Laymar, Julea Bradley

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
S1SD-04		1/24/96	NO	1010	O		NO	Mysid tox test
S1SD-05		1/24/96	NO	1045	O		NO	Mysid tox test
S1SD-03		1/24/96	NO	1150	O		NO	Mysid tox test
S1SW-04		1/24/96	NO	1010	O		NO	Silverside, Oyster, and Sea Urchin tox test
S1SW-05		1/24/96	NO	1045	O		NO	Silverside, Oyster, and Sea Urchin tox test
S1SW-03		1/24/96	NO	1150	O		NO	Silverside, Oyster, and Sea Urchin tox test
S25D-01		1/24/96	NO	1415	O		NO	Amphipod tox test
S25W-01		1/24/96	NO	1415	O		NO	Silverside tox test
S25D-05		1/24/96	NO	1445	O		NO	Amphipod tox test
S25W-05		1/24/96	NO	1445	O		NO	Silverside tox test

RELINQUISHED BY: Rachel M Laymar	DATE: 1/24/96	TIME: 1630	RECEIVED BY: Fed Ex Airbill # 9230385091	DATE: TIME:
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY: [signature]	DATE: 1/26/96 TIME: 0930
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE: TIME:

COMMENTS:

A CHAIN OF CUSTODY IS REQUIR ITH EACH SET OF SAMPLES

CHAIN OF CUSTODY RECORD

COC #6

ENVIROSYSTEMS, INCORPORATED

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE OF

CLIENT: NAS Key West, BRE	CONTACT: Kevin Walter	PROJECT NAME: NAS Key West	P.O. #
REPORT TO: Kevin Walter	ADDRESS: 900 Trail Ridge Road, Aiken, SC 29803		PHONE: 803-649-7963
INVOICE TO: Same as above	ADDRESS:		SAMPLED BY:

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
BG15W-01		1-26-96	NO	0945	O		NO	Silverside tox
BG15D-01				0945				Amphipod tox *
BG 3SS-01				1145				Earthworm tox.
BG 3SW-01				1145				Silverside, Oyster, Sea Urchin tox test
BG3SD-01				1145				Mysid shrimp tox test
BG-2SS-01				1340				Earthworm tox test *
BG-2SW-01				1340				Silverside, Oyster, Sea Urchin tox test
BG-2SD-01				1340				Mysid tox test *
BG15S-01				0945				Earthworm tox test

RELINQUISHED BY: Julie Bradley	DATE: 1-26-96	TIME: 1730	RECEIVED BY: Fed Ex Air Bill #: 9230385172	DATE: 1-26-96	TIME: 1730
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY: L Houghtaling	DATE: 1/27/96	TIME: 1045
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:

COMMENTS: * This sample was not received. – Rec 1/29/96 1915 x15

A CHAIN OF CUSTODY IS REQUIRED WITH EACH SET OF SAMPLES

COC#

CHAIN OF CUS' DY RECORD

ENVIROSYSTEMS, INCORPORATED

One Lafayette Road, P.O. Box 778, Hampton, New Hampshire 03842 | Customer Services: Phone # (603) 926-3345 • Fax # (603) 926-3521 | PAGE (OF)

CLIENT: B2RE	CONTACT:	PROJECT NAME: NAS Key West	P.O. #
REPORT TO: Kevin Walter	ADDRESS:		PHONE:
INVOICE TO:	ADDRESS:		SAMPLED BY: Rachel Layman

SAMPLE #	YOUR FIELD IDENTIFICATION (MUST AGREE WITH CONTAINER)	DATE SAMPLED	COMPOSITE (YES/NO)	TIME SAMPLED	E-EFFLUENT D-DILUENT O-OTHER	CONTAINER #/VOL/TYPE	DID YOU FIELD PRESERVE	ANALYSIS REQUESTED (SPECIAL INSTRUCTIONS, CAUTIONS, ETC.)
S25W-05		1/31/96	NO	0940	O	500ml	NO	Resampled
S25W-01		1/31/96	NO	0950	O	500ml	NO	Resampled
								~~Resampled~~ RL 1/31/96 ~~earthworm tox~~
S1SS-04		1/31/96	NO	0840	O	2L	NO	earthworm tox
S1SS-05		1/31/96	NO	0900	O	2L	NO	earthworm tox
S1SS-07		1/31/96	NO	0920	O	2L	NO	earthworm tox

RELINQUISHED BY: Rachel M Layman	DATE: 1/31/96	TIME: 1430	RECEIVED BY: Fed EX # 9230385231	DATE:	TIME:
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY: Jon T. Bedard	DATE: 2/1/96	TIME: 1015

COMMENTS:

A CHAIN OF CUSTODY IS REQUIR ITH EACH SET OF SAMPLES

PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Beaut Root

TEST SUBSTANCE: _____ TEST TYPE: SCREEN ___ DEFINITIVE ___

SURVIVAL DATA:

STUDY INITIATION DATE: _____ **TEST SPECIES:** _____

TEST VESSEL	NOMINAL	REP	NUMBER ALIVE		
			28 Days		
~~CONTROL~~ LH 2/29	~~0~~ 5155-7	A	7		
		B	10		
		C	8		
		D	6		
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
		A			
		B			
		C			
		D			
RECORDED BY:			LH		
DATE:			2/29		

NOTES: _____

PRODUCT REGISTRATION LABORATORY - RAW DATA FORM

STUDY NUMBER: 5563 SAMPLE NUMBER: Brown + Root

TEST SUBSTANCE: _____ TEST TYPE: SCREEN ___ DEFINITIVE ___

SURVIVAL DATA:

STUDY INITIATION DATE: _____ **TEST SPECIES:** _____

TEST VESSEL	NOMINAL	REP	NUMBER ALIVE 28 Days		
CONTROL	0	A	4		
		B	5		
		C	6		
		D	9		
control		E A	5		
		F B	4		
		G C	6		
		H D			
	BG 1SS – 01	A	–		
		B	–		
		C	–		
		D	–		
	BG 2SS – 01	A	5		
		B	4		
		C	0		
		D	0		
	BG3SS -01	A	0		
		B	0		
		C	0		
		D	0		
	5SS – 4	A	0		
		B	0		
		C	3		
		D	11		
	5SS 5	A	–		
		B	–		
		C	–		
		D	–		
RECORDED BY:			LH		
DATE:			2/29		

NOTES: _____

APPENDIX G

FIELD PROCEDURES

TABLE OF CONTENTS

SECTION		PAGE
1.0	**FIELD PROCEDURES**	**G-1**
1.1	SURFACE INVESTIGATION	G-1
1.1.1	Surface Soil Sampling	G-1
1.1.2	Surface Water and Sediment Sampling	G-1
1.2	SUBSURFACE INVESTIGATIONS	G-2
1.2.1	Drilling Methods	G-2
1.2.2	Subsurface Soil Sampling	G-3
1.3	GROUNDWATER INVESTIGATIONS	G-4
1.3.1	Monitoring Well Installation	G-4
1.3.2	Well Surface Completion	G-8
1.3.3	Well Development	G-8
1.3.4	Groundwater Sampling	G-9
1.3.5	Well Abandonment	G-11
1.4	BIOLOGICAL INVESTIGATIONS	G-11
1.4.1	Ecology	G-11
1.4.2	Toxicity Testing	G-11
1.4.3	Tissue Analysis	G-13
1.5	QUALITY ASSURANCE/QUALITY CONTROL STATUS	G-18
1.5.1	Trip Blanks	G-18
1.5.2	Equipment Rinsate Blanks	G-18
1.5.3	Field Duplicates	G-18
1.5.4	Field Blanks	G-19
1.6	SAMPLE MANAGEMENT	G-19
1.6.1	Sample Bottle and Container Preparation	G-19
1.6.2	Sample Identification	G-20
1.6.3	Packaging and Shipping Procedures	G-21
1.6.4	Sample Custody	G-22
1.7	EQUIPMENT DECONTAMINATION	G-23
1.7.1	Soil Sampling Equipment	G-24
1.7.2	Groundwater Sampling Equipment	G-24
1.7.3	Major Equipment	G-24
1.8	INVESTIGATION-DERIVED WASTE MANAGEMENT	G-24

TABLE OF CONTENTS (Continued)

SECTION *PAGE*

1.9 SURVEYING G-25
1.10 WATER-LEVEL MEASUREMENTS G-26
1.11 RECORDING KEEPING G-26
1.11.1 Logbooks G-27
1.11.2 Boring Logs G-27
1.11.3 Well Construction Forms G-28
1.11.4 Well Development Forms G-29
1.11.5 Chain of Custody G-29

2. 0 DATA QUALITY ASSESSMENT G-31

2.1 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA G-31
2.1.1 Precision G-31
2.1.2 Accuracy G-32
2.1.3 Representativeness G-33
2.1.4 Completeness G-34
2.1.5 Comparability G-35
2.2 FIELD INSTRUMENT CALIBRATION PROCEDURES G-35
2.3 ANALYTICAL PROCEDURES G-35
2.3.1 Identification of Methods G-35
2.3.2 Detection and Quantitation Limits G-36
2.3.3 Method Calibration G-36
2.4 DATA MANAGEMENT, REDUCTION AND VALIDATION G-36
2.4.1 Data Management G-36
2.4.2 Data Reduction G-37
2.4.3 Data Validation G-37
2.5 QUALITY CONTROL FOR FIELD AND LABORATORY OPERATIONS G-40
2.5.1 Field Quality Control Checks G-40
2.5.2 Laboratory Quality Control G-40
2.6 PERFORMANCE AND SYSTEMS AUDITS G-42

TABLE OF CONTENTS (Continued)

SECTION *PAGE*

3. 0 DATA INTERPRETATION AND PRESENTATION G-43

3.1 INVESTIGATION RESULTS G-43
3.1.1 Site Background G-43
3.1.2 Site Environmental Setting G-44
3.1.3 Nature and Extent of Contamination G-44
3.1.4 Facility-Wide Contaminant Fate and Transport G-47
3.2 METHODS FOR THE HUMAN HEALTH RISK ASSESSMENT APPROACH G-57
3.2.1 Preliminary Risk Evaluation G-59
3.2.2 Data Evaluation G-60
3.2.3 Toxicity Assessment G-67
3.2.4 Exposure Assessment G-73
3.2.5 Risk Characterization G-94
3.2.6 Uncertainty Analysis G-96
3.2.7 Remedial Goal Options G-100
3.3 ECOLOGICAL RISK ASSESSMENT METHODOLOGY G-105
3.3.1 Preliminary Problem Formulation and Ecological Effects Characterization G-107
3.3.2 Preliminary Exposure Assessment and Risk Characterization G-125
3.3.3 Uncertainty Analysis G-133
3.3.4 Ecological Risk Assessment Approach Summary G-138

4. 0 DETERMINATION OF BACKGROUND LEVELS G-139

4.1 TECHNICAL APPROACH G-141
4.1.1 Upper Tolerance Limit G-142
4.1.2 Testing of Data Distribution G-142
4.1.3 Descriptive Statistics G-143
4.1.4 Evaluation of Organic Compounds G-144
4.2 SUMMARY OF BACKGROUND ANALYTICAL RESULTS G-144

REFERENCES G-146

TABLE OF CONTENTS (Continued)

NUMBER ***PAGE***

TABLES

G.1-1 Number of Fish and Oyster Samples Collected for Chemical Analyses During January 1996 ..... G-14
G.1-2 Fish Collected by Gill Nets During January 1996 ..... G-16
G.1-3 Fish Collected by Seines and Minnow Traps During January 1996 ..... G-17
G.1-4 Water Quality Data for SWMUS 1, 2, 3, and 9 ..... G-17
G.3-1 Summary of Physical and Chemical Data for Chemicals of Potential Concern Sitewide - Surface Water, Sediment, Surface Soil, and Subsurface Soil G-48
G.3-2 Dose Response Parameters - Potential Chemicals of Concern G-68
G.3-3 EPA Weight of Evidence Carcinogenic Classifications G-71
G.3-4 Relative Potency Factors for Carcinogenic PAHs G-74
G.3-5 Input Parameters for Calculating Chemical Intake from Ingestion, Dermal, and Inhalation Exposure to Surface Soils Future Resident G-81
G.3-6 Input Parameters for Calculating Chemical Intake from Ingestion, Dermal, and Inhalation Exposure to Surface Soils Current Adolescent and Adult Trespassers G-82
G.3-7 Input Parameters for Calculating Chemical Intake from Ingestion, Dermal, and Inhalation Exposure to Surface Soils Site Maintenance Worker G-83
G.3-8 Input Parameters for Calculating Chemical Intake from Ingestion, Dermal, and Inhalation Exposure to Surface Soils Industrial Worker G-84
G.3-9 Input Parameters for Calculating Chemical Intake from Ingestion, Dermal, and Inhalation Exposure to Subsurface Soil Site Excavation Worker G-86
G.3-10 Input Parameters for Calculating Chemical Intake from Ingestion And Dermal Exposure to Sediment (Wading Scenario) Future Resident G-88
G.3-11 Input Parameters for Calculating Chemical Intake from Ingestion and Dermal Exposure to Sediment (Wading Scenario) Current Adolescent and Adult Trespassers G-89
G.3-12 Input Parameters for Calculating Chemical Intake from Ingestion and Dermal Exposure to Surface Water (Wading Scenario) Future Residents G-91

TABLE OF CONTENTS (Continued)

NUMBER		PAGE
G.3-13	Input Parameters for Calculating Chemical Intake from Ingestion and Dermal Exposure to Surface Water (Wading Scenario) Current Adolescent and Adult Trespassers	G-92
G.3-14	Surface Water Benchmark Values	G-102
G.3-15	Sediment Benchmark Values	G-103
G.3-16	Groundwater Benchmark Values	G-114
G.3-17	Surface soil Benchmark Values	G-117
G.3-18	Terrestrial Plant Benchmark Values	G-119
G.3-19	Derivation of Reference Dose (RfD) Values for the Lower Keys Marsh Rabbit	G-122
G.3-20	Exposure Parameters for the Lower Keys Marsh Rabbit (*Sylvilagus Palustris Hefneri*)	G-127

FIGURES

NUMBER		PAGE
G.1-1	Monitoring Well Detail (Above Ground Completion)	G-5
G.1-2	Monitoring Well Detail (Below Ground Completion)	G-6
G.3-1	General Conceptual Site Model for NAS Key West SWMUS 1, 2, 3, and 9	G-78
G.3-2	Steps in the Ecological Risk Assessment Process	G-108
G.4-1	NAS Key West High Priority Installation Restoration Sites	G-140

1.0 FIELD PROCEDURES

This section discusses the general sampling operations and procedures used during the Supplemental Resource Conservation and Recovery Act (RCRA) Field Investigation (RFI) and Remedial Investigation (RI) performed in January 1996, Details of the procedures referenced herein can be found in the Supplemental RFI/RI Sampling and Analysis Plan (SAP) (ABB, 1995b).

Environmental samples including surface and subsurface soils, surface water, sediment, groundwater and biota were collected. The sample collection procedures presented in the following section cover the range of activities performed during the field investigation at NAS Key West. These procedures are consistent with the requirements of the Florida Department of Environmental Protection (FDEP) and the U.S. Environmental Protection Agency (EPA) Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (1991d).

1.1 SURFACE INVESTIGATION

1.1.1 Surface Soil Sampling

Surface debris and vegetation were removed from the ground surface before sample collection. Surface soil samples were collected from the ground surface to a maximum depth of 12 inches. A stainless steel trowel was used to collect samples. If the sample was unconsolidated, it was scraped directly into the sample bottle. If the sample material was consolidated, the sample was collected in a stainless steel bowl, homogenized, then transferred to the sample bottle. Volatile organic compound (VOC) samples were directly transferred to the sample bottle to avoid loss of volatiles.

1.1.2 Surface Water and Sediment Sampling

Surface water grab samples were collected from surface water bodies, including borrow pits, drainage ditches, ocean inlets, and lagoons. Surface water samples were collected by lowering the sample bottle beneath the surface until water began to flow into it (after rinsing the unpreserved bottle three times with surface water from that location). Surface water metal and cyanide volumes were collected by pouring water from a rinsed unpreserved bottle into the preserved sample container. Surface water VOC samples were collected by slowly lowering the sample bottle horizontally until water began to flow into it. The bottle was then slowly turned upright, keeping the lip just below the surface as it filled.

If there was insufficient depth of water for use of the direct sample method, a clean, dedicated transfer bottle or a decontaminated stainless steel bowl was used to collect the sample. Rinsate samples were not collected for water samples that were sampled directly or were collected and transferred using clean, dedicated sample bottles.

Temperature, pH, specific conductivity, color, salinity, dissolved oxygen (DO), and turbidity were noted on the Sample Log Form for each surface water sample.

Sediment samples were collected using a variety of sampling equipment including stainless steel trowels or dredges, as required by the sample location and conditions. The sample was usually collected in finer-grained sediments that had the greatest potential for adsorbed contaminants. Depth of sample collection and sediment description were recorded on sample log forms for each sediment sample.

In addition, the following procedures were applied during surface water and sediment sampling: samples were collected first at downstream locations, and surface water samples were collected before sediment samples.

Additional guidance used for the collection of surface water and sediment samples is provided in the Halliburton NUS Standard Operating Procedure (SOP) SA1.2 [Quality Assurance Project Plan (QAPP), Appendix C].

1.2 SUBSURFACE INVESTIGATIONS

This section describes the procedures followed by field operations personnel during subsurface soil sampling and drilling.

1.2.1 Drilling Methods

Subsurface soil sampling was performed by hollow-stem auger (HSA) drilling. Investigation-derived waste (IDW) was containerized, and disposal was handled by NAS Key West personnel following receipt of analytical results.

1.2.1.1 General Drilling Requirements

The drilling protocol was approved by the state of Florida as a part of the 1993 IT Work Plan. The items listed below were part of the standard operating procedure during drilling and well construction:

- Water was the only fluid used during drilling, as necessary.
- Boring logs (Appendix I of the Supplemental RFI/RI Report) were completed for all borings drilled by HSA. This was done through visual analysis of continuous split-spoon samples which were taken every 2 feet in subsurface soil borings and every 5 feet during well installation.
- All data related to well construction were documented on a Well Construction Form (Appendix K of the Supplemental RFI/RI Report) .
- Each well was constructed by a driller and drilling company certified by the State of Florida.
- A geologist from B&R Environmental logged all holes and oversaw all drilling operations.
- Well locations were approved by NAS Key West before installation.
- Casing material conformed to American Society for Testing and Materials (ASTM) Standard F-480.88A or National Sanitation Foundation Standard 14.
- A notch was cut into the top of the casing to be used as a reference point for the elevation survey and for the measuring of water-levels.

1.2.1.2 Hollow-Stem Auger Drilling

Five soil borings were advanced using an HSA rig during the RFI field investigation. Boreholes drilled for installation of monitoring wells were installed using a truck mounted drilling rig equipped with a 4.25 inch-inner diameter HSA. Upon completion of sampling operations, abandoned boreholes were backfilled to the surface with cement-bentonite grout. The grout was a mixture of 2 gallons of water to each 20-pounds of Portland Type I cement plus 1 pound of sodium bentonite. If settling of the grout occurred during the curing process, the borehole was topped off with additional grout.

1.2.2 Subsurface Soil Sampling

This section describes the technique used to sample subsurface soil and the criteria used in selecting portions of a sample for laboratory analysis.

1.2.2.1 Soil Borings

Subsurface soil samples collected using a drilling rig were retrieved using a 2-foot long stainless steel split spoon. Samples were typically collected continuously at 2-foot depth intervals. Samples were collected to enable field screening and observation of soils for selection of samples for laboratory analyses and for lithologic logging of the entire depth of the boring.

1.2.2.2 Sample Selection Criteria

During the course of the Supplemental RFI/RI field investigation, SWMU 9 was the only site where subsurface soil samples were collected. The interval of boring which was sent to the laboratory for analysis was selected based on headspace analysis with a photo-ionization detector (PID). An 8 oz glass jar was half filled with sample from a given interval of boring and covered with tin foil. After allowing 5 minutes for equilibration, the PID probe was inserted through the foil into the headspace. A composite of the 2 foot interval which produced the greatest PID response was sent to the laboratory for analysis. In the event that no portion of the boring produced a PID response, a sample was collected and analyzed from the deepest interval. The PID used an 11.7 eV HNu lamp.

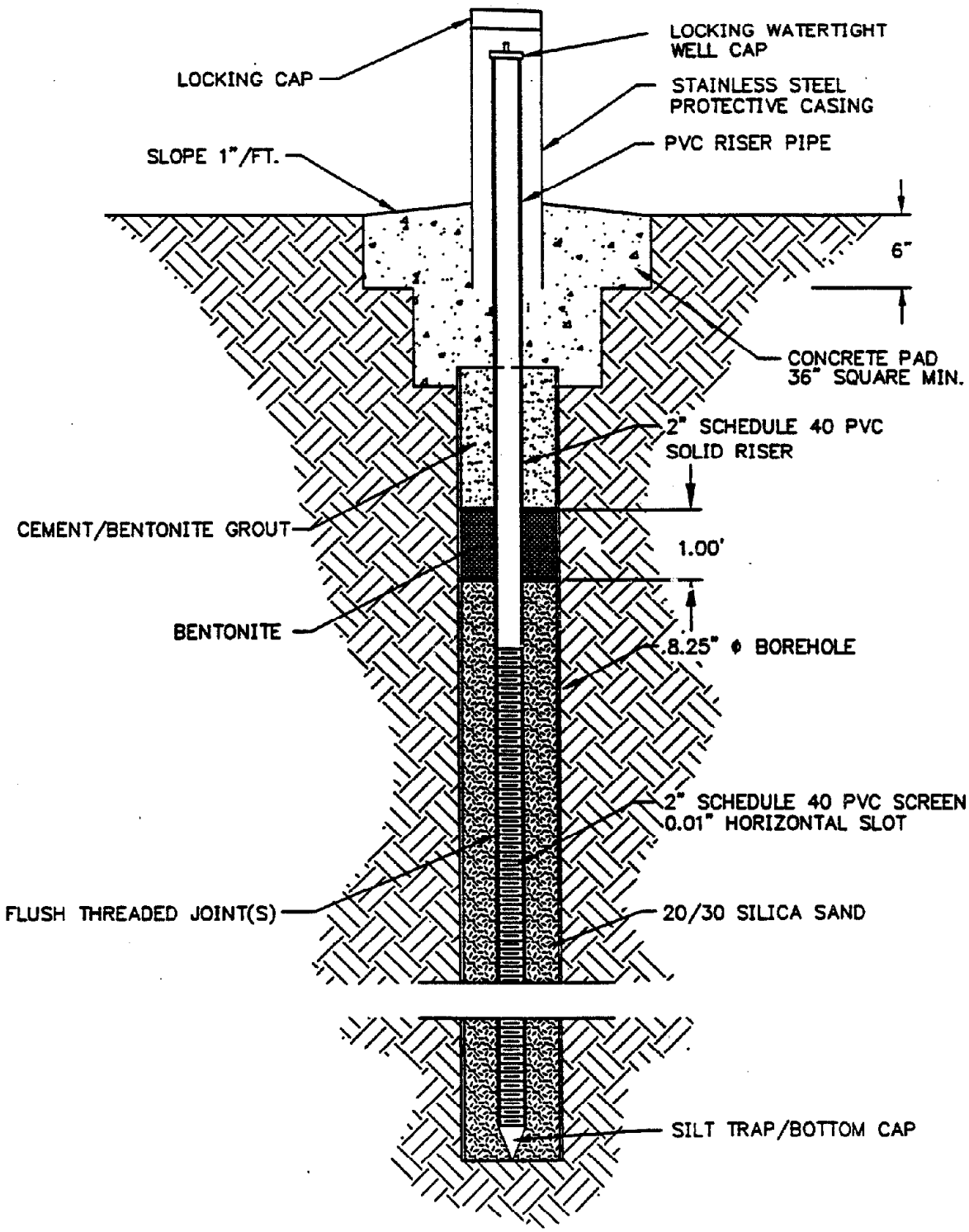
1.3 GROUNDWATER INVESTIGATIONS

Twelve permanent groundwater monitoring wells were installed during the field investigation. These wells were used to determine groundwater-levels, to collect samples for analysis, and to investigate aquifer parameters.

During the construction of all monitoring wells, a complete and detailed log of all materials and their placement was recorded by the on-site geologist. The information was recorded on a Well Completion Form (Appendix K of the Supplemental RFI/RI Report) that became part of the permanent project file.

1.3.1 Monitoring Well Installation

After boring to a sufficient depth in the target zone of groundwater saturation, monitoring wells were installed in the borehole. An 8.25 inch outer diameter HSA was used, providing more than three inches of filter pack annulus once the well was installed (a minimum 2-inch filter pack annulus is required). Shallow wells were installed to depths of approximately 13 feet below land surface (bls). Flush mount wells were installed where necessitated by vehicular traffic or the mowing of grass. Typical above- and below-ground completions are shown in Figures G.1-1 and G.1-2.



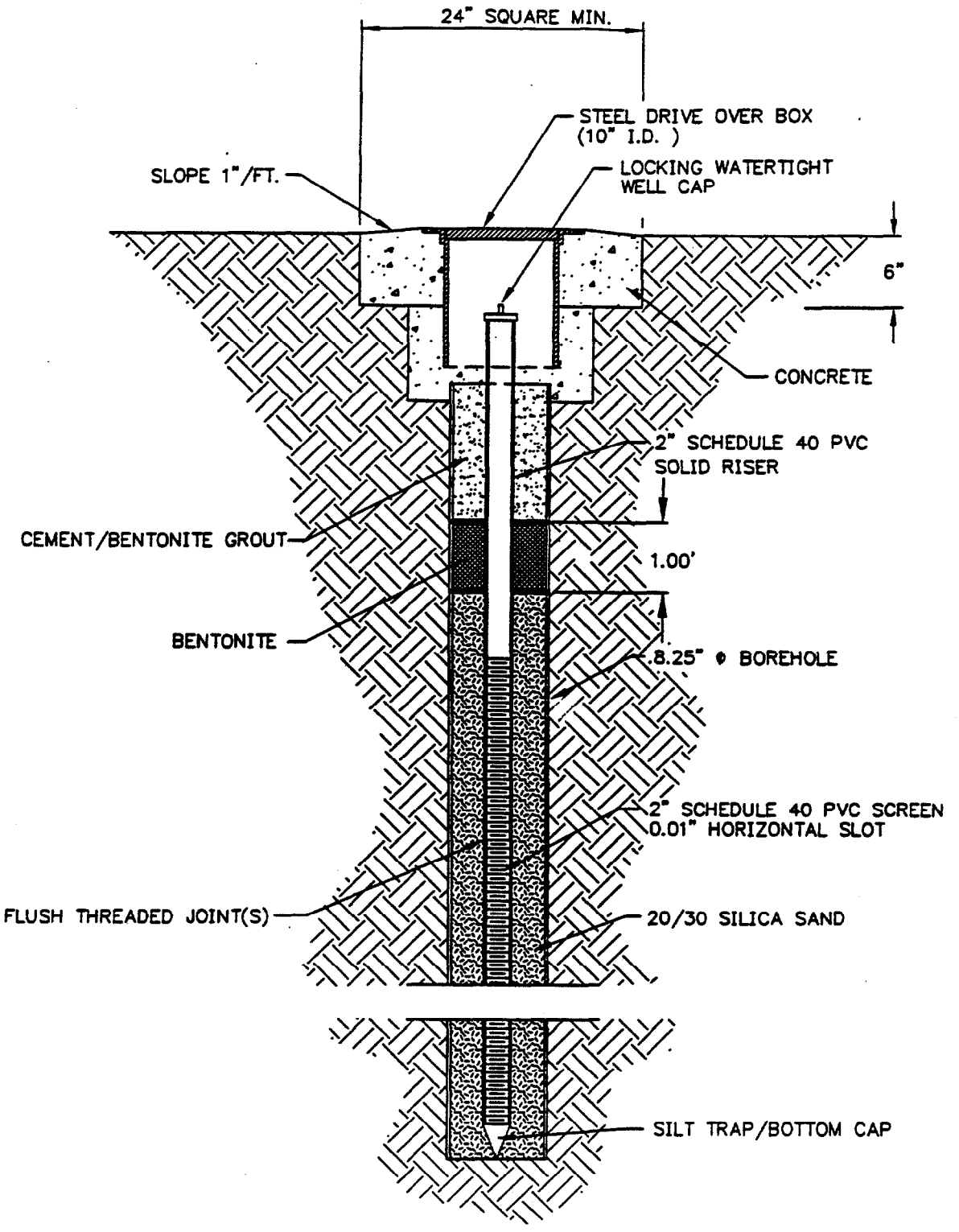
MONITORING WELL DETAIL

(ABOVE GROUND COMPLETION)

SITE MANAGER: RD	CHECKED BY: KW
DRAWN BY: TCB	DRAWING DATE: 7/24/96
SURVEYED BY:	SURVEY DATE:
SCALE: N.T.S.	
CAD DWG. NO.: HK7046-D	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE G.1-1
MONITORING WELL DETAIL
(ABOVE GROUND COMPLETION)
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



MONITORING WELL DETAIL
(BELOW GROUND COMPLETION)

SITE MANAGER: RD	CHECKED BY: KW
DRAWN BY: TCB	DRAWING DATE: 7/27/96
SURVEYED BY:	SURVEY DATE:
SCALE: N.T.S.	
CAD DWG. NO.: HK7046-D	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE G.1-2
MONITORING WELL DETAIL (BELOW GROUND COMPLETION)
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

Ideally the screen should intersect the water table at all times, and water table fluctuations should be accounted for during installation. However, the water table was at 2 feet bls or less in most locations at NAS Key West, but the top of the screen was placed at approximately 2 to 3 feet bls to allow for a minimum of 1 foot sand pack above the top of screen, at least 1 foot of bentonite seal, and approximately 6 inches of concrete cap. The original IT Workplan (1993) called for 2 feet of bentonite seal. This was reduced to place the top of the screen at the highest possible elevation.

Fully penetrating 10-foot screens were used, and the borehole was typically drilled 1 foot below the desired screened interval to accommodate a silt trap. The annulus around the silt trap was then backfilled with the filter pack material.

The filter pack used for the wells was silica sand certified as clean by the manufacturer. It was placed from the bottom of the hole to at least 1 foot above the top of the well screen. When shallow wells were installed through HSAs, the augers were used as a tremmie pipe. The augers were lifted at the approximate rate that the sand was emplaced. Potable water that had been determined to be clean through the use of field blank samples was used to emplace the filter pack, when necessary. All the monitoring wells were completed in the indigenous oolitic limestone. A 20/30 sieve-size filter pack was selected because it was readily available and promoted interstitial drainage of the filter material. This procedure simplified and standardized the well construction process and facilitated meeting the requirements to obtain consistent readings of temperature, pH, conductivity, and turbidity (i.e., the parameters monitored to determine when a well was developed or sufficiently purged). The very fine-grained filter pack required to match the standard water well design specifications described below [which were considered inappropriate for monitoring wells in nonaquifer formations (Gass, 1988 and 1989)] was not used. The use of very fine-grained filter materials slows the well development and purging process because of these materials' high specific retention and lower conductivity (compared to a 20/30-size sand). Over time they may also be more susceptible to invasion and clogging by formation fines and encrustation by microbes and chemical precipitation. A screen slot size of 0.01 inch was used with the 20/30-size filter pack.

The wells were constructed with 2-inch diameter machine-slotted, 10-foot long, Schedule 40 polyvinyl/chloride (PVC) screens and silt traps. Above each screen section was a 2-inch, threaded, Schedule 40 (PVC) riser topped with a well cap. The top of the sand pack was sounded during placement to verify its depth. If after surging the well the sand level subsided, additional sand was placed into the annulus to return the top of the sand to at least 1 foot above the top of the screen.

One foot of 100 percent sodium bentonite pellets or powder were placed into the annulus on top of the filter pack. The bentonite was hydrated with potable water and allowed to cure for over 24 hours, producing a seal to prevent downward migration of the overlying grout or percolation of surface water into the filter pack.

In permanent wells, a grout mixture was placed from the top of the bentonite seal to the ground surface. It was mixed at the following proportions: 20 pounds of neat Type 1 Portland or American Petroleum Institute Class A cement to not more than 1 pound of 100 percent sodium bentonite powder with not more than 2 gallons of water.

1.3.2 Well Surface Completion

The permanent monitoring wells were constructed using above ground or flush completion methods. Wells constructed above ground had steel protector casing with a normal diameter at least 6 inches greater than the diameter of the well riser. Each aboveground completion had a 3-foot by 3-foot by 6-inch steel-reinforced concrete pad sloping at 1-inch/foot away from the steel casing. The bottom of the pad was set 2 inches bls. A well identification information tag was permanently affixed to the protective casing.

Surface completions were flush with the ground where above ground construction was not feasible. The well riser was cut approximately 3 inches bls. A freely draining valve box (or equivalent) with a bolt-down cover was placed over the well head. The top of the well riser was approximately 1 foot above the bottom of the box. The lid was centered in a 2-foot by 2-foot, 6-inch thick concrete pad sloping at 1-inch per foot away from the box. Well identification was permanently marked on the box lid and well cap (where possible).

1.3.3 Well Development

Monitoring wells were developed to remove fine-grained sediments and to break down the filter cake or smearing along the borehole wall. The preferred method of development was surging alternating with peristaltic pumping. All development equipment was decontaminated before placement in the well. Throughout the development procedure discharge water color and volume were documented. Wells were developed until the criteria below were achieved:

- Turbidity remained within a 10-nephelometric unit range.

- The following parameters stabilized:
  - Temperature plus or minus 1° centigrade
  - pH plus or minus 1 unit
  - Electrical conductivity plus or minus 5 percent
- Accumulated sediment was removed from the well.

At most locations the well screen was placed in the oolitic limestone. The primary function of these wells was to provide representative, sediment-free samples of the formation water. The wells were not intended for sustained water production. Large hydraulic gradients that might induce piping of fines through the filter pack and into the well were avoided through the use of low-energy well development and well purging techniques and through minimization of drawdown. The objective of monitoring well development was to flush the well screen and well casing and to compact and stabilize the filter pack around the well screen (Gass, 1989). Development in this case proceeded with gentle (low-energy) surging alternated with low-flow-rate pumping. The action continued until the stabilization parameters had been reached or until five borehole volumes had been extracted, whichever was first. This criteria was based on the FDEP SOPs for well purging.

In general, the items below were conducted or considered in the well development process.

- Development began no sooner than 24 hours after well installation.
- Wells were free of suspended sediments or fines.
- No detergents, bleaches, soaps, or other such agents were used to develop a well.

1.3.4 Groundwater Sampling

Groundwater samples were collected from monitoring wells after they had been properly developed and purged, and not before the water level had recovered to 80 percent of its static level. Samples were not collected within 24 hours of the well development. Also, the sequence of well sampling was performed in order of increasing known or suspected contamination at a given site of investigation. The purging procedure was designed to remove stagnant water from the well casing and the filter pack around the casing, ensuring that fresh formation water was sampled. The calculation of the purge volume required

that the following two variables be known: height of the water column in well and diameter of the well casing.

The casing volume was calculated using the formula below.

$$V = (\pi r^2 h)\ 7.48$$

where

V	=	volume of well casing and borehole, in gal
π	=	3.14
r	=	radius of well casing, in ft
h	=	height of water column in well, in ft
7.48	=	gal/ft^3

Before purging, the air in the breathing zone was checked with a PID (which used an 11.7 eV HNu lamp) at SWMU 9 and with a Sensodyne flame ionization detector (FID) at the other sites, as prescribed in the Health and Safety Plan.

Wells were purged with a peristaltic pump constructed of stainless steel and Teflon®. Purging took place at a "low-flow" rate (approximately 300 ml/min) as to prevent agitation of sediments in the well. The dedicated pump tubing was lowered into the well in a slow, controlled manner.

The temperature, pH, DO, electrical conductivity (EC), salinity, and turbidity were measured and recorded after removal of each gallon during purging. Purging was considered complete after a minimum of three casing volumes had been removed and time-consecutive readings were within 5 percent and turbidity was below 5 nephelometric turbidity units (NTUs), if possible. If such stabilization of parameters could not be attained, then a maximum of five casing volumes was removed.

Precleaned Teflon® bailers and nylon cords dedicated to each monitoring well were used to collect the groundwater samples for all analyses but metals. Samples for metals analysis were collected from the pump discharge tubing immediately after field parameter stabilization. The remaining groundwater samples were collected with bailers. The portion of the sample for VOC analysis was collected first. VOC sample vials were filled completely to the top by slowly pouring the water along the side of the vial. The

vials were checked for air bubbles after filling. If bubbles were present in a vial, the vial was discarded and another was filled for laboratory analysis.

1.3.5 Well Abandonment

No wells were abandoned during this field investigation.

1.4 BIOLOGICAL INVESTIGATIONS

As mentioned earlier, based on the results of RFI/RI Phase I screening-level ecological risk assessment (IT Corporation, 1994), and in consultation with FDEP, additional ecological investigations were recommended at SWMUs 1, 2, 3, and 9. Elevated concentrations of contaminants in Phase I media samples and the resulting potential for significant risks, determined in screening-level ecological risk assessments, resulted in the need for detailed biological investigations at each SWMU to determine whether the elevated concentrations of contaminants may be impacting ecological receptors. Additional chemical analysis of media samples was also proposed to confirm Phase I data. The biological investigations performed as part of Phase II analysis are described below.

1.4.1 Ecology

Site visits were made by B&R Environmental biologists during November 1995 and January 1996. Site specific features and habitat descriptions in this report are based on these site visits and on other sources (IT, 1994; FNAI, 1994). Dominant vegetation types and potential aquatic, semi-aquatic, and terrestrial ecological receptors at each SWMU were identified to determine the receptors that may be at risk from site-related contaminants, the appropriate surrogate species for toxicity testing and the species to be collected for tissue analysis. Conclusions regarding the presence or potential occurrence of endangered and threatened species at NAS Key West were based on B&R Environmental site visits, the aforementioned FNAI (1994) report, discussions with the NAS Key West Natural Resources Manager, and discussions with Florida Game and Fresh Water Fish Commission (FGFWFC) biologists.

1.4.2 Toxicity Testing

Toxicity tests were performed on surface water and sediment samples collected at SWMUs 1, 2, 3 and 9, and on soil samples collected at SWMU 1. Five different surface water and sediment samples underwent toxicity testing at each of the four SWMUs, while three soil samples (one was used as site-specific background) from SWMU 1 were used in earthworm toxicity testing. Tests were performed to determine

whether the elevated concentrations of contaminants detected in various media at the four SWMUs could cause adverse effects in ecological receptors. The same tests were conducted on samples collected from three background sites. Samples were collected between January 22 and February 1, 1996 and shipped to EnviroSystems, Incorporated (ESI), Hampton, New Hampshire, where all toxicity tests were performed.

The species used in aquatic and sediment toxicity tests were dependent upon the salinity of overlying water. At SWMUs 2 and 3, where the salinity was less than 25 parts per thousand (ppt), surface waters were evaluated using the silverside minnow (*Menidia beryllina*), and sediment toxicity was evaluated using the amphipod *Hyalella azteca*. At SWMUs 1 and 9, where the salinity was greater than 25 ppt, surface waters were evaluated using the silverside minnow, mytilid mussel (*Mytilus edulis*) larvae, and sea urchin (*Strongylocentrotus franciscana*) gametes, while sediments were evaluated using the mysid shrimp (*Mysidopsis bahia*). Soils at SWMU 1 were evaluated using the earthworm (*Eisenia foetida*).

The survival of silverside minnows was the test endpoint in 96-hour static acute toxicity tests conducted with this species. The mussel assay utilized a 48-hour exposure period with larval development as the endpoint. Sea urchin sperm motility and fertilization were investigated in 2-hour assays. The survival and growth of amphipods and mysid shrimp were the test endpoints in 10-day assays. The earthworm assay was conducted as a 14-day test with survival as the endpoint.

The tests were conducted according to procedures described in the following documents:

- Methods for Measuring the Acute Toxicity of Effluent and Receiving Water to Freshwater and Marine Organisms (EPA, 1993a)
- Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms (EPA, 1994c)
- Protocol for Short Term Toxicity Screening of Hazardous Waste Sites (EPA, 1989c)
- Aquatic Toxicology and Risk Assessment: Thirteenth Volume (ASTM, 1990)
- Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates (ASTM, 1991)
- Standard Methods for the Examination of Water and Wastewater (APHA, 1989)

Detailed descriptions of the methodology and results of the toxicity tests are provided in the final toxicity testing report (ESI, 1996), provided as Appendix F of the Supplemental RFI/RI Report.

1.4.3 Tissue Analysis

Although elevated concentrations of several types of contaminants were detected in various media at SWMUs 1, 2, 3, and 9 during Phase I sampling activities, no biological samples were collected to determine whether ecological receptors were accumulating site-related contaminants. Hence, biological samples were collected for chemical tissue analysis to investigate potential uptake and retention of contaminants at each SWMU.

1.4.3.1 Aquatic Biota

As discussed in Section 1.3 of the Supplemental RFI/RI Report, groundwater, soil, sediment and surface water samples collected from SWMUs 1 and 2 during the Phase I RFI/RI (IT, 1994) were found to contain contaminants (e.g., DDT, various metals) that are known to accumulate in aquatic food chains. Consequently, during January 1996 fish were collected from SMWUs 1 and 2 for whole body tissue analyses. Due to the close proximity of a large lagoon at SWMU 3, concerns have been raised regarding the contamination of aquatic resources from that site. Thus, fish were also collected from SWMU 3 for tissue analysis. An inlet of the Gulf of Mexico is located adjacent to SWMU 9; concerns have also been raised regarding the contamination of aquatic resources from that site. Mangrove oysters (*Isognomon alatus*) were collected from the water's edge at SWMU 9 for tissue analysis. Fish were not collected from SWMU 9 due to the open nature of the inlet and the presumed transient nature of fish in this area. Mangrove oysters were not available for collection at SWMUs 1, 2, and 3.

Species collected at each SWMU and at background sites are provided in Table G.1-1. Minnow-sized fish were collected in minnow traps and beach seines at SWMUs 1, 2, and 3, and consisted of sheepshead minnow (*Cyprinodon variegatus*), crested goby (*Lophogobius cyprinoides*), sailfin molly (*Poecilia latipinna*), fat sleeper (*Dormitator maculatus*), and marsh killifish (*Fundulus confluentus*). An American eel (*Anguilla rostrata*) was also collected from SWMU 3 in a minnow trap. Fish collected in gill nets at SWMU 2 consisted of ladyfish (*Elops saurus*), striped mullet (*Mugil cephalus*), yellowfin mojarra (*Gerres cinereus*), and tarpon (*Megalops atlanticus*).

At SWMU 1, fish were collected from three small ponded areas within the mangrove swamp in the eastern portion of the site. At SWMU 2, fish were collected from the drainage ditch at the south edge of the site, and from the lagoon in the immediate vicinity of the mouth of the drainage ditch. At SWMU 3, fish were collected from the edge of the lagoon adjacent to the site. Mangrove oysters were collected by hand from submersed mangrove roots in the inlet adjacent to SWMU 9. Individual lengths and weights of the gill-

TABLE G.1-1

NUMBER OF FISH AND OYSTER SAMPLES COLLECTED FOR CHEMICAL ANALYSES DURING JANUARY 1996 NAS KEY WEST

Fish Species	BG 1	BG 2	BG 3	SWMU 1	SWMU 2	SWMU 3	SWMU 9
Tarpon					4		
Striped mullet	2				8		
Ladyfish	5				4		
Yellowfin mojarra	3				6		
Pinfish		4					
Gray snapper		3					
Bluestriped grunt		1					
Sea robin		1					
American eel						1	
Sheepshead minnow*	1		5	2	1	3	
Gulf killifish*			12				
Marsh killifish*						3	
Sailfin molly*	10	1	1	5	2	16	
Fat sleeper*				2			
Crested goby*	4			1			
Mangrove oyster*			3				2
Total No. samples analyzed	**25**	**10**	**21**	**10**	**25**	**23**	**2**

* Composite sample

netted fish were measured. Individual lengths and weights of minnow-sized fish were not determined. Instead, lengths of the smallest and largest fish in each minnow sample were measured, and minnows were pooled by species to create samples of sufficient mass (30 grams wet weight) to perform the required analyses. Lengths and weights are provided in Tables G.1-2 and G.1-3.

Chemical analyses were performed on whole-body samples of fish and on fleshy tissue of mangrove oysters. The tissue was removed from the oyster shells at the testing laboratory.

Sample preservation, packaging, and shipping were performed as described in Section 4.0 of the Sampling and Analysis Plan (ABB, 1995b). Chain-of-custody forms were completed in the field and transported with the samples. Data recorded in the field included the date and time that samples were collected, sample location, sample identification number, and initials of the sampler.

Water quality measurements were taken in association with the aquatic biota sampling at each SWMU and each of three background (control) sites. Table G.1-4 lists water quality data for SWMUs 1, 2, 3, and 9. Background site water quality is discussed in Appendix J. Water quality data are important because fish habitat quality is determined by ambient and historical water quality conditions as well as existing levels of contaminants. Fish abundance and diversity may be low if an aquatic environment is subject to extreme fluctuations in temperature and oxygen levels whether or not contaminants are present. Conversely, fish abundance and diversity may be high in waters that are contaminated (particularly if contaminants are in a form that is not bioavailable) but offer cover, a variety of micro-habitats, high levels of DO, and abundant invertebrate life.

1.4.3.2 Terrestrial Biota

Results of the Phase I RFI/RI (IT, 1994) indicated that terrestrial organisms at SWMU 1 may be at risk from bioaccumulation of contaminants, including metals, polynuclear aromatic hydrocarbons (PAHs), and pesticides. Consequently, attempts were made to identify soil dwelling organisms suitable for tissue analysis. Invertebrates such as earthworms are commonly used for this purpose. However, earthworms are rarely found in the rocky Key West soils, and no other terrestrial invertebrates found at NAS Key West are commonly used in toxicity tests or for tissue analyses. Instead, to investigate bioaccumulation of contaminants by soil-dwelling organisms at SWMU 1, earthworms were reared in soil samples for an additional 14 days beyond the 14-day toxicity test described in Section 1.4.2. Following the 28-day study, earthworm samples were subjected to laboratory analysis of metals.

TABLE G.1-2

FISH COLLECTED BY GILL NETS DURING JANUARY 1996
NAS KEY WEST

Species	Sample ID No.	Total Length (mm)	Weight (g)
Tarpon (*Megalops atlanticus*)	S2F-11	570	1,200
	S2F-12	595	1,550
	S2F-13	517	970
	S2F-20	580	1,250
Striped mullet (*Mugil cephalus*)	S2F-01	511	1,500
	S2F-02	545	1,400
	S2F-03	505	1,350
	S2F-14	325	334
	S2F-15	336	340
	S2F-16	380	508
	S2F-17	343	390
	S2F-18	505	1,300
	BG1F-08	530	1,480
	BG1F-09	538	1,250
Ladyfish (*Elops saurus*)	S2F-04	535	720
	S2F-05	532	658
	S2F-06	525	634
	S2F-21	495	522
	BG1F-03	487	516
	BG1F-04	465	488
	BG1F-05	477	478
	BG1F-06	470	560
	BG1F-07	485	500
Yellowfin mojarra (*Gerres cinereus*)	S2F-07	235	167
	S2F-08	235	182
	S2F-09	260	222
	S2F-10	257	223
	S2F-19	223	146
	S2F-22	338	500
	BG1F-01	380	606
	BG1F-02	370	594
	BG1F-10	381	570
Pinfish (*Lagodon rhomboides*)	BG2F-06	247	224
	BG2F-07	225	178
	BG2F-08	261	240
	BG2F-09	250	228
Gray snapper (*Lutjanus griseus*)	BG2F-01	315	414
	BG2F-02	365	698
	BG2F-03	277	300
Sea robin (*Prionotus sp.*)	BG2F-04	246	204
Bluestriped grunt (*Haemulon sciurus*)	BG2F-05	257	256

TABLE G.1-3

FISH COLLECTED BY SEINES AND MINNOW TRAPS DURING JANUARY 1996
NAS KEY WEST

Species	Length[1] (mm)	Weight[2] (g)
Sheepshead minnow (*Cyprinodon variegatus*)	26-57	461
Gulf killifish (*Fundulus grandis*)	77-110	493
Marsh killifish (*Fundulus confluentus*)	37-105	97
Sailfin molly (*Poecilia latipinna*)	25-63	1,344
Fat sleeper (*Dormitator maculatus*)	93-122	75
Crested goby (*Lophogobius cyprinoides*)	36-92	141
American eel (*Anguilla rostrata*)[3]	385	99

1 Individual lengths and weights of small fish were not always determined. Lengths provided here indicate the range of the smallest to the largest fish.
2 Aggregate weight of fish collected.
3 One eel collected in minnow trap.

Note: At each site, minnows were pooled by species to create samples of approximately 30 - 35 grams each.

TABLE G.1-4

WATER QUALITY DATA FOR SWMUS 1, 2, 3, AND 9
NAS KEY WEST

Location	Date	Temperature (°C)	DO (mg/L)	pH	Specific Conductance (mS/cm)	Salinity (ppt)
SWMU1-04[a]	1-24-96	22.0	No data	6.75	37.5	24.0
SWMU1-05[b]	1-24-96	21.5	0.5	6.91	37.3	23.7
SWMU2-01[c]	1-24-96	23.8	2.0	7.40	No data	No data
SWMU2-02[c]	1-25-96	21.0	2.2	6.50	15.8	9.2
SWMU2-03[c]	1-25-96	21.3	2.28	7.45	16.4	9.6
SWMU2-04[c]	1-25-96	21.1	2.35	7.64	16.5	9.6
SWMU2-05[d]	1-24-96	23.2	7.32	7.81	15.0	8.7
SWMU3-01	1-25-96	22.8	2.10	7.5	12.6	7.2
SWMU3-02	1-25-96	24.9	3.33	7.6	12.6	7.2
SWMU3-03	1-25-96	32.7	7.58	8.16	14.6	8.4
SWMU3-04	1-25-96	24.3	3.32	7.6	12.7	7.3
SWMU3-05	1-25-96	23.2	2.41	7.2	12.4	7.1
SWMU9-01	1-23-96	21.0	4.1	6.8	41.0	26.0
SWMU9-02	1-23-96	21.0	4.1	7.5	41.0	26.0
SWMU9-03	1-23-96	22.0	4.8	7.6	41.0	26.0
SWMU9-04	1-23-96	22.0	4.5	7.4	41.0	26.0
SWMU9-05	1-23-96	21.0	4.9	7.5	41.0	26.0

a Middle pond.
b Southern-most pond.
c Ditch draining DDT Mixing Area.
d Lagoon at east end of ditch.

1.5 QUALITY ASSURANCE/QUALITY CONTROL STATUS

The following sections describe the various QA/QC samples taken and the respective frequencies of collection for each type of sample. The QA/QC sample identification procedure is presented in Section 1.6.2.

1.5.1 Trip Blanks

Trip blanks are required for assessing the potential for VOC contamination of samples during sampling or in transit. Trip blanks were VOC sample bottles filled in the laboratory with volatile-organic-free water, transported to the site, handled in a manner similar to that of environmental samples, and returned to the laboratory for VOC analysis. Trip blanks were not opened in the field. At least one trip blank accompanied each shipping container (cooler) used to store or transport VOC samples.

1.5.2 Equipment Rinsate Blanks

Rinsate blanks were used to assess the adequacy of decontamination procedures and to trace potential cross contamination. Rinsate blanks were prepared on site by pouring analyte-free water over or through freshly decontaminated field equipment. One equipment rinsate blank was collected for every 20 samples collected of like media and like sample method. These blanks were tested for the same analytes as were the environmental samples collected by the sampling team on the same day.

1.5.3 Field Duplicates

Field duplicate samples are two or more samples collected simultaneously into separate containers from the same source under identical conditions. Field duplicates of water samples were collected independently of other water samples, but at same time and location as the other samples. Soil and sediment field duplicates consisted of a single sample collected at a given location and then divided into two samples (one as the primary sample and the other as the duplicate). Subsurface soil duplicates were obtained from the same interval as the original sample. The entire interval was composited and divided equally between the sample and sample duplicate containers. Soil, sediment, and water field duplicates were prepared and analyzed at a rate of 10 percent for all water and soil samples collected within each SWMU. Water and soil duplicates were labeled in such a manner that the laboratory could not determine which samples were duplicates.

1.5.4 Field Blanks

Field blanks were obtained by sampling each water source used in decontamination during the field investigation. The blanks were used to confirm that neither the analyte-free water nor the potable water source was contributing to sample contamination. Field blanks were collected for each type of water used for decontamination and were submitted at a frequency of one sample per water source per sampling event. Three water sources were used during the course of this investigation: de-ionized (DI) water, potable water from Truman Annex-building 112 and potable water from the fuel farm adjacent to Taxiway A and SWMU 2.

1.6 SAMPLE MANAGEMENT

Each sample was placed directly into the laboratory-supplied pre-preserved sample containers, labeled, and placed on ice in a cooler. Each sample was assigned a unique sample number for tracking. Pertinent field data (e.g., color, odor, texture, pH, conductivity, turbidity, temperature, DO, salinity) for each sample were recorded on a sampling form specific to the type and matrix of the sample collected. Each sample collected was also recorded in the field log book and tracked by chain-of-custody throughout its transport from the field to the laboratory. The details of these activities are discussed in the following sections.

1.6.1 Sample Bottle and Container Preparation

The laboratory provided the field sampling team with clean sample bottles containing the proper preservatives for collection of soil, sediment, and water samples. A certificate of cleanliness was included with each shipment. The types of sample containers were determined by the various analyses to be performed. If preservatives were required, sample containers were shipped from the laboratory in a pre-preserved state so that no preservatives had to be added while in the field. When sample bottles were ready to be shipped to the field, the shipping clerk placed the sample bottles in the ice chest. When requested, custody seals, temperature blanks and trip blanks were also included. The ice chests were sealed with custody tape to guard against tampering, and the seals were applied in such a way that they would break when the chest was opened.

The laboratory included a sample bottle checksheet, which documented the preparation of each set of bottles. Documentation included the type and number of bottles; analysis type for each bottle; date of preparation; special cleaning procedures; preservative, if any; and initials of the shipping clerk. Labels were then placed on all prepared bottles indicating the preservative used and the date of preparation.

1.6.2 Sample Identification

Two methods of sample identification were used during the course of the B&R Environmental's field investigation at NAS Key West. One system of labeling was used strictly for environmental samples, while a second identification system was applied to samples such as trip blanks and method blanks, which used for QA/QC purposes

1.6.2.1 Environmental Sample Identification

Each environmental sample was assigned a unique alphanumeric code (number) to track the sample from collection through laboratory analysis and into the final reports. Each number consists of three subparts that indicate the sample site, the sample matrix, and the sample location, respectively, as shown in the example below.

S1	SS	- 01
(Sample Site)	**(Sample Matrix)**	**(Sample Location)**

The first two or three characters indicate the abbreviation for the SWMU or background site. For example, SWMU 2 was abbreviated S2 or background 1 as BG1.

Following the site code is the two-character sample matrix code. These codes indicate the specific type of environmental sample collected. The specific matrix abbreviations are shown below.

- GW- Groundwater
- SS- Surface Soil
- SB- Soil Boring (subsurface soil)
- SW- Surface Water
- SD- Sediment

The last portion of the sample number is a two-character sample location identifier. It denotes the specific physical or geographic location of the sample's origin.

1.6.2.2 QA/QC Sample Identification

Each QA/QC sample was assigned a unique alphanumeric code (number) similar to the environmental samples' identification. However, the QA/QC sample type is also designated.

For example, a surface soil duplicate sample from SWMU-1 was designated S1SSDP-01. For trip blanks, field banks, and rinsate blanks, two characters representing the type of QA sample were followed by a two-digit number and the date. For example TB01-011596 was the identification code for a trip blank collected on January 15, 1996, FB02-010396 was the appropriate identification for a field blank collected on January 3, 1996, and RB01-011496 was the designation for a rinsate blank collected on January 14, 1996.

This sample identification system was used to ensure that the QA/QC samples could be tracked from collection through laboratory analysis and into the final reports, but that the analytical laboratory would be "blind" to the true identity of the samples.

1.6.3 Packaging and Shipping Procedures

Soil, sediment, water, and biota samples collected were considered low-concentration environmental samples (low in pollutant concentration) and were collected from naturally occurring media such as estuaries, lagoons, ditches, soils, and groundwater. Soil, sediment, water and biota samples were packaged and shipped as described below. These shipping procedures comply with U.S. Department of Transportation (DOT) regulations (40 Code of Federal Regulations 171-179).

- Each sample bottle was placed in a plastic bag and the bag was sealed.
- The ice chest was lined with a large plastic bag.
- Inside the bag, several plastic bags filled with ice were placed at the bottom of the ice chest
- The large plastic bag lining the ice chest was filled one-quarter full of inert, absorbent packing material (such as vermiculite).
- Environmental samples, a temperature blank, and a trip blank (if appropriate) were placed in the ice chest.
- Several plastic bags were filled with ice chips and placed between the samples.

- Additional ice-filled bags were placed on top of samples before the large plastic bag was sealed.
- The large plastic bag lining the ice chest was filled with inert packing material and closed and sealed with tape.
- The required paperwork, including chain-of-custody records was sealed inside a plastic bag and taped to the inside of the ice chest lid.
- The ice chest was closed and sealed with strapping tape, and at least two custody seals were placed over the edges in such a way that they would break when the ice chest was opened.
- The ice chest was delivered, using a standard airbill, to Federal Express (or other overnight carrier) within 48 hours (typically within 24 hours) of sample collection.

Tissue samples were typically wrapped in foil and placed in clean, unused Ziploc plastic bags and frozen. Large tissue samples which could not fit into Ziplocs were placed in garbage bags and frozen. Minnow samples were not wrapped in foil. After freezing, tissue samples were placed in ice chests lined with a plastic bag. Dry ice was placed in brown paper bags and packed around the sealed liner bag. The paperwork was then completed, and the ice chest was sealed and shipped as described above.

1.6.4 Sample Custody

The possession of samples was traceable from the time the samples were collected until the analytical results were submitted by the laboratory. This information was available as a result of the use of Chain-of-Custody Forms. These forms accompanied the samples and were shipped in the appropriate shipping container (cooler). Copies of the completed Chain-of-Custody Forms were included in the analytical data packages. Field custody began when materials were placed in clean sample containers obtained from the laboratory and ended when the collected samples were relinquished to the laboratory for testing. This sequence of custody was reflected by the appropriate entries on the Chain-of-Custody Forms.

A sample was considered to be under field custody when: it was in the field investigator's physical possession; it was in the field investigator's view, after being in his physical possession; and it was placed in a designated secure area.

To simplify the chain-of-custody record, as few people as possible handled the samples. For this reason, one individual from the field sampling team was designated as the individual responsible for all sample transfer activities. This field investigator was personally responsible for the care and custody of the samples collected until they were properly transferred to another person or facility.

Field documentation of each sample was made on a Sample Logsheet and in the Site Logbook. This documentation was made in ink and consisted of a notation of the sample identification number, the sample location, and the time/date of collection. All samples were accompanied by a chain-of-custody record. This record documented the transfer of custody of samples from the field investigator to another person, to the laboratory, or to another organizational element, and each change of possession was accompanied by two signatures, one indicating relinquishment and the other receipt of the samples. Completed Chain-of-Custody Forms were enclosed in a plastic cover and placed inside the shipping container used for sample transport from the field to the laboratory.

When samples were relinquished to a shipping company for transport, the tracking number from the shipping bill/receipt was recorded on the Chain-of-Custody Form.

Custody seals were used on the shipping containers when samples were shipped to the fixed-base laboratory to ensure that no sample tampering occurred during transport. At least two custody seals were placed on each shipping container. One was placed on the front, and one was placed on the hinge side. Each was signed and dated by the B&R Environmental employee who packed the container.

1.7 EQUIPMENT DECONTAMINATION

Sampling equipment decontamination was performed in accordance with procedures presented in Appendix B of the EPA Region IV Environmental Compliance Branch Standard Operating Procedure and Quality Assurance Manual (EPA, 1991).

Decontamination of major equipment (e.g., drilling rigs) and sampling equipment was necessary to eliminate the spread of contamination to clean zones, to reduce exposure of personnel, and to reduce cross-contamination of samples when equipment was used at more than one sampling location.

Major equipment was decontaminated using the procedures specified in Section 1.7.3. Sampling equipment was decontaminated in tubs or drainage pans so that solvents could be collected and properly disposed. Rinsate samples were collected, as required, from the decontaminated sampling equipment by rinsing the clean equipment with analyte-free water. The sampling equipment was then wrapped in aluminum foil and stored in a clean area until used. Clean sampling equipment was not allowed to come into contact with the ground or any potentially contaminated surfaces before and during use at the sampling location.

1.7.1 Soil Sampling Equipment

All stainless steel spoons, bowls, trowels, dredges and other soil sampling equipment were decontaminated after each use. The following decontamination procedure was used:

- Wash and scrub the equipment with a solution of Alconox (or equivalent) and potable water.
- Rinse with potable water.
- Rinse with deionized free water.
- Rinse with isopropanol.
- Air dry (if possible).
- Rinse with deionized water, if it is necessary to use equipment before air drying is complete.
- Wrap in oil-free foil (if appropriate).

1.7.2 Groundwater Sampling Equipment

Peristaltic pumps were used to purge and collect groundwater samples. Dedicated discharge lines were used for each sampling location. Peristaltic pumps were cleaned outside before each use.

1.7.3 Major Equipment

Between use at each site, all major equipment such as drill rigs was decontaminated. The drill rig was steam cleaned and, if necessary, surfaces were scrubbed until all visible soil and possible contaminants had been removed. The casing, drill rods, and auger flights were decontaminated by a rinse with potable water, followed by an Alconox wash and steam cleaning.

1.8 INVESTIGATION-DERIVED WASTE MANAGEMENT

During RFI field operations, several types of solid and liquid wastes were generated, including disposable equipment and supplies as well as decontamination and well development/purging fluids. The ultimate disposal of these wastes was dependent upon the degree of environmental contamination present at the site and the likelihood that the investigation wastes would be similarly contaminated. The discussion that follows outlines the strategy for waste management at NAS Key West.

All soil boring cuttings were drummed, transported, and stored temporarily at each SWMU until analytical results from each soil boring were evaluated by the NAS Key West RCRA Coordinator.

Fluids from decontamination of major equipment were not containerized unless B&R Environmental had reason to believe that the fluid was contaminated to such a degree as to pose a threat to human health or the environment. Such a determination was made based on prior knowledge of the levels of contaminants at a particular drilling location, odor, sheen, or a FID or PID reading taken from the decontamination fluids. If containerization of the fluid was required, it was collected and stored in drums. These drums were handled in a manner similar to that used with the soil cuttings.

Upon removal from the monitoring wells, well development/purge water was containerized in labeled drums for proper disposal. Disposal of these fluids was conducted by NAS Key West.

Miscellaneous solid wastes such as disposable gloves, disposable protective clothing, and paper towels were placed in trash bags and disposed of as municipal waste.

1.9 SURVEYING

All groundwater sample locations and elevations were measured by a certified B&R Environmental land surveyor. Each point was measured from a reference location that was tied to the state plane system. An X-Z coordinate system was used to identify locations. The X coordinate describes the east-west axis location (Easting), the Y coordinate describes the north-south axis location (Northing), and the Z coordinate was the vertical elevation above the National Geodetic Vertical Datum. The accuracy of the coordinates and elevations of all survey points was closely scrutinized by B&R Environmental. The locations were compared to field notes and drawings, and elevations were compared to finished floor elevations derived from engineering drawings and aerial photographs of the base which were supplied by the Navy. In some instances, locations were cross-checked using Global Positioning System (GPS) equipment. When discrepancies were noted, the root cause was investigated, and in many instances the surveyor was required to verify the data.

All surveyed locations were reported using the Florida State Plane Coordinate System-Eastern Zone. Existing installation benchmarks served as the horizontal and vertical data for the survey. Elevations and horizontal locations were recorded to the nearest hundredth of a foot. The elevations of all monitoring wells were surveyed at the water-level measuring notch on the riser pipe and on the undisturbed ground surface adjacent to the pad, as well as on the pad itself.

1.10 WATER-LEVEL MEASUREMENTS

Water-level measurements were taken at each monitoring well where groundwater samples were obtained during the Supplemental RFI/RI sampling. Measurements were made at least 24 hours after well development with an electrical water-level indicator and using the top of the well casing as the reference point for determining depths to water. Water-level measurements were recorded to the nearest 0.01 foot in the appropriate field logbook or Water-level Survey Form. Static water-levels were measured in each well before any fluid was withdrawn. If floating hydrocarbon was detected in monitoring wells, the thickness of the free product was measured with an electronic interface probe.

1.11 RECORDING KEEPING

The project and field logbooks are considered to be the primary sources of field documentation. Field data (Appendix I and K of the Supplemental RFI/RI Report) were recorded on various field forms that included, but were not limited to, those listed below.

- Sample Logsheets
- Calibration Sheets
- Chain-of-Custody Forms
- Sample Collection Forms
- Boring Logs
- Water-level Measurement Logs
- Well Construction Forms
- Well Development Forms

These documents, once completed by the field team, were reviewed by the Field Operations Leader (FOL) for completeness and accuracy before being incorporated into the project files.

Project files are maintained in file cabinets located in an area designated for file storage. Each project file contains a project file index that specifies the types and location of all project records to allow for easy access and retrieval. Whenever a record is removed from the project file, it is replaced with a record

withdrawal card that indicates the date the record was removed, the name of the individual removing the record, and a description of the record taken.

All project records will be maintained for the period specified by the contract (no longer than 3 years), after which time the client will be contacted for final record disposition. All documents, including voided entries, will be maintained within the project files located at the Brown and Root Environmental office in Aiken, SC.

1.11.1 Logbooks

The field logbooks are considered the primary sources of field documentation. These logbooks are hard-covered, bound logbooks with sequentially numbered pages. The fronts of the logbooks were labeled with the project name and the dates of use, and they were numbered sequentially as they were completed. Entries in the logbooks were made in real time and included all significant site activities, such as:

- Times of specific events
- Weather conditions
- Site observations (e.g., sample activities, construction progress)
- Specific problems encountered and their solutions (e.g., equipment malfunctions, construction delays)
- Reference to sample custody records
- Personnel on site (names of visitors and times of visits)
- References to equipment calibration records (if appropriate)

The field investigator signed each day's logbook. Entries made after the fact were made below this signature and also signed and dated by the individual making the additional entry.

1.11.2 Boring Logs

During the drilling to collect subsurface soil samples or to install monitoring wells, a complete and detailed log of the drilling conditions and formations encountered was recorded by the on-site geologist. The information was recorded on a Boring Log that became part of the permanent project file. A list of the primary information recorded is shown below.

- Boring or well identification
- Purpose of the boring
- Location in relation to an easily identifiable landmark
- Names of drilling contractor and logger
- Start and finish dates and times
- Drilling method
- Weather conditions
- Lithologic descriptions
  - Predominant particle size
  - Particle size estimate
  - Mineral characteristics
  - Lithologic structure
- Depths of lithologic boundaries
- Analytical samples
- Sampling interval depths and blow counts, where appropriate

1.11.3 Well Construction Forms

The site geologist completed the Well Construction Forms during installation of all permanent wells. Information on the logs included the following:

- Well name and date of installation
- Name of drilling contractor, driller, and geologist
- Total depth of borehole and well
- Depth intervals of screen, sand pack, bentonite seal

- Materials used

1.11.4 Well Development Forms

Following installation, all monitoring wells were developed under the site geologist's supervision. At 5 or 10 minute intervals, the temperature, pH, conductivity, color, turbidity, and total volume of purge water flowing from the well was recorded. Additional information, also noted on the Well Development Form, included the following:

- Well name and date of installation
- Well stickup, total depth, and inside diameter
- Static level before purging
- One casing volume
- Date and time of development
- Method of development
- Name of individual performing development
- Casing volume(s) removed
- Time completed

1.11.5 Chain of Custody

All samples collected in the field were accompanied to the laboratory by a Chain-of-Custody Form. Information recorded on the form included the following:

- Names(s) of the sampler(s)
- Site name from which the sample was collected
- Sample name, date, and time of collection
- Analytical parameters to be tested
- Number of containers per sample

- Date, time, and signature for relinquishing samples

Chain-of-custody records originated on self-duplicating forms. A copy of each completed chain-of-custody record was retained in the field by the sample team. Two copies were shipped with the samples to the laboratory. After the form was signed and the custody of the samples was accepted by the laboratory, one copy of the Chain-of-Custody Form was retained by the laboratory and one was sent to B&R Environmental with the analytical data sheets.

2.0 DATA QUALITY ASSESSMENT

A Sampling and Analysis Plan (SAP) (ABB, 1995b), consisting of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP) (IT, 1993), was prepared for the Supplemental RFI/RI at the Naval Air Station (NAS) Key West. The contents of these documents meet the requirements of the State of Florida hazardous waste regulations and are consistent with the requirements of EPA's RFI guidance.

The SAP defines the project activities necessary to ensure that field activities performed and analytical data generated during the RFI/RI sampling and monitoring well installation activities at NAS Key West were technically valid and adequate to support any remedial alternatives. The SAP specifies field sampling, analytical, and Quality Assurance/Quality Control (QA/QC) requirements. These requirements are briefly summarized in the following sections.

2.1 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The goal of QA is to assure that project activities are planned and performed according to accepted standards and practices and that the resulting data are valid and retrievable. QC is an integral part of the overall QA function and is comprised of all those actions necessary to control and verify that project activities and resulting data meet established requirements.

Data Quality Objectives (DQOs) for measurement data are expressed by EPA in terms of precision, accuracy, representativeness, completeness, and comparability. DQOs provided the mechanism for ongoing control and evaluation of measurement data quality throughout the project and were used to define data quality for the various measurement parameters. The QA/QC effort focused on controlling measurement error within the established limits and provided a database for estimating the actual uncertainty in the measurement data.

2.1.1 Precision

Precision is a measure of the amount of variability and bias inherent in a data set. This parameter also describes the reproducibility or degree of agreement among replicate measurements of a single analyte. The closer the numerical values of the replicate measurements are to each other, the more precise the measurement. Analytical precision for a single analyte is expressed as the relative percent difference (RPD) between results of matrix spikes and matrix spike duplicates (MS/MSDs) for organic analyses or

between laboratory duplicate results of unspiked sample aliquots for inorganic analyses. Field duplicate precision is expressed as the RPD between results of field duplicate samples.

The range and RPD were calculated as shown below.

$$\text{Range} = D_1 - D_2$$

$$\text{RPD (\%)} = \left((D_1 - D_2) \Big/ \left(\frac{D_1 + D_2}{2} \right) \right) \times 100$$

where

RPD = relative percent difference

D_1 = first sample value

D_2 = second sample value (duplicate)

Laboratory-derived control limits for precision, typically set at plus or minus three times the standard deviation of a series of RPD or range values, were used for evaluation of MS/MSD and laboratory duplicate RPDs. Control limits of 30 percent (for aqueous samples) and 50 percent (for solid samples) were used for evaluation of field duplicate RPDs.

2.1.2 Accuracy

Accuracy refers to the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement is to the true value, or actual concentration, the more accurate the measurement. Analytical accuracy may be expressed as the percent recovery of an analyte that has been added to the environmental sample at a known concentration before analysis. For example, accuracy can be determined from the results of MS, surrogate, and laboratory control sample (LCS) analyses.

Accuracy (standard recovery) as percent recovery (P) was calculated as shown below.

$$P = ((\Theta - X) \times 100) \ / \ T$$

where:

P = percent recovery

Θ = measured value of analyte (concentration in the sample after spike was added)

X = measured value of analyte (concentration in the sample before spike was added)

T = value of spike

Laboratory-derived upper and lower control limits for accuracy were typically set at the mean plus or minus three times the standard deviation of a series of percent recovery values.

The accuracy of simple, yet fundamental, field analyses is difficult to assess quantitatively. Sampling accuracy can be maximized, however, by the adoption of and adherence to a strict QA program. For the analytical work performed at NAS Key West, all procedures were documented as standard protocol, and all equipment and instrumentation were properly calibrated and well maintained. In addition to equipment operation procedures and SOPs, a high level of accuracy was maintained by thorough and frequent review of field procedures. In this manner any deficiencies could be quickly documented and corrected. Trip blanks (volatiles only), field (water source) blanks, and equipment rinsate blanks were also collected during field sampling events to assess the potential for any contamination that might have occurred. Trip blanks were submitted at a frequency of one per each shipment of samples scheduled for volatile analysis. Field blanks were collected from each water source at the beginning and at the completion of the field investigation. Equipment rinsate blanks were collected at a frequency of one per day or one per decontamination event.

2.1.3 Representativeness

Representativeness is defined by the degree to which the data accurately and precisely represent

- A characteristic of a population
- Parameter variations at a sampling point
- A process condition
- An environmental condition

Representativeness is ensured by collecting sufficient samples of an environmental medium, properly chosen with respect to place and time. The methods and protocols used to select samples that are representative of a particular sampling site are described in the SAP.

2.1.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data originally intended to be obtained. Under ideal conditions, the completeness objective would be 100 percent; however, samples can be rendered unusable during shipment, preparation (e.g., bottles broken or extracts accidentally destroyed), or analysis (e.g., loss of instrument sensitivity, strong matrix effects). Therefore, the overall DQO for completeness during this investigation was 95 percent.

Samples for which critical data points were determined invalid and unusable via data validation were reanalyzed (provided adequate sample volume was available and holding times could be met) or resampled (with the approval and direction of the Project Manager).

Completeness was calculated as shown below.

$$C = (V / T) \times 100$$

where

C = completeness of analytical effort, in percent

V = number of valid sample analyses

T = total number of samples

A completeness calculation was performed on the analytical results obtained during the Supplemental RFI/RI from surface water, soil, sediment, groundwater, and tissue samples. A total of 1,084 analytical results were rejected during the data validation process out of a total of 43,511 data points, which produces a completeness of 97.5 percent. Therefore, the data obtained during the Supplemental RFI/RI met the overall DQO for completeness.

2.1.5 Comparability

Comparability is defined by the confidence with which one data set can be compared to another. Comparability was achieved by using standardized sampling and analysis methods and standardized data reporting formats (including use of consistent units of measure and reporting of solid matrix sample results on a dry-weight basis).

2.2 FIELD INSTRUMENT CALIBRATION PROCEDURES

While in the field, all field instruments and equipment were calibrated daily using manufacturer's recommended procedures to verify the usability and general accuracy of instruments. Calibration checks were documented in the field logbook and included the following information:

- Date of calibration check
- Identification number(s) of the instruments
- Initials of person(s) performing the calibration
- Instrument readings
- Standard used (as applicable)

Section 2.2 of the Field Sampling Plan (IT, 1993) contains a more detailed presentation of the field instrument calibration procedures that were used.

2.3 ANALYTICAL PROCEDURES

This section addresses the identification of analytical methods which were used in sample analysis, the determination of instrument detection and quantitation limits, and calibration procedures which were used in association with sample analysis.

2.3.1 Identification of Methods

Methods of analysis for samples were taken principally from Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) (EPA, 1986c) and EPA Contract Laboratory Program Statement of Work for Inorganics Analysis (ILM03.0 with all revisions). Sample analyses were performed in

conformance with the EPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, as specified in the SAP.

2.3.2 Detection and Quantitation Limits

Instrument Detection Limits (IDLs) or Method Detection Limits (MDLs) are determined through the performance of detection limit studies. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The IDL is defined as the minimum concentration of substance that can be reliably detected above background noise for a particular instrument. IDLs or MDLs are statistically derived, depending on the parameter of interest. For metals the procedure is defined in the EPA Contract Laboratory Program Statement of Work (CLP SOW) for Inorganics Analysis, Multi-Media, Multi-Concentration, Document No. ILM03.0 (including Revision 1). For all other parameters, the appropriate procedure is defined in 40 CFR 136, Appendix B.

Practical quantitation limits (PQLs) are derived by considering the effects of the sample matrix on the IDL or MDL. PQLs are defined in SW-846 (EPA, 1986c) with allowances made for differing types of sample matrices (e.g., groundwater, soil). Contract Required Detection Limits (CRDLs), which are applicable to metals and cyanide analyses for this project, are specified in the CLP SOW ILM03.0.

2.3.3 Method Calibration

Calibration procedures, including frequency of calibration, were performed as specified in the applicable analytical methods.

2.4 DATA MANAGEMENT, REDUCTION AND VALIDATION

Data management, reduction, and validation considerations are addressed in this section.

2.4.1 Data Management

Proper data management is an integral part of the reporting process and provides a basis for ensuring the validity, correctness, and completeness of reported data. The laboratory will archive all raw data/data packages associated with the analysis of project samples for a minimum of 7 years after project completion. These packages include QA/QC standards, chromatograms, data notebooks, injection logs, instrument calibration and performance data, and any associated workbooks and calculations. In addition,

all field data, including log sheets, notebooks, photographs, etc., will be retained by the contractor in project files. Upon completion of the contract, all pertinent files will be relinquished to the custody of the United States Navy.

2.4.2 Data Reduction

Field instruments used by B&R Environmental were direct-reading, making field calculations and subsequent data reduction unnecessary. Field data were recorded in project logbooks or on field data logsheets. If data entries required correction, the change did not obscure the original entry and the correction or the change was initialed and dated at the time it was made.

Most of the data produced in the laboratory were generated through the use of instrumentation with microcomputer interfaces. The computer received the original signal from the instrument and transformed the raw data into a quantitative value, which was reviewed by an experienced analyst for validity and correct identification.

Other laboratory instrumentation did not interface with computers. The signal from these instruments was recorded as a strip chart trace, numerical output on a printer strip, or direct reading from a digital or analog dial. In these instances, the analyst reduced the data to a reportable format. The original signal was multiplied by a calibration factor or compared with a standard curve. The aliquot result was then divided by the mass or volume of the sample to produce a concentration based final data result. Hand held calculators were used to calculate the data results. All data were recorded by the analyst in a dedicated bench book.

2.4.3 Data Validation

Since some data was acquired directly in the field, while other data were obtained through the laboratory analysis of samples, two types of data validation were necessary. Field data validation considerations, as well as laboratory data validation considerations are discussed below.

2.4.3.1 Field Data Validation

All field data were reviewed by the Field Operations Leader (FOL) or another individual responsible for the collection and verification of data while in the field. Data were initially accepted or rejected by this individual before leaving the sampling site. Extreme readings (i.e., readings that appeared significantly different from other readings at the same site) were accepted only after the instrument had been checked

for malfunction and the readings had been verified by retesting (with an alternate instrument, if possible). Field data validation entailed review and evaluation of field records for the parameters discussed below:

- Field Record Completeness: This examination ensured that established procedures had been followed, all work had been performed in accordance with the Supplemental RFI SAP (ABB, 1995b) and sample integrity had been maintained.
- Sample Identification: Field forms and logbooks were checked for accuracy of information.
- Anomalous Field Test Data: When necessary, field records were examined for anomalous data.
- Precision and Accuracy: When applicable, the precision and accuracy of field test data were evaluated.

Discrepancies found during examination and evaluation of field records were documented, and their effects on the project are discussed in this RFI Report.

2.4.3.2 Laboratory Data Validation

Formal laboratory data validation performs three basic functions. First, it serves as an independent QA check of the veracity of laboratory results. Second, it is a means of evaluating laboratory performance and determining the impact of noncompliance to the data. Finally, through the use of data qualifiers, it lends interpretive guidance as to the proper usage and limitations of the data. Laboratory data validation is essential to the overall defensibility of the data and also provides a secure platform from which to make risk assessment decisions.

Laboratory data validation is a systematic review and evaluation of the data conducted according to the following EPA national protocols (modified as necessary for SW-846 methods): *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994f) and *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1994g).

A full data validation was performed on ten percent of the analytical data obtained for NAS Key West. In accordance with these protocols, organic data were evaluated based on the following parameters:

- Data completeness
- Laboratory blank analyses

- Holding times
- Surrogate spike recoveries
- Gas chromatograph/mass specrometer (GC/MS) tuning and mass calibration
- MS/MSD analyses
- Initial and continuing calibration
- Detection limits
- Internal standards performance
- Sample quantitation

Inorganic data were evaluated based on the following parameters:

- Data completeness
- Laboratory control sample (LCS) results
- Holding times
- Furnace atomic absorption (AA) results
- Initial and continuing calibration verification
- Serial dilution analysis
- Laboratory blank analyses
- Detection limits
- MS and duplicate analyses
- Sample quantitation
- Interference check sample results

Results from field QC analyses (i.e., field blanks and field duplicates) were also evaluated according to these protocols.

A limited data validation was performed on the remaining ninety percent of the analytical data to eliminate false positives and false negatives. This limited data validation included several considerations, for organic and inorganic data: evaluation of holding times, GC/MS tuning and mass calibration (as applicable), initial and continuing calibration, and laboratory and field blank analyses.

Results and conclusions drawn from the laboratory validation were submitted as an internal correspondence memo addressed to the B&R Environmental Task Order Manager. This data validation memo explained the findings of the data evaluation process, provided interpretations of actions taken on the data, and included a summary of the data qualifiers assigned. Qualified laboratory results and supporting documentation consisting of photocopied pages depicting the noncompliances are kept on file in the B&R Environmental Chemistry Department.

2.5 QUALITY CONTROL FOR FIELD AND LABORATORY OPERATIONS

The principal functions of a sampling and analysis program are to obtain reliable and representative environmental samples and to document data quality. To accomplish this task, a program to assess field and laboratory data was planned. This program established the types and frequency of QC checks for field sampling and laboratory activities.

2.5.1 Field Quality Control Checks

The types of field QC samples collected include field duplicate samples, trip blanks, equipment rinsate blanks, and field water blanks. These samples and the frequency at which they were collected are discussed in the field procedures in Section 1.5.

2.5.2 Laboratory Quality Control

Laboratory QC checks included several procedures to assess laboratory accuracy and precision. Analytical instrument performance was determined by routinely conducting calibration verification as specified in the applicable analytical methods.

The primary types of laboratory QC samples used during the present study were method blanks, internal standards, surrogates, spikes, MS/MSDs and LCSs.

2.5.2.1 Method Blanks

Method blanks consisted of laboratory-grade water that was carried through the same analytical process as the environmental samples. Method blanks measured contamination associated with laboratory preparation or instrumentation. For most parameters a method blank was analyzed with each batch of samples or at a frequency of 1 per 20 samples if more than 20 samples were run in a given batch.

2.5.2.2 Internal Standards

Internal standards were measured amounts of certain compounds added after preparation or extraction of each sample for GC/MS volatile or semivolatile analysis. Internal standards were used to monitor sensitivity and response for GC/MS analyses.

2.5.2.3 Surrogates

Surrogates were measured amounts of certain compounds added before preparation or extraction of a sample. The recovery of a surrogate was measured to determine systematic extraction, analysis problems, or sample matrix problems. Surrogates were added to all samples analyzed using chromatographic organic methods (volatiles, semivolatiles, and pesticides/polychlorinated biphenyls (PCBs) by GC or GC/MS).

2.5.2.4 Spikes

Spikes were aliquots of samples for inorganic analysis to which known amounts of analyte had been added. They were subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for spiking were purchased or prepared independently of calibration standards. The spike recovery measured the effects of interferences in the sample matrix and reflected the accuracy of the determination.

Additional sample volume was collected for samples requiring spike analyses, and spikes were prepared and analyzed at a frequency of at least 1 per 20 project samples for inorganic analyses.

2.5.2.5 MS/MSDs

MS/MSDs were duplicate aliquots of samples for organic analysis to which known amounts of the target analytes had been added. MS/MSDs were subjected to the same preparation and analytical procedures

as the original samples. The MS/MSD percent recoveries measured the effects of interferences in the sample matrix and reflected the accuracy of the determination, while the RPD between the MS and the MSD measured the precision of a given analysis.

Additional sample volume was collected for samples requiring MS/MSD analyses, and MS/MSDs were prepared and analyzed at a frequency of at least 1 per every 20 project samples of similar matrix undergoing organic analysis. A matrix was defined in terms of sample type (e.g., soil/sediment or aqueous) and concentration (e.g., low-level, medium-level).

2.5.2.6 LCSs

LCSs were aliquots of organic free or deionized water to which known amounts of analyte had been added for aqueous matrices. Other reference materials were sometimes used for nonaqueous matrices. LCSs were subjected to the same sample preparation or extraction and analysis procedures as the environmental samples. The stock solutions used for LCSs were purchased or prepared independently of calibration standards. The LCS recovery tested the function of analytical methods and equipment. LCSs were prepared and analyzed with each analytical batch.

2.6 PERFORMANCE AND SYSTEMS AUDITS

An audit of field activities was performed by the B&R Environmental Quality Assurance Manager during the second week of the field investigation at the NAS Key West. This audit was performed to confirm that work was being completed in compliance with the requirements of the SAP. The audit entailed review and evaluation of facilities and equipment, sampling and sample handling procedures, and data handling and documentation procedures. In addition, the FOL, or designee, performed daily reviews of field procedures and records.

Laboratories performing sample analysis for NAS Key West were approved as part of the U.S. Navy's laboratory contracting program. Laboratory audits are completed by the U.S. Navy for each contracted laboratory on an 18-month schedule.

3.0 DATA INTERPRETATION AND PRESENTATION

This section presents an overview of how the analytical data were used in interpreting and presenting the nature and extent of contaminants at the SWMUs as well as in assessing the human health and ecological risks associated with those contaminants. Section 3.1 discusses how the analytical data were evaluated in conjunction with each site's history and waste generation activities, physical setting, and geology and hydrogeology to construct a link between the analytical data and the nature and extent of impacts to environmental media at the site. Many of the data manipulation and presentation techniques, especially for tabular and graphical displays, are explained so as to provide the reader with an understanding of the investigation results presented in Section 4.0 of the Supplemental RFI/RI Report.

Sections 3.2 and 3.3 focus on the methodologies, standards, scenarios, and techniques used in assessing the potential human health and ecological risks resulting from the chemicals that were detected at each SWMU. These sections are based on the *Supplemental Resource Conservation and Recovery Act Facility Investigation and Remedial Investigation Work Plan* for NAS Key West (ABB, 1995a) and the *Supplemental Resource Conservation and Recovery Act Facility Investigation and Remedial Investigation Sampling and Analysis Plan* for NAS Key West (ABB, 1995b), both of which were approved by EPA Region IV and Florida Department of Environmental Protection (FDEP). Sections 3.2 and 3.3 explain the systematic methodology for evaluating detections of each contaminant at each site, the qualitative process for selecting Chemicals of Potential Concern (COPCs), and Ecological Contaminants of Potential Concern (ECPC), and the quantitative determination of contaminants of concern that may cause acute or chronic risks under the existing or future land use scenarios.

3.1 INVESTIGATION RESULTS

The results of the RFI/RI are presented in Sections 4.1 through 4.4 of the Supplemental RFI/RI Report. Each of those sections include a discussion of each SWMU and presents the contaminants that were detected at the site as well as the spatial and, if applicable, temporal extent to which all environmental media have been impacted and interprets how the findings are related to activities that occur during base operations.

3.1.1 Site Background

The discussion of each SWMU begins with a brief historical account of the site's uses and activities as well as its geographic and physical features, a description of previous investigations, and the rationale and

scope of the RFI/RI. These report subsections are intended to establish a basis for the suspected and/or documented releases of contaminants to the environment. Figures are included for each SWMU showing the pertinent habitats, physical features, and sampling locations.

3.1.2 Site Environmental Setting

A discussion of the site-specific soils, geology, and hydrogeology follows the background information in each SWMU section. Natural physical features such as topography, climate, surface water hydrology, geology, soils, hydrogeology, ecology, and climate are very consistent across the base; therefore, they are presented from a base-wide perspective in Section 3.0 of the Supplemental RFI/RI Report.

Site-specific details and exceptions to the typical environmental setting are discussed in Section 4.0 of the Supplemental RFI/RI Report. The general information presented in Section 3.0 of the Supplemental RFI/RI Report is not repeated in each site's discussion. A site-specific geologic cross section and hydrogeological data (monitoring well hydrographs and site potentiometric surface maps) are presented for each SWMU in Section 4.0 of the Supplemental RFI/RI Report. Historical groundwater elevations for each monitoring well at the site are also presented. The description of the site's environmental setting provides the basis for understanding the physical properties of media that have been impacted, mechanisms for cross-media impacts, contaminant fate and transport mechanisms, and pathways for human and ecological contaminant exposures.

3.1.3 Nature and Extent of Contamination

The nature and extent of contamination are presented in two sections within each site discussion in Section 4 of the Supplemental RFI/RI Report. The first section is a medium-specific (i.e., soil) discussion of the chemicals which were detected, by analytical fraction (i.e., VOCs versus inorganics). All of the COPCs were compared to applicable or relevant and appropriate requirements (ARARs) and Screening Action Levels (SALs) for each medium. The COPCs determined to exceed the most restrictive ARARs or SALs (Tables 2-3 through 2-6 of the Supplemental RFI/RI Report) are addressed in the media-specific discussion. The compounds which were frequently detected and/or in excess of ARARs and SALs are shown on figures within the site-specific discussion of contamination nature and extent. If possible, the extent of each analytical fraction in each medium is correlated with a potential contaminant source or process that occurred at the site. The second portion of the nature and extent discussion is a contaminant release summary that attempts to link observed trends in the types of COPCs detected across the various impacted media, their frequency of detection, intermedia transfer, and/or geographic distribution at the site

with a potential source area or site process to present a consolidated interpretation of the overall nature and extent of all COPCs and the mechanisms of their release.

At most sites investigated, the quantity or timing of releases is known relative only to the site's history. Records of product volumes used or waste streams generated are not available, and the date of release(s) is not known. Very often a release (e.g., from disposal areas, chemical storage areas, burning of wastes during fire training, maintenance areas) consisted of a potentially wide variety of chemicals, and in some cases a specific release mechanism cannot be documented (e.g., a nonpoint source). At many sites, therefore, the nature and extent of contamination are used to develop an hypothesis as to the source of the environmental impacts.

3.1.3.1 Data Tables

Data tables are included within each media-specific discussion under the nature and extent of contamination for each SWMU. Four tables are therefore provided for each SWMU; one showing contaminant data for soil, another for sediment, a third for surface water, and finally, a table showing groundwater contaminant data. In some cases, a fifth table is also provided, showing the results of subsurface soil sampling. Subsurface soil sampling was not performed at all the sites. Each table lists only the chemicals that were detected in the specific environmental medium being discussed. For example, if a chemical was not detected in any soil sample for a given site, it is not listed in the table containing soil data. These tables provide an inclusive list of the COPCs detected at the site by medium, incorporating data gathered during the 1996 field investigation conducted by B&R Environmental, as well as historical data, gathered in past field investigations. Data validation qualifiers are provided in these tables and are defined at the end of each table; however, rejected data are not included.

The common human nutrients calcium, magnesium, potassium, and sodium are shown in these tables, but are not discussed in the nature and extent analyses. Iron is also shown, but is not discussed in the nature and extent analyses because it is a common element of rock fragments and clay minerals that are pervasive in the soils and sediments encountered in the geological setting at the base.

3.1.3.2 Contaminant Distribution Maps

Maps showing the concentration and distribution of the COPCs which were detected in excess of ARARs and SALs are presented in Section 4.0 of the Supplemental RFI/RI Report for each SWMU, by media. Generally, soil, sediment, surface-water and subsurface soil (where sampled) analytical results are shown on single maps, with groundwater contamination depicted on several maps, by year. This was done since

groundwater samples were often taken repeatedly from the same monitoring well and looking at groundwater contaminant trends over time can provide a better understanding of the nature and degree of contamination at a site. Soil and sediment data for SWMU 2 are also shown on several maps. Since pesticide soil contamination was a major concern at that site, it is shown on one map, with other soil contaminants depicted on a separate figure. In sediment at SWMU 2, a sample was taken in the same location at two different times. Since concentrations at that location were significantly different in the two samples, the sediment contamination at that site is shown on separate maps, by year.

The intent of these maps is to display the distribution and extent of COPCs, to identify areas of greatest impact, and to link the release and, if applicable, the migration of contaminants to the site's physical features and/or environmental setting. The concentrations of chemicals of interest (COIs) are shown at sampling points where an ARAR or SAL was exceeded. When a large number of chemicals were found in a given media at a site, it was not always possible to show all the chemicals which exceeded an ARAR or SAL. In these cases, COIs were selected based on frequency of detection, known use at the site (i.e., 4,4'-DDT at the DDT mixing area), representativeness of the analytical fraction, and the degree to which ARAR/SAL criteria were exceeded. Other chemicals which exceeded ARARs or SALs were referenced in a note on the figure. Where possible, lines of equal concentration of chemicals (isocons) are provided on the map to show the concentration gradient. A number of other considerations made during the preparation of the contaminant distribution maps are discussed below:

- Isocons are only shown for chemicals for which there were sufficient data for interpretation, and for which trends were apparent.
- At locations where duplicate samples were analyzed, an average concentration is shown on the maps.
- Non-detect data and data which fell below the most restrictive ARAR/SAL for a given chemical is not represented on the figures.
- A data box on each figure provides the ARAR/SAL concentration which was used as a basis of comparison for each chemical shown. Tables 2-3 through 2-6 of the Supplemental RFI/RI Report provides an inclusive list of all ARARs and SALs which were considered.
- When data from several sampling exercises is depicted on a single map, the year of the investigation accompanies each set of data shown at a given sampling location.

- Subsurface soil samples were sometimes taken from different depths at different locations, but due to the limited number of soil borings performed, all the subsurface data for a given SWMU is illustrated on a single map.

3.1.4 Facility-Wide Contaminant Fate and Transport

The ultimate fate of chemicals in the environment is determined by a multitude of physical, chemical, and biological factors. The role and significance of different physical properties such as specific gravity, solubility, and vapor pressure in determining what environmental fate and transport processes occur for a particular chemical can depend upon numerous additional factors. For example, solubilities of metals are not truly constant in the environment but may be dramatically enhanced or reduced when certain ligand species are available for complexation or precipitation, when organic matter is present in dissolved form, or when pH is altered. Physical properties such as soil/water partition ratios and groundwater retardation factors can vary considerably from location to location, even within the same geologic regime. Chemical and biological transformational processes can also be significantly affected by localized effects such as clay or mineral catalysts, chemical or biological inhibitors, and pH, Eh, and DO.

This section of the report will summarize the physical and chemical transport properties for the chemicals detected at the SWMUs. No distinction of location or magnitude of chemicals will be made in this section. The information presented will discuss chemical persistence and transport phenomena for the general classes of compounds detected in the environmental media sampled at the SWMUs. Each of the SWMU-specific fate and transport sections (Sections 4.1.6, 4.2.6, 4.3.6 and 4.4.6) will address probable contaminant migration routes and qualitatively identify potential routes of human exposure.

3.1.4.1 Physical and Chemical Properties

Physical and chemical properties of the detected contaminants are presented and discussed in this section. These parameters are used to quantitatively describe the environmental behavior of chemicals found at SWMUs 1, 2, 3 and 9. Empirically determined literature values of the specific gravity, vapor pressure, solubility, octanol/water partition coefficient, organic carbon partition coefficient, soil-water partitioning coefficient, and Henry's Law constant are presented. Calculated values are presented if literature values are not available. A summary of the physical and chemical transport properties for all detected chemicals at NAS Key West is provided in Table G.3-1. These data are used to evaluate contaminant migration and assess exposures in the risk assessment. A discussion of the environmental significance of each of these parameters follows.

TABLE G.3-1

SUMMARY OF PHYSICAL AND CHEMICAL DATA FOR CHEMICALS OF POTENTIAL CONCERN
SITEWIDE - SURFACE WATER, SEDIMENT, SURFACE SOIL, AND SUBSURFACE SOIL
NAS KEY WEST
PAGE 1 OF 3

CHEMICAL OF CONCERN	MOLECULAR WEIGHT	SOLUBILITY (mg/L)	Log Kow	VAPOR PRESSURE (mmHg, 20C)	HENRY'S LAW CONSTANT (atm cu. m/mol)	BIOCONCENTRATION FACTOR (ug/kg/ug/L)	SPECIFIC GRAVITY	Koc
HERBICIDES								
2,4-D	-	-	-	-	-	-	-	-
Methyl parathion	-	-	-	-	-	-	-	-
INORGANICS								
Aluminum	26.98	INSOLUBLE	-	0	-	-	2.708	-
Antimony	121.75	-	-	1 (886C)	-	1.00E+00	6.684	-
Arsenic	74.92	-	-	1 (372C)	-	4.40E+01	5.72	-
Barium	137.34	DECOMPOSE	-		-	1.00E+00	3.5	-
Beryllium	9.01	-	-	1 (1520C)	-	1.90E+01	1.85	-
Cadmium	112.4	INSOLUBLE	-	1 (1284C)	-	6.40E+01	8.642	-
Calcium	40.08	DECOMPOSE	-		-	-	1.57	-
Chromium	52	INSOLUBLE	-	0	-	1.60E+01	7.2	-
Cobalt	58.93	INSOLUBLE	-	0	-	1.00E+00	8.9	-
Copper	63.54	INSOLUBLE	-	1 (1628C); 10 (1870C)	-	3.60E+01	8.92	-
Iron	55.85	INSOLUBLE	-	0	-	-	7.86	-
Lead	207.19	INSOLUBLE	-	1 (980C)	-	1.00E+00	11.35	-
Magnesium	24.312	-	-	-	-	-	1.738	-
Manganese	54.94	DECOMPOSE	-	1 (1292C)	-	1.00E+00	7.2	-
Mercury	200.59	5.6E-03g/100cc	-	2E-03 (25C)	-	1.00E+00	13.5939	-
Nickel	58.71	INSOLUBLE	-	1 (1810C)	-	4.70E+01	8.902	-
Potassium	39.1	DECOMPOSE	-	-	-	-	0.862	-
Selenium	78.96	INSOLUBLE	-	0	-	1.00E+00	4.26-4.81	-
Silver	107.87	INSOLUBLE	-	0	-	5.00E-01	10.5	-
Sodium	22.9898	DECOMPOSE	-	-	-	-	0.97	-
Thallium	204.37	-	-	-	-	-	11.85	-
Tin	118.69	-	-	-	-	-	-	-
Vanadium	50.94	-	-	-	-	1.00E+00	5.96	-
Zinc	65.37	-	-	1 (487C)	-	4.70E+01	7.133	-
Cyanide	27	SOLUBLE	-	657.8 (21.9C)	-	-	0.699	-
PESTICIDES/PCBs								
4,4'-DDD	320.1	0.09 (25C)	1.60E+06	1.2E-7 (25C)	2.20E-08	1.80E+05	-	7.70E+05
4,4'-DDE	318	0.04 (20C)	4.28	6.50E-06	6.80E-05	8.00E+06	-	4.40E+06
4,4'-DDT	354.5	0.0055 (25C)	6.19 (20C)	1.9E-7 (25C)	1.58E-05	8.00E+06	-	3.90E+06
Aldrin	364.91	1.70E-02	5.11E+00	2.30E-06	5.00E-04	4.70E+03	1.7	4.98E+00
Aroclor-1260	375.7	0.08 (24C)	7.15	4E-5 (25C)	0.74	1.00E+05	-	6.70E+06
Alpha-BHC	-	-	-	-	-	-	-	-

TABLE G.3-1

SUMMARY OF PHYSICAL AND CHEMICAL DATA FOR CHEMICALS OF POTENTIAL CONCERN
SITEWIDE - SURFACE WATER, SEDIMENT, SURFACE SOIL, AND SUBSURFACE SOIL
NAS KEY WEST
PAGE 2 OF 3

CHEMICAL OF CONCERN	MOLECULAR WEIGHT	SOLUBILITY (mg/L)	Log Kow	VAPOR PRESSURE (mmHg, 20C)	HENRY'S LAW CONSTANT (atm cu. m/mol)	BIOCONCENTRATION FACTOR (ug/kg/ug/L)	SPECIFIC GRAVITY	Koc
PESTICIDES/PCBs (cont.)								
Beta-BHC	290.83	7.00E-01	3.8	1.70E-01	2.30E-07	1.30E+02	1.9	3.58E+00
Delta-BHC	290.83	2.10E+01	4.14E+00	2.00E-02	2.50E-07	1.30E+02	1.9	3.58E+00
Gamma-BHC	-	-	-	-	-	-	-	-
Endosulfan I	-	-	-	-	-	-	-	-
Endosulfan II	406.95	3.30E-01	3.62E+00	1.00E-05	1.91E-05	2.70E+02	1.7 (20/20C)	2.30E+00
Endosulfan sulfate	422.92	2.20E-01	3.66E+00	NA	2.60E-05	-	-	1.62E+00
Endrin	380.92	2.60E-01	5.60E+00	2.00E-07	4.00E-07	4.00E+03	1.7	3.23E+00
Endrin aldehyde	380.92	2.60E-01	5.60E+00	2.00E-07	3.90E-07	4.00E+03	-	2.83E+00
Endrin ketone	380.92	-	-	-	4.00E-07	7.10E-02	-	-
Heptachlor	373.32	5.60E-02	4.40E+00	3.00E-04	1.50E-03	1.10E+04	1.6	4.08E+00
Heptachlor epoxide	-	-	-	-	-	-	-	-
Methoxychlor	345.65	4.00E-02	4.68E+00	-	3.00E-05	8.30E+03	1.4	4.90E+00
Toxaphene	-	-	-	-	-	-	-	-
SEMIVOLATILES ORGANIC COMPOUNDS								
1,2-dichlorobenzene	147.01	100	3.56	1.00E+00	1.93E-03	7.30E+02	1.31E+00	1.70E+03
1,3-dichlorobenzene	-	-	-	-	-	-	-	-
1,4-dichlorobenzene	147.01	79	3.56E+00	1.18	3.10E-03	7.30E+02	1.70E+03	
1,2,4-trichlorobenzene	30	3.90E-01	4.28	2.91E-01	2.30E-03	1.82E+02	1.574	9.23E+03
1-methylnaphthalene	-	-	-	-	-	-	-	-
2,4-dimethylphenol	-	-	-	-	-	-	-	-
2-methylnaphthalene	142.19	26-28 (25C)	4.26	0.087 (25C)	6.00E-04	1.00E+03	0.994	5.80E+03
4-methyl-2-pentanone	-	-	-	-	-	-	-	-
Acenaphthene	154.2	3.42 (25C)	3.92	1.55E-3 (25C)	9.10E-05	1.80E+03	1.0242	4.60E+03
Acenaphthylene	152.2	3.93 (25C)	3.72	2.90E-02	1.45E-03	1.00E+03	-	2.50E+03
Acetophenine	-	-	-	-	-	-	-	-
Anthracene	178.2	0.045 (25C)	4.45	1.7E-5 (25C)	8.60E-05	4.70E+03	1.283	1.40E+04
Benzo(a)anthracene	228.28	0.0057	5.61	2.20E-08	1.00E-06	5.30E+04	-	2.00E+05
Benzo(a)pyrene	252	0.0038 (25C)	5.98	5.60E-09	4.90E-07	1.09E+04	-	5.50E+06
Benzo(b)fluoranthene	252.3	0.0014 (25C)	6.57	5.00E-07	1.22E-05	1.40E+05	-	5.50E+05
Benzo(g,h,i)perylene	276	0.00026 (25C)	7.23	1.03E-10 (25C)	1.44E-07	3.50E+05	-	1.60E+06
Benzo(k)fluoranthene	252.3	0.0043 (25C)	6.84	5.00E-07	3.87E-05	1.40E+05	-	5.50E+05
Bis(2-chloroisopropyl)ether	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	390.62	0.4 (25C)	5.3	2.00E-07	3.00E-07	2.30E+08	0.99	2.00E+09
Chrysene	228.3	0.0018 (25C)	5.61	6.3E-9 (25C)	1.05E-06	5.30E+04	1.274	2.00E+05
Di-n-butylphthalate	278.35	4.00E+02	5.20E+00	1.00E-01	2.80E-07	8.90E+01	1	5.23E+00

TABLE G.3-1

SUMMARY OF PHYSICAL AND CHEMICAL DATA FOR CHEMICALS OF POTENTIAL CONCERN
SITEWIDE - SURFACE WATER, SEDIMENT, SURFACE SOIL, AND SUBSURFACE SOIL
NAS KEY WEST
PAGE 3 OF 3

CHEMICAL OF CONCERN	MOLECULAR WEIGHT	SOLUBILITY (mg/L)	Log Kow	VAPOR PRESSURE (mmHg, 20C)	HENRY'S LAW CONSTANT (atm cu. m/mol)	BIOCONCENTRATION FACTOR (ug/kg/ug/L)	SPECIFIC GRAVITY	Koc
SEMIVOLATILES ORGANIC COMPOUNDS (cont.)								
Dibenz(a,h)anthracene	278.4	0.005 (25C)	5.97	1.00E-10	7.30E-08	6.90E+05	-	3.30E+06
Dibenzofuran	168.2	10	4.12	-	-	-	-	8.13E+03
Diethylphthalate	222.2	210	2.47	3.5E-3 (25C)	1.20E-06	1.07E+02	1.12	1.42E+02
Fluoranthene	202.3	0.26 (25C)	5.33	5E-6 (25C)	6.50E-06	1.20E+04	1.252	3.80E+04
Fluorene	116.2	1.69 (25C)	4.18	7.10E-04	6.40E-05	3.80E+03	1.203	7.30E+03
Indeno(1,2,3-cd)pyrene	276.3	0.00053 (25C)	7.66	1.00E-10	6.95E-08	3.50E+05	-	1.60E+06
Methacrylonitrile	-	-	-	-	-	-	-	-
Naphthalene	128.2	31.7 (25C)	3.01/3.45	8.7E-3 (25C)	4.60E-04	4.20E+02	1.152	9.40E+02
Phenanthrene	178.2	1.0(25C)	4.45	9.6E-4 (25C)	2.30E-04	4.70E+03	1.025	1.40E+04
Pyrene	202.3	0.13 (25C)	5.18	2.5E-6(25C)	5.10E-06	1.20E+04	-	3.80E+04
VOLATILES ORGANIC COMPOUNDS								
1,1,1-trichloroethane	133.41	720	2.47	1.23E2 (25C)	3.00E-02	8.10E+01	1.35	1.52E+01
1,1-dichlorethane	98.96	5500	1.79	1.80E+02	4.26E-03	1.90E+01	1.174	3.00E+01
1,1-dichloroethene	96.94	400	1.48	5.91E+02	1.90E-01	5.30E+01	1.218	6.50E+01
1,2-dichloroethene (total)	96.94	800 (20C)	-	200 (25C)	4.08E-03	4.80E+01	1.28	5.90E+01
1,1,1,2-tetrachloroethane	-	-	-	-	-	-	-	-
2-butanone	72.1	35300	0.26	78	2.08E-05	6.00E-01	0.805	1.70E+01
2-hexanone	100.16	-	-	-	-	-	-	-
Acetone	58.08	680000	-0.24	2.70E+02	3.43E-05	3.00E-01	0.791	9.20E+00
Acetonitrile	-	-	-	-	-	-	-	-
Benzene	78.12	1780	2.13	95.2 (25C)	5.50E-03	7.84E+00	-	6.50E+01
Benzyl alcohol	-	-	-	-	-	-	-	-
Bromomethane	-	-	-	-	-	-	-	-
Carbon disulfide	76.14	2300	1.84	2.60E+02	1.13E-02	1.10E+01	1.263	1.42E+02
Dibromomethane	-	-	-	-	-	-	-	-
Ethylbenzene	106.16	152	3.15	7.00E+00	6.60E-03	6.68E+01	0.867	1.10E+03
Hexachlorophene	-	-	-	-	-	-	-	-
Iodomethane	-	-	-	-	-	-	-	-
Methylene chloride	-	-	-	-	-	-	-	-
Toluene	92.13	534.8 (25C)	2.69 (20C)	2.87E+01	6.66E-03	2.50E+01	0.867	3.00E+02
Trans-1,4-dichloro-2-butene	125	-	-	-	-	-	-	-
Vinyl acetate	-	-	-	-	-	-	-	-
Vinyl chloride	62.5	2700	1.23	2.66E+03	8.14E-02	5.70E+00	0.9121	8.20E+00
Xylene (total)	106.16	187	2.77-3.2	6.50E+00	4.33E-63	1.50E-02	0.86-0.88	2.48E+02

- = Physical or chemical properties not available for this chemical in this classification.

3.1.4.1.1 Specific Gravity

Specific gravity is the ratio of the weight of a given volume of a chemical to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a contaminant will have a tendency to float or sink in water if it is present as a pure compound or at very high concentrations. Contaminants with a specific gravity less than 1.0 will float, whereas contaminants with a specific gravity greater than 1.0 will sink.

3.1.4.1.2 Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary significance at environmental interfaces, such as surface soil/air and surface water/air. Volatilization is not as important when evaluating contaminated groundwater and subsurface soils. However, in order to conservatively evaluate chemical exposures at the SWMUs, it will be considered. Chemicals with high vapor pressures are expected to enter the atmosphere more readily than chemicals with low vapor pressures. Semivolatile organics and pesticides and PCB compounds generally have low vapor pressures and hence are not expected to volatilize readily.

3.1.4.1.3 Solubility

The rate at which a chemical is leached by infiltrating precipitation is directly proportional to its water solubility. Several of the detected VOCs have relatively high water solubilities, but the low concentrations observed in soils indicate low potential for significant desorption. Pesticides and PCBs typically have low solubilities and generally do not migrate through the soil column to the water table. The solubility of inorganics is strongly influenced by their valence state(s) and forms (hydroxides, oxides, carbonates, etc.). The solubility is also strongly dependent on pH, Eh, and the presence of other ionic species in solution (the Debye-Huckel theory). Solubility products reported in the literature vary with the type of ionic species.

3.1.4.1.4 Octanol-Water Partition Coefficient (K_{ow})

The octanol/water partition coefficient (K_{ow}) is a measure of the equilibrium partitioning of chemicals between octanol and water. A linear relationship between the K_{ow} and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor) has been determined (Lyman et al. 1990). The K_{ow} is useful in characterizing the sorption of compounds by organic soils where experimental values are not available. Larger organic molecules such as semivolatiles and pesticides and PCBs are very likely to partition to fatty tissues, whereas less complex organic chemicals have lower K_{ow} values.

3.1.4.1.5 Organic Carbon Partition Coefficient (K_{oc})

The soil/sediment partition (organic carbon partition) coefficient (K_{oc}) indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high K_{oc} values generally have low water solubilities and vice versa. This parameter may be used to infer the relative rates at which chemicals are transported in groundwater. Complex organic chemicals are relatively immobile and are preferentially bound to the soil phase. These compounds are not subject to rapid groundwater transport. These immobile chemicals are, however, easily transported by erosional processes when they are present in surface soils.

3.1.4.1.6 Distribution Coefficient (K_d)

The soil-water partitioning (distribution) coefficient (K_d) is a measure of the equilibrium distribution of a chemical or ion in soil/water systems. The distribution of organic chemicals is a function of both the K_{oc} and the amount of organic carbon in the soil. The K_{oc} and the fractional organic carbon content of the soil (FOC) may be used to determine an equilibrium distribution coefficient (K_d) for the solid and aqueous matrices:

$$K_d = K_{oc} * FOC$$

where:

K_d = Distribution coefficient

FOC = Fractional organic carbon content of the soil

K_{oc} = Organic carbon partition coefficient

Published values exist for K_d for inorganics. These are specific to the type of mineral-clay; however, K_d values are also dependent on the complexation (ligands) present in solution with the inorganic.

3.1.4.1.7 Henry's Law Constant (H)

Both the vapor pressure and the water solubility are of use in determining volatilization rates from surface water bodies and groundwater. The ratio of these two parameters (the Henry's Law constant) is used to calculate the equilibrium contaminant concentrations in the vapor versus the liquid phases for dilute solutions. In general, chemicals with a Henry's Law constant below 5×10^{-6} atm-m^3/mole should volatilize very little and be present only in minute amounts in the atmosphere or in soil gas. Henry's Law constant

will be used to calculate the equilibrium soil gas vapor concentration for volatile organic compounds in groundwater.

3.1.4.1.8 Bioconcentration Factor (BCF)

The bioconcentration factor (BCF) provides a measure of the accumulation tendency for chemicals in biological and ecological systems. BCFs represent the ratio of aquatic animal tissue concentration to the water concentration of a chemical. The ratio is both contaminant and species specific. When SWMU-specific values are not measured, literature values are used or the BCF is derived from the octanol/water partition coefficient. All of the organic chemicals detected during the RI are bioaccumulative to some extent, but many of the semivolatile organics are more bioaccumulative than the volatile organics.

3.1.4.2 Summary

Table G.3-1 presents a summary of the fate and transport data that are used in this RI in discussions of the nature and extent of contamination, contaminant fate and transport, and the baseline risk assessment sections.

3.1.4.3 Contaminant Persistence

The persistence of the classes of organic contaminants is discussed in this section. The text addresses general classes of the detected chemicals because the fate of chemicals in the environment is usually similar for chemicals within a particular chemical family.

3.1.4.3.1 Ketones

Ketones are characterized by high aqueous solubility and volatility and are readily biodegradable in both soil and water. Hydrolysis is not considered to be a significant fate process for this class of chemicals. The bioaccumulation of ketones is not significant, due to low octanol/water partitioning coefficient. In general, ketones (especially acetone) were detected sporadically in all media.

3.1.4.3.2 Chlorinated Aliphatics

Research has demonstrated that aerobic bacteria are more likely to degrade components with organic compounds containing zero, one, or two halogens, and anaerobic bacteria when more halogens are present. Thus, highly chlorinated aliphatic hydrocarbons such as PCE are subject to reductive

dehalogenation via the action of anaerobic bacteria. It does not appear that appreciable degradation of highly halogenated aliphatics occurs in aerobic aquatic systems or unsaturated soils (Lyman et al. 1990).

The transformation pathways for chlorinated aliphatic hydrocarbons in soil systems have been documented by Dragun et al. (1988). PCE and TCE are transformed via reductive dechlorination to 1,1-dichloroethene (1,1-DCE) and 1,2-DCE isomers. The terminal product of the transformation series is vinyl chloride, the chlorinated ethene with highest toxicity.

3.1.4.3.3 Phthalate Esters

Phthalate esters are considered to be relatively persistent environmental contaminants. Although numerous studies have demonstrated that phthalate esters undergo biodegradation, it appears that this is a very slow process in both soil and surface water. Certain microorganisms have been shown to excrete products that increase the solubility of phthalate esters and enhance their biodegradation (Gibbons and Alexander, 1989). Biodegradation of bis(2-ethylhexyl) phthalate and other phthalate esters is an important fate mechanism, as is bioaccumulation. Hydrolysis of phthalate esters is very slow, with calculated half-lives of 3 years (dimethyl phthalate) to 2,000 years [bis(2-ethylhexyl) phthalate] (EPA, 1979). Similarly, photolysis is considered to be an insignificant degradation mechanism (EPA, 1982).

3.1.4.3.4 Monocyclic Aromatic Hydrocarbons

Monocyclic aromatic compounds such as benzene, toluene, ethylbenzene, and xylenes are not considered to be persistent environmental contaminants in comparison to PAHs, phthalate esters, and metals. Monocyclic aromatics are subject to degradation in both soil and water via the action of microorganisms. The biodegradation of these compounds in the soil matrix is dependent on the abundance of microflora, macronutrient availability, soil reaction (pH), temperature, oxygen, etc.

Although these compounds are amenable to microbial degradation, the rate of degradation cannot be predicted without information on the availability of nutrients and the type of bacteria present. If these contaminants discharge to a surface water body, volatilization and biodegradation may occur relatively rapidly. For example, a reported first-order biodegradation rate constant for benzene is 0.11 day^{-1} in aquatic systems (Lyman et al. 1990). This corresponds to an aquatic half-life of approximately 6 days. Other monocyclic aromatics are subject to similar degradation processes in aquatic environments (EPA, 1982).

Additional degradation processes such as hydrolysis and photolysis are considered to be insignificant fate mechanisms for monocyclic aromatics (EPA, 1982). However, some monocyclic aromatic compounds, such as benzene and toluene, have been shown to undergo clay-, mineral-, and soil-catalyzed oxidation (Dragun, 1988).

3.1.4.3.5 Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs are common constituents of oil and grease. Landspreading applications have indicated that PAHs are amenable to microbial degradation. Studies have demonstrated that PAHs are much more amenable to degradation in soil matrices than in aquatic environments (EPA, 1979). Under existing SWMU conditions, the rate of microbial degradation cannot be predicted without knowledge of microbial populations. PAHs do not contain functional groups that are susceptible to hydrolytic actions, and hydrolysis is considered to be an insignificant degradation mechanism. Photolysis may be a major degradation mechanism in aquatic environments but is probably insignificant in surface soil.

3.1.4.3.6 Pesticides

Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. Pesticides are subject to degradation mechanisms in the environment. Pesticides typically have a high affinity for binding to organic particulates in soil, are relatively insoluble in water, and have very low vapor pressures and Henry's Law constants. Consequently, these chemicals are some of the most immobile and persistent of environmental contaminants.

3.1.4.3.7 Metals

The transport and fate of metals in the environment are primarily controlled by sorption to soil/sediment material. The metal-organic relationships, both in soil and water, increase in importance as the organic carbon content increases. Fulvic and humic acids can affect sorption, but the cation exchange capacity of the clay lattice is also important. Some metals, such as arsenic, are extremely soluble and mobile in the environment. Many other metals, such as nickel, selenium, zinc, and copper, have an affinity for hydrous iron and manganese oxides, as well as for organic materials, and are therefore preferentially adsorbed to soil. The mobility of most metals increases as the soil pH decreases.

3.1.4.4 Contaminant Migration Routes

Based on the positively detected chemicals and associated analytical results for NAS Key West, general conclusions can be made with respect to contaminant fate and transport and the possible exposure endpoints.

Groundwater chemical contaminants can migrate from the original source of the release. The most common transport mechanism is water infiltration through a contaminated zone, where partitioning from solid to aqueous phase can occur. The potential amount of chemical dissolving into infiltration water is determined by a number of factors including residence time, solubility, partitioning factor, and pH of infiltration water.

The dissolved chemicals continue downward migration and are able to interact with stationary (soil) particles in the saturated and/or unsaturated zones. For SWMUs at NAS Key West, the very shallow depth of the groundwater table could shorten the time for vertical migration of chemicals from the surface to the groundwater. In addition, dissolution of chemicals in groundwater is likely to be enhanced by the tidal rise and fall of the groundwater table.

After percolation through the capillary zone, dissolved contaminants are then able to enter groundwater where transport can occur via advection. The chemical concentrations in groundwater increase significantly to a maximum level shortly after initial groundwater impact. The longer-term effects at the source are a gradual decrease in the concentrations over time as chemical removal from the source area occurs. Short-term variations in release rate and impact to groundwater can occur, but long-term trends of decreased levels are usually observed. Molecular diffusion and hydrodynamic dispersion occur in the groundwater flow regime.

As materials are transported by the groundwater, a number of processes occur that can reduce the concentration of the chemicals. Diffusion and attenuation effects are nontransformational mechanisms that result in a direct decrease in chemical concentration. Chemical and biological reactions with dissolved chemicals can also result in decreases in chemical concentration. The products of chemical/biological reactions, however, may have significantly different chemical, transport, and toxicological properties from the parent compounds.

Groundwater chemical concentration can vary over periods of time as climatic and meteorological conditions change. Also, as materials from the release (source) area are depleted, lower concentrations

of contaminant are released into the groundwater. Eventually, the impacts to groundwater cease, and residual chemicals are subjected to dilution and degradation via natural mechanisms.

Groundwater chemicals can discharge to surface water bodies, carrying chemicals dissolved in groundwater to the surface water and sediments. For SWMUs at NAS Key West, discharge to the ocean is the endpoint of the groundwater migration pathway. However, aqueous and sediment concentrations at or near groundwater discharge points are expected to be attenuated by dilution and mixing with seawater. Sediments may also be affected by surface water runoff and erosional dispersion, which can transport contamination from surface soils and allow limited migration of contaminated sediments. Some degree of migration in surface soil could occur also through windblown particulate emissions; however, fugitive dust exposure is controlled by vegetative cover and climatic factors that result in a limited rate of windblown migration at NAS Key West SWMUs. No significant volatilization is expected to occur at the Key West SWMUs.

3.2 METHODS FOR THE HUMAN HEALTH RISK ASSESSMENT APPROACH

This section provides a description of the human health risk assessment (HHRA) methods used for evaluating the NAS Key West data collected at SWMUs 1, 2, 3, and 9 on Boca Chica Key. The objectives of the risk assessment were to estimate the actual or potential risks to human health resulting from the presence of contamination in surface soil, subsurface soil, sediment, groundwater, and surface water and to provide the basis for determining the need for remedial measures for these media in the CMS.

Three major aspects of chemical contamination must be considered when assessing public health risks: contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; potential exposure points must exist either at the source or via migration pathways if exposure occurs at a remote location other than the source; and human or environmental receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without any one of the three factors listed above, there is no risk.

The risk assessment estimated the potential for human health risk attributable to each NAS Key West SWMU. Information regarding the toxicity of the compounds detected in the various media, the distribution of contamination, potential migration pathways, and a SWMU-specific estimate of chemical intake via assumed exposure routes were combined to estimate potential risks for each NAS Key West SWMU. The risk assessment processes used at NAS Key West were in accordance with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a; EPA, 1995a; ABB, 1995a) and were performed

according to methods established in the ABB Workplan (1995a), which was reviewed and approved by EPA Region IV and FDEP.

The human health risk assessment consists of five sections: Preliminary Risk Evaluation, Data Evaluation, Toxicity Assessment, Exposure Assessment, Risk Characterization Uncertainty Analysis, and Remedial Goal Options (ABB, 1995a). Each section is briefly discussed below.

Preliminary Risk Evaluation (Section 3.2.1) is primarily concerned with running preliminary risk assessments on all four SWMUs to determine if a baseline risk assessment was needed for each particular SWMU.

Data Evaluation (Section 3.2.2) was primarily concerned with the Identification of Chemicals of Potential Concern (COPCs), a special note concerning groundwater, distributional analysis of the data, representative concentrations, and a special note concerning chromium concentrations. COPCs selected in this section are representative of the type expected for potential human health exposure. Distributional analysis of the data, contaminant concentrations relative to background levels, contaminant release and environmental transport mechanisms, exposure routes, and toxicity were all considered in order to develop a list of COPCs used to define the SWMU-associated risks.

The Toxicity Assessment (Section 3.2.3) presents available reference doses, cancer slope factors, EPA-weight of evidence, adjustment of the dose-response parameters, and relative potencies for PAHs. Quantitative toxicity indices, where available, are presented in this section, including any applicable regulatory standards and criteria.

The Exposure Assessment (Section 3.2.4) identifies potential human health exposure including a characterization of the site setting, selection of potential receptors, selection of exposure routes by medium, a presentation of a site-conceptual model, derivation of exposure estimates for each pathway, and a special explanation of the blood lead modeling. This section generally identifies potential pathways of COPC migration, selected potential receptors, and the estimated intakes of COPCs for the identified receptors.

Risk Characterization (Section 3.2.5) presents the approaches for determining darcinogenic risks, noncarcinogenic risks, and lead risks. The risk characterization evaluates the potential for adverse health effects from exposure to COPC concentrations in environmental media by integrating information developed during the toxicity and exposure assessments.

The Uncertainty Analysis (Section 3.2.6) is a discussion of the uncertainties associated with the HHRA.

Remedial Goal Options (Section 3.2.7) presents the methods for selecting chemicals of concern (COCs) for exposure pathways in each SWMU and determining remedial clean-up goals. The purpose of this section is to provide the risk manager with a range of risk-related media levels as a basis for developing remediation aspects of the Feasibility Study and Proposed Plan for the Corrective Measures Study.

3.2.1 Preliminary Risk Evaluation

A preliminary risk evaluation (PRE) was conducted at each of the four SWMUs to determine if any required a baseline HHRA. If the risk screening evaluation showed that there were incomplete exposure pathways or if chemical concentrations were present at de minimus concentrations then a recommendation for no further action at the SWMU was made. However, if the PRE indicated that there might be SWMU risks that exceed those appropriate for the current or intended land use, it was necessary to perform a risk assessment that quantified risks associated with that SWMU. The risk screening process was as follows (EPA, 1994e):

- Carcinogenic risks and noncarcinogenic hazards were evaluated separately. Since chemicals with both carcinogenic and noncarcinogenic hazards have only one risk-based concentration (RBC), it was necessary, in some cases, to calculate the other RBC from toxicity data.
- A comparison between the maximum detected chemical and the EPA Region III risk-based screening levels was applied (EPA, 1995g). This comparison was the ratio between the media concentration and the screening value. These ratios were preliminary estimates of risk and hazards associated with individual chemicals. The risk ratios were as follows:

$$\text{Carcinogenic Risk Ratio} = \frac{\text{Media Concentration}}{\text{Screening Value}} * 1E-06$$

$$\text{Noncarcinogenic Risk Ratio} = \frac{\text{Media Concentration}}{\text{Screening Value}}$$

- Soil was evaluated using residential and industrial soil RBCs (EPA, 1995g).

- Surface water was evaluated using very conservative Tap Water RBCs (EPA, 1995g). Although this represents a conservative approach since the intake of surface water will be well below the drinking water intake level used to calculate a Tap Water RBC, the purpose of a PRE is to determine an estimate of the risks at a SWMU, and this conservative approach was well within those guidelines.

- Sediments were evaluated using Residential Soil RBCs (EPA, 1995g).

- These preliminary estimates of risk were then summed to come up with an aggregate risk for that medium. NCP (40 CFR 300) and EPA (1989a) state that individual receptors should be protected; therefore, the sums for each media were added and the aggregate estimated risk/hazard for each use scenario was estimated.

- If the use scenario cancer risks at a given SWMU are greater than 1E-04, or the noncarcinogenic risk is greater than 1.0, the SWMU will require further evaluation.

- No lease restrictions are put on the SWMU; therefore, all media and current and future exposure scenarios was determined. For simplicity's sake, only residential surface soil, sediment, surface water, and industrial subsurface soil pathways were evaluated.

The results of the PRE and accompanying text are presented for each SWMU in Section 4 of the Supplemental RFI/RI Report.

3.2.2 Data Evaluation

This section presents the approaches for identifying COPCs, distributional analysis of the data, and representative concentrations.

3.2.2.1 Identification of Chemicals of Potential Concern (COPCs)

COPC selection was based on various aspects of chemical concentration, occurrence, distribution, and toxicity. Chemicals were selected to represent SWMU contamination and provided the framework for the quantitative risk assessment.

Inorganic and organic samples were collected from the NAS Key West SWMUs in surface soil, subsurface soil, sediment, groundwater, and surface water media at SWMU 1, 2, 3, and 9 except that no organics were collected in SWMU 1 subsurface soil. The positively detected chemicals for each SWMU are presented in tables in the nature and extent of contamination sections of this report. COPC selection was based on these tables and the following rules (EPA, 1995a):

- Comparison to risk-based criteria (EPA, 1995g; EPA, 1995b). A chemical was eliminated as a COPC at a SWMU if the concentration was less than any screening criteria.
  - The maximum concentration detected in surface soils (collected at a depth of 0-12 feet) was compared to the residential screening values for soil ingestion determined at a risk level of 1E-06 or a hazard quotient (HQ) of 0.1.
  - The maximum concentration detected in subsurface soils (collected below a depth of 0-12 feet) was compared to the industrial screening values for soil ingestion determined at a risk level of 1E-06 or a hazard quotient (HQ) of 0.1.
  - The maximum concentration detected in sediment was compared to the residential screening values for soil ingestion determined at a risk level of 1E-06 or a hazard quotient (HQ) of 0.1.
  - The maximum concentration detected in groundwater was compared to the tap water values determined at a risk level of 1E-06 or a hazard quotient (HQ) of 0.1.
  - The maximum concentration detected in surface water was compared to the Water Quality Standard for human health (consumption of water and organisms) values.
- The essential nutrients, including calcium, chlorine, iodine, magnesium, phosphorus, potassium, and sodium, were eliminated as COPCs if they were not present at high concentrations at a SWMU (EPA, 1989a; EPA, 1995a).
- If the maximum detected concentration was less than twice the arithmetic mean of the background concentration (for inorganics only) the analyte was excluded as a COPC. In the event that the only detection for a given analyte met this criteria, it was not eliminated as a COPC (EPA, 1995a).
- Chemicals were eliminated as COPCs based on a comparison to blank contamination (EPA, 1989a; EPA, 1995a). Blank samples provided a measure of contamination that was introduced into the sample set either in the field or in the laboratory. Blanks should be compared to results from samples with which the blanks were associated; however, if this was not possible because of logistical problems, the entire SWMU data set was compared against the entire blank data set. The comparison of concentrations detected in blanks with concentrations detected in samples was based on the procedures listed below.
- Regarding data collected by B&R Environmental, only:
  - Comparison of blanks to common laboratory contaminants. The common laboratory contaminants are acetone, 2-butanone, methylene chloride, toluene, and phthalate esters. If

the blank contained detectable levels of common laboratory contaminants, then the sample results were considered positive if the concentrations in the sample data set exceeded ten times the maximum amount detected in any blank. If the concentration was less then ten times the amount detected in the blank, it was concluded that the laboratory contaminant was not detected in that particular sample and the blank-related concentrations of the chemical were considered to be the quantitation limit for the chemical in that sample.

- All other blanks. If the blank contained detectable levels of common laboratory contaminants, then the sample results were considered positive if the concentrations in the sample data set exceeded five times the maximum amount detected in any blank. If the concentration was less then five times the amount detected in the blank, it was concluded that the laboratory contaminant was not detected in that particular sample and the blank-related concentrations of the chemical were considered to be the quantitation limit for the chemical in that sample.

- Regarding data collected by parties other than B&R Environmental:

  - Regarding soil and sediment data only: Only two chemicals, methylene chloride and bis(2-ethylhexyl)phthalate, were qualified with a "B" designation. The usual quantitation limit for methylene chloride is 10 µg/kg and the usual quantitation limit for bis(2-ethylhexyl)phthalate is 400 µg/kg. The highest "B" qualified result for methylene chloride in soil was 70 µg/kg and the highest "B" qualified result for bis(2-ethylhexyl)phthalate was 2,200 µg/kg. No data were available for laboratory blanks associated with previously collected data. These results may or may not have been ten times above the maximum result detected in any laboratory blank. However, since the "B" qualified data were present well above the quantitation limit, the data sets for soil and sediment include these results.

  - Regarding water data only: Only one chemical, methylene chloride had "B" qualifiers. The usual quantitation limit for methylene chloride is 10 µg/L. The highest "B" qualified result for methylene chloride in water was 2 µg/kg. No data were available for laboratory blanks associated with previously collected data. These results may or may not have been ten times above the maximum result detected in any laboratory blank. However since the levels detected were well below the quantitation limit, the methylene chloride "B" qualified data were considered non-detected values in the data sets for water.

- Previously eliminated chemicals were evaluated to determine whether any fell within the following three classifications:
  - If the chemical was a break-down product of a COPC, it was included as a COPC for that medium.
  - If a chemical was eliminated as a COPC based on blank contamination, it was included as a COPC for that medium if the chemical had a detection limit above a risk-based screening level (as long as the detection limit also exceeds two times the average background concentration).
  - If a chemical was a member of the same class of chemicals that were selected as COPCs, that chemical was included as a COPC for that media (e.g., carcinogenic PAHs).

3.2.2.2 Special Note Concerning Groundwater

Groundwater was not considered as a medium of concern at the Key West SWMUs for several reasons: As discussed in Section 3.5.2 of this RI report, groundwater at Key West has been classified by the State of Florida as Class G-III (nonpotable water), based on a criterion of total dissolved solids greater than 10,000 mg/L. Groundwater obtained from the surficial aquifer at Key West has a high salinity, unsuitable for drinking, as documented by a 1990 groundwater quality sampling study by USGS (ABB, 1995a). The Monroe County Health Department recognizes the public water supply obtained from the mainland as the only potable water source available on Key West. There are no freshwater public or registered domestic wells on NAS Key West, although reported surficial aquifer wells are used by domestic residences for nonpotable uses such as flushing water. These alternative sources of water might, in some cases be used for drinking after treatment such as reverse osmosis; however, the local water authority regulates all potable supplies in the Keys.

For comparison purposes the concentrations of COPCs in groundwater at all four SWMUs were compared to Tap Water RBCs (EPA, 1995g) and MCLs (EPA, 1995d) for each SWMU. These results are reported in Section 4.0 of the Supplemental RFI/RI Report.

If the groundwater is classified as potable water in the future, a reevaluation of the quantitative risks associated with groundwater exposure to potential receptors should be conducted.

3.2.2.3 Special Note Concerning Fish

Fish and shellfish consumption at the four SWMUs were not considered a human health concern for the following reasons:

- At SWMU 1, surface water consists of shallow water in mangrove swamps and shallow pools after heavy rain events. The shallow water is approximately 1 to 4 inches deep where present, and thus, the only fish available are small minnows. Three small ponded areas in the mangrove swamp east of the area excavated during interim remediation are 2 to 3 feet. Intensive fishing efforts during January 1996 revealed that the only edible fish in these ponds are small minnows. Thus, no other fish than minnows exist at SWMU 1. Additionally, no shellfish exist at the site.

- At SWMU 2, the entire site, including the former DDT mixing area, ditch, and lagoon, is located adjacent to runways and taxiways, is within view of the airport control tower, and is off limits for routine activities such as fishing. Due to the active status of the Naval Air Station, the tower is continuously manned and the area surrounding the site is a high security area. Therefore, although large fish exist in the lagoon and ditch, human consumption of fish and shellfish will not occur as long as the base remains an active Naval Air Station.

- SWMU 3 is located near Runway 31 and is accessed via a gate through a chain link fence east of the site. The lagoon ranges in depth from 16 to 28 inches. Intensive fish collection efforts in January 1996 revealed that no fish, other than minnows and one eel, were observed or captured. A few blue crabs were observed. Therefore, fish large enough for human consumption do not exist in the lagoon and shellfishing for blue crabs is unlikely due to access restrictions.

- SWMU 9 is located adjacent to an inlet of the Gulf of Mexico. Fish were not sampled from the inlet, due to the transient nature of fish in the area (i.e., wide-ranging fish would presumably be exposed to contaminants from SWMU 9 only a very small fraction of the time, eliminating the potential for significant bioaccumulation). Mangrove oysters (which are far less transient in nature than fish, but they are not consumed by humans) were sampled from the inlet adjacent to the site. Since contaminant levels in the oysters were similar to those from a background site, there does not appear to be any potential for contaminant impacts on shellfish in the inlet.

3.2.2.4 Distributional Analysis of the Data

Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989a) suggests the use of statistics in data evaluation, especially concerning distributional analysis of the data. Statistical analyses discussed in this section adhere to the guidance referenced in several EPA and related publications (EPA, 1989a, 1989b, 1991b, 1992c, 1995a and Gilbert, 1987). Before representative concentrations were estimated for each SWMU, the underlying statistical distribution of data (using the Shapiro-Wilk W test) was determined for each chemical in each medium. However, EPA (1995a) states that it is generally reasonable to assume that Superfund solid sampling data are lognormally distributed. Lognormally distributed data have a skewed shape (more results at the high-concentration tail). Lognormal distribution was assumed for this risk assessment.

3.2.2.5 Representative Concentrations

The risk assessment for NAS Key West was performed using a representative concentration for each COPC in each medium identified at the particular SWMU of interest. Current and historic concentrations of detected chemicals at each SWMU medium were evaluated. Usability of results is discussed below. The representative concentration was calculated using the latest risk assessment guidance from EPA (EPA, 1989a, 1995a).

The validated data were used to calculate representative concentrations. The data were collected over several years by various parties. For chemicals with at least one positive detection, the corresponding non-detects were assumed to be one-half the detection limit (sample quantitation limit). For the data set collected by B&R Environmental during January 1996, rejected values (R) were eliminated from further consideration. Estimated and biased values (J, K, L) were used as the reported value.

Duplicate samples were averaged together and considered as one result. For duplicates, where one result was positive and the other result was a non-detect, the problem of calculating an average result arose whenever half the detection limit exceeded the positive result. In these situations, the positive result was used to represent the non-detect.

The calculation of the representative concentration is a two-step process. First, the distribution of the data must be determined as discussed in the preceding section. Then, based on the distribution of the data, a representative concentration is either calculated or selected. Environmental data collected at these SWMUs were determined to be lognormally distributed (default).

For data that are considered to be lognormally distributed, the standard deviation of the log-transformed sample set must be determined, as follows:

$$S = \sqrt{\Sigma\left(\frac{\left(X_i - \mu\right)^2}{n-1}\right)}$$

where:

S = Standard deviation of the log-transformed data

X_i = Individual sample value (log-transformed)

μ = Arithmetic mean of the log-transformed n samples

n = Number of samples

The one-sided upper 95 percent confidence limit (UCL_{LOG}) is then calculated as follows:

$$UCL_{LOG} = e^{\left[\mu + 0.5s^2 + \left(\frac{sH}{\sqrt{n-1}}\right)\right]}$$

where:

e = constant (base of the natural log, equal to 2.718)

μ = Arithmetic mean of the log-transformed data

H = H-statistic (e.g., from table published in Gilbert, 1987)

S = Standard deviation of the log-transformed data

n = Number of samples

The representative concentration is then selected as the lesser value of the one-sided 95 percent UCL and the maximum positive value in the data set.

The maximum positive value is frequently the default choice when the number of samples in the data set is small or when a lognormal distribution (having a higher upper confidence limit from the distributional shape) is used. For example, the number of surface water samples taken at each SWMU are generally

low in number, and the representative concentration was estimated based on lognormal distribution of the surface water data; therefore, the representative concentration normally defaulted to the maximum detection of a chemical in those surface water samples.

3.2.2.6 Special Note Concerning Chromium Concentrations

A conservative approach to the treatment of chromium was applied to this HHRA. Chromium data were considered to be the hexavalent chromium (VI) form as opposed to the trivalent form (chromium III) because no speciation data were available. Hexavalent chromium is considered the more toxic form, and this is considered the conservative approach.

3.2.3 Toxicity Assessment

The purpose of this section is to identify the potential health hazards associated with exposure to each of the COPCs. A toxicological evaluation characterizes the inherent toxicity of a compound. The literature indicates that the COPCs have the potential to cause carcinogenic and/or noncarcinogenic health effects in humans. Although the COPCs may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects, as discussed below. Toxicity information for the COPCs at all SWMUs at NAS Key West is presented in Table G.3-2 and Appendix A of the Supplemental RFI/RI Report in the form of toxicological profiles.

An important component of the risk assessment process is the relationship between the intake of a compound (the amount of a chemical that is absorbed by a receptor) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts can be quantified. The published information of doses and responses is used in conjunction with information on the nature and magnitude of human exposure to develop an estimate of potential health risks.

Reference doses (RfDs) and slope factors (SFs) have been developed by EPA (1995b, 1995c) and other sources for many organics and inorganics. This section provides a brief description of these parameters.

TABLE G.3-2

DOSE-RESPONSE PARAMETERS - POTENTIAL CHEMICALS OF CONCERN
NAS KEY WEST
PAGE 1 OF 2

Substance	Fraction of COPC Absorbed in the Gastrointestinal Tract (unitless)**	Toxicity Values											
		Noncarcinogenic					Carcinogenic						
		RfD Oral (mg/kg)/day	Target Organ/Critical Effect	RfD Dermal (mg/kg)/day	RfD Inhalation (mg/kg)/day	Critical Effect	SF* Oral (mg/kg)/day	Tumor Type	Weight of Evidence	SF Dermal 1(mg/kg)/day	SF Inhalation 1(mg/kg)/day	Tumor Type	Weight of Evidence
INORGANICS													
Aluminum	0.20	1.00E+00 E	–	5.00E-02	–	–	–	–	–	–	–	–	–
Antimony	0.20	4.00E-04	C	8.00E-05	–	–	–	–	D	–	–	–	–
Arsenic (total)	0.20	3.00E-04	S	6.00E-05	–	–	1.50E+00	Skin - humans	A	7.50E+00	1.51E+01	Lung - Occupational	A
Barium	0.20	7.00E-02	C, GI M, RS	1.40E-02	1.43E-04 A	F	–	–	D	–	–	–	–
Beryllium	0.20	5.00E-03	–	1.00E-03	–	–	4.30E+00	Various - rats	B2	–	8.40E+00	Lung - Occupational	B2
Cadmium	0.20	5.00E-04	K	1.00E-04	5.71E-05 E	RI	–	–	D	–	6.30E+00	Lung - Occupational	B1
Chromium, trivalent	0.20	1.00E+00	–	2.00E-01	5.71E-07 W	–	–	–	D	–	–	–	–
Chromium, hexavalent	0.20	5.00E-03	K	1.00E-03	–	–	–	–	A	–	4.20E+01	Lung - Occupational	A
Cobalt	0.20	6.00E-02 E	B, C, T	1.20E-02	–	–	–	–	–	–	–	–	–
Copper	0.20	4.00E-02 E	B, K, L	8.00E-03	–	–	–	–	D	–	–	–	–
Cyanide	0.20	2.00E-02	–	4.00E-03	–	–	–	–	–	–	–	–	–
Iron	0.20	3.00E-01 E	L, P	6.00E-02	–	–	–	–	–	–	–	–	–
Lead, total	0.20	–	B, CNS	–	–	–	–	Renal - mice/rats	B2	–	–	–	–
Manganese	0.20	5.00E-03	CNS	1.00E-03	1.43E-05	RI	–	–	–	–	–	–	–
Mercury	0.20	1.00E-04 H	K, CNS	2.00E-05	8.57E-05 H	CNS	–	–	D	–	–	–	–
Nickel	0.20	2.00E-02	CNS	4.00E-03	–	–	–	–	D	–	–	–	–
Selenium, total	0.20	5.00E-03	S	1.00E-03	–	–	–	–	–	–	–	–	–
Silver	0.20	5.00E-03	S	1.00E-03	–	–	–	–	D	–	–	–	–
Thallium	0.20	8.00E-05	S, K, L, CNS	1.60E-05	–	–	–	–	–	–	–	–	–
Vanadium	0.20	7.00E-03 H	–	1.40E-03	–	–	–	–	D	–	–	–	–
Zinc	0.20	3.00E-01	B	7.50E-02	–	–	–	–	D	–	–	–	–
PESTICIDES/PCBs													
4,4'-DDD	0.50	–	–	–	–	–	2.40E-01	Lung, liver - rats	B2	4.80E-01	–	–	–
4,4'-DDE	0.50	–	–	–	–	–	3.40E-01	Liver, tyroid - rats	B2	6.80E-01	–	–	–
4,4'-DDT	0.50	5.00E-04	L	2.50E-04	–	–	3.40E-01	Liver - mice/rats	B2	6.80E-01	3.40E-01	Liver - mice/rats	B2
Aroclor 1260	0.50	–	S, H, RS	–	–	–	7.70E+00	Liver - rats	B2	1.54E+01	–	–	B2
Beta-BHC	0.50	–	–	–	–	–	1.80E+00	Liver - mice	C	3.60E+00	1.80E+00	Liver - mice	C
Delta-BHC	0.50	–	–	–	–	–	–	–	D	–	–	–	–
Endosulfan sulfate	0.50	–	–	–	–	–	–	–	–	–	–	–	–
Endrin ketone	0.50	–	–	–	–	–	–	–	–	–	–	–	–
Endrin aldehyde	0.50	–	H, CNS, RS	–	–	–	–	–	–	–	–	–	–
Heptachlor	0.50	5.00E-04	L	2.50E-04	–	–	4.50E+00	Liver - mice	B2	9.00E+00	4.55E+00	Liver - mice	B2

TABLE G.3-2

DOSE-RESPONSE PARAMETERS - POTENTIAL CHEMICALS OF CONCERN
NAS KEY WEST
PAGE 2 OF 2

	Fraction of COPC	Toxicity Values											
SEMIVOLATILE ORGANIC COMPOUNDS													
Anthracene	0.50	3.00E-01	–	1.50E-01	–	–	–	–	D	–	–	–	–
Benzo(a)anthracene	0.50	–	–	–	–	–	7.30E-01 E	Same as B(A)P	B2	1.46E+00	3.10E-01 E	Same as B(A)P	B2
Benzo(a)pyrene	0.50	–	–	–	–	–	7.30E+00 E	Various - mice/rats	B2	1.46E+01	3.10E+00 W	Various - mice/rats	B2
Benzo(b)fluoranthene	0.50	–	–	–	–	–	7.30E-01 E	Same as B(A)P	B2	1.46E+00	3.10E-01 E	Same as B(A)P	B2
Benzo(g,h,i)perylene	0.50	–	–	–	–	–	–	–	D	–	–	–	–
Benzo(k)fluoranthene	0.50	–	–	–	–	–	7.30E-02 E	Same as B(A)P	B2	1.46E-01	3.10E-02 E	Same as B(A)P	B2
Chrysene	0.50	–	–	–	–	–	7.30E-03 E	Same as B(A)P	B2	1.46E-02	3.10E-03 E	Same as B(A)P	B2
Dibenz(a,h)anthracene	0.50	–	–	–	–	–	7.30E+00 E	Same as B(A)P	B2	1.46E+01	3.10E+00 E	Same as B(A)P	B2
Fluoranthene	0.50	4.00E-02	B,K,L	2.00E-02	–	–	–	–	D	–	–	–	–
Hexachlorophene	0.50	3.00E-04	–	1.50E-04	–	–	–	–	–	–	–	–	–
Pyrene	0.50	3.00E-02	K	1.50E-02	–	–	–	–	D	–	–	–	–
Indeno(1,2,3-cd)pyrene	0.50	–	–	–	–	–	7.30E-01 E	Same as B(A)P	B2	1.46E+00	3.10E-01 E	Same as B(A)P	B2
VOLATILE ORGANIC COMPOUNDS													
2-hexanone	0.80	–	–	–	–	–	–	–	–	–	–	–	–
Trans-1,4-dichloro-2-butene	0.80	–	–	–	–	–	–	–	–	–	9.30E+00 H	Nasal - Rats	H

– = No dose-response value is available for this chemical in this classification.
* = All toxicity values are from Integrated Risk Information System (IRIS) unless otherwise noted
** = Modifying factor applied only to the dermal RfDs and SFs, from EPA (1995a)

A = HEAST Alternative (EPA, 1995c)
B = Blood
C = Heart
CNS = Central Nervous System
E = EPA-NCEA Regional Support provisional service (EPA, 1995b)
H = Health Effects Assessment Summary Tables (HEAST)(EPA, 1995c)
K = Kidney
L = Liver
RS = Reproductive System
S= Skin
W = Withdrawn from IRIS or HEAST

3.2.3.1 Reference Doses (RfDs)

The RfD is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is based solely on the noncarcinogenic effects of chemical substances. The RfD is usually expressed as a dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a No-Observed-Adverse-Effect-Level (NOAEL) or a Lowest-Observed-Adverse-Effect-Level (LOAEL) by an appropriate uncertainty factor. NOAELs, etc. are determined from laboratory animal or epidemiological toxicity studies. The uncertainty factor is based on the extent and applicability of toxicity data to human exposure.

Uncertainty factors are generally applied as multiples of 10 to represent specific areas of uncertainty in the available data. A factor of 10 is used to account for variations in the general population (to protect sensitive subpopulations), extrapolation of test results from animals to humans (to account for interspecies variability), derivation of a NOAEL from a subchronic study (instead of a chronic study) for developing the RfD, and use of a LOAEL instead of a NOAEL. In addition, EPA reserves the use of a modifying factor of up to 10 for professional judgment of uncertainties in the database not already accounted for. The default value of the modifying factor is 1. The RfD incorporates the reliability of the evidence for chronic human health effects. Even if applicable human data exist, the RfD (as reduced by the uncertainty factor) still maintains a margin of safety so that chronic human health effects are not underestimated. Thus, the RfD is an acceptable guideline for evaluation of noncarcinogenic risk, although the associated uncertainties preclude its use for precise risk quantitation. RfDs for NAS Key West SWMU contaminants are provided in Table G.3-2.

Noncarcinogenic risks for lead were not quantitated and compared to RfDs because EPA has implemented an approach to evaluating lead risks that goes beyond providing a single point estimate output. Instead, expected blood-lead increases were estimated, and a discussion of these results is presented in Section 3.2.4.6.

3.2.3.2 Cancer Slope Factors (SFs)

SFs are applicable for estimating the lifetime probability (assumed 70-year lifespan) of human receptors developing cancer as a result of exposure to known or potential carcinogens. This factor is generally reported in units of 1/(mg/kg/day) and is derived through an assumed low-dosage linear relationship of extrapolation from high to low dose responses determined from animal studies. The value used in reporting the slope factor is the upper 95 percent confidence limit. SFs for NAS Key West SWMU contaminants are provided in Table G.3-2.

Carcinogenic risks for lead were not quantitated because no EPA consensus currently exists with respect to an inorganic lead SF. Instead, potential lead exposures were calculated using a biokinetic model to estimate expected blood-lead increases, and a discussion of these results is presented in Section 3.2.4.6.

3.2.3.3 EPA Weight-of-Evidence

The weight-of-evidence designations indicate the preponderance of evidence regarding carcinogenic effects in humans and animals. The categories are defined in Table G.3-3 (EPA, 1992d).

3.2.3.4 Adjustment of Dose-Response Parameters

Risks associated with dermal exposures are evaluated using toxicity values that are specific to dermally absorbed doses. Most oral toxicity values are based on administered doses rather than absorbed doses (TCE being an important exception). Therefore, In accordance with Region IV EPA (1995a) and EPA (1989a, Appendix A), the toxicity values based on administered doses were adjusted before they were used for evaluation of absorbed doses. Dermal RfDs and SFs are obtained from oral RfDs and SFs via the following relationships:

$$RfD_{Adjusted} = RfD_{Oral} * ABSEFF_{Oral}$$

$$SF_{Adjusted} = {}^{SF_{Oral}}\!/_{ABSEFF_{Oral}}$$

where:

$ABSEFF_{Oral}$ = Absorption Efficiency in the study that is the basis of the oral toxicity value.

The default ABSEFFs are as follows (EPA, 1995a):

80 percent for volatile organics chemicals

50 percent for semivolatile organics and pesticides

20 percent for inorganic chemicals

TABLE G.3-3

EPA WEIGHT OF EVIDENCE CARCINOGENIC CLASSIFICATIONS

EPA Category	Description of Group	Description of Evidence
Group A	Human carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer
Group B1	Probable human carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies
Group B2	Probable human carcinogen	Sufficient evidence of carcinogenicity in animals; inadequate evidence of carcinogenicity in humans
Group C	Possible human carcinogen	Limited evidence of carcinogenicity in animals
Group D	Not classified	Inadequate evidence of carcinogenicity in animals
Group E	No evidence of carcinogenicity	No evidence for carcinogenicity in at least two adequate animal tests or in both epidemiological and animal studies

3.2.3.5 Relative Potency Factors for PAHs

Carcinogenic PAHs are related by chemical structure. Only benzo(a)pyrene [B(a)P] has an EPA published SF (EPA, 1995g). All other carcinogenic PAHs have SFs based on their potency relative to B(a)P's, and these factors are published by EPA (1995a). Table G.3-4 shows the relative potency factors (which are also commonly known as toxicity equivalence factors (TEFs).

3.2.4 Exposure Assessment

The purpose of this section is to evaluate the potential for human exposure to the chemicals detected in the environmental media at the NAS Key West SWMUs investigated under this RI. This section characterizes the exposure setting, characterizes the potentially exposed populations, identifies actual or potential exposure routes, presents a general conceptual site model, and summarizes the methods used to generate exposure estimates. The nature and extent of contamination upon which the exposures are based is presented in Chapter 4 of the Supplemental RFI/RI Report. To determine whether there is an actual or potential exposure, the most likely pathways of contaminant release and transport, as well as the human and environmental activity patterns, must be considered. A complete exposure pathway has three components: a source, a route of transport, and an exposure point for receptors. These components are addressed in this section.

3.2.4.1 Characterization of the Exposure Setting

A description of the facility, its setting, and its surroundings are provided in Section 1.2 of the Supplemental RFI/RI Report. Chapter 3.0 of the Supplemental RFI/RI Report provides a characterization of general site conditions, including physiography and topography, climate, soil, surface-water hydrology, and public water supply and use.

3.2.4.2 Potential Receptors

The receptors chosen for the SWMUs at NAS Key West are presented in this section. All of the receptors listed below are applicable to every SWMU because the same exposures to media are anticipated at each SWMU.

TABLE G.3-4

RELATIVE POTENCY FACTORS FOR CARCINOGENIC PAHS
NAS KEY WEST

Carcinogenic PAH	Relative Potency Factor
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

The current exposure scenarios are, as follows:

- Adolescent and Adult Trespasser - A trespasser is an adult or adolescent who trespasses at NAS Key West for 45 days/year adolescent age 6-16 years, adult; ABB, 1995a). These receptors are potentially exposed via ingestion of, dermal contact with, and inhalation of chemicals of potential concern (COPCs) in surface soil and ingestion of and dermal contact with COPCs in sediment and surface water.

- Occupational Worker - The full-time onsite worker is an adult who works at NAS Key West all year (250 days/year). This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil.

- Site-Maintenance Worker - The site-maintenance worker is an adult who works at NAS Key West but is exposed in shorter durations (12 days/year) than the Occupational Worker. This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil.

Future exposure scenarios are, as follows:

- Future Excavation Worker - A future excavation worker is an adult who is assumed to work at NAS Key West in the future during any type of excavation activity (30 days/year). This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in subsurface soil.

- Future Resident - A future resident is a person who will live in a residence at or near NAS Key West in a hypothetical future scenario. This receptor resides at the residence for 30 years, 0 through 6 years as a child and the remaining 24 years as an adult. This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil and ingestion of and dermal contact with COPCs in sediment and surface water. The carcinogenic risks for this receptor are estimated over a lifetime (0-6 years as a child, 24 years as an adult). The noncarcinogenic risks for this receptor are estimated over a 6 year period (i.e., for child resident only).

3.2.4.3 Exposure Routes by Medium

There are four environmental media at NAS Key West through which potential receptors (see previous section) can be either directly or indirectly exposed to site-related COPCs: surface soil, subsurface soil, sediment, or surface water. All four media have been sampled at all of the NAS Key West SWMUs. Potential exposure routes include ingestion, dermal contact, and inhalation.

3.2.4.3.1 Surface Soil

Surface soil exposure routes include incidental ingestion, dermal contact, and inhalation of fugitive dust. All scenarios are based on COPC representative concentrations in surface soils. All three exposure routes were evaluated using occupational workers, maintenance workers (current scenarios), and residential receptors (future scenario). These receptors were chosen because it is unknown whether NAS Key West will remain open to industrial employees only or whether NAS Key West (or a portion of it) might become a residential area in the future. For fugitive dust emissions under both scenarios, the assumption of surface cover would resemble the type of vegetation, paving, and buildings that are currently in place. For surface soil, low levels of VOCs did not warrant full-scale modeling and an estimation of the exposure. VOCs were generally not detected in surface soil. Therefore, exposure to volatilized chemicals is expected to be negligible at NAS Key West, and ingestion and dermal contact would contribute to the bulk of the risk.

3.2.4.3.2 Subsurface Soil

Because there is currently no direct contact with subsurface soil, only potential future incidental ingestion, dermal contact, or inhalation of fugitive dusts could be evaluated. All three exposure routes were evaluated using excavation workers (future scenario). The exposure scenarios for subsurface soil are based on the assumption that subsurface soil could eventually become surface soil if excavations, erosion, construction, or landscaping activities occurred. Exposure scenarios related to concentrations in subsurface soil are conservative based on this assumption. For fugitive dust emissions from subsurface soil under the future industrial scenario, the assumption of surface cover would be based on the type of vegetation, paving, and buildings that are currently in place.

Subsurface soil contamination may also have an impact upon future groundwater quality, especially for relatively mobile contaminants such as VOCs. This risk assessment does take into account future loading of COPCs from subsurface soils to groundwater in the fate and transport and remedial goal options sections of the report.

3.2.4.3.3 Sediment

Sediment exposure routes include incidental ingestion and dermal contact. These exposure routes were evaluated using adult and adolescent trespassers (current scenario) and residential receptors (future scenario). Inhalation of chemicals in sediment was eliminated as a pathway because the sediment is not

expected to be in a dry streambed. Furthermore, the frequency of contact with sediment by these receptors is expected to be low.

3.2.4.3.4 Surface Water

Surface-water exposure routes include incidental ingestion and dermal contact. These exposure routes were evaluated using adult and adolescent trespassers (current scenario) and residential receptors (future scenario). Inhalation of VOCs in surface water was eliminated as a pathway because VOCs were detected infrequently in surface water. Furthermore, the frequency of contact with surface water by the these receptors is expected to be low.

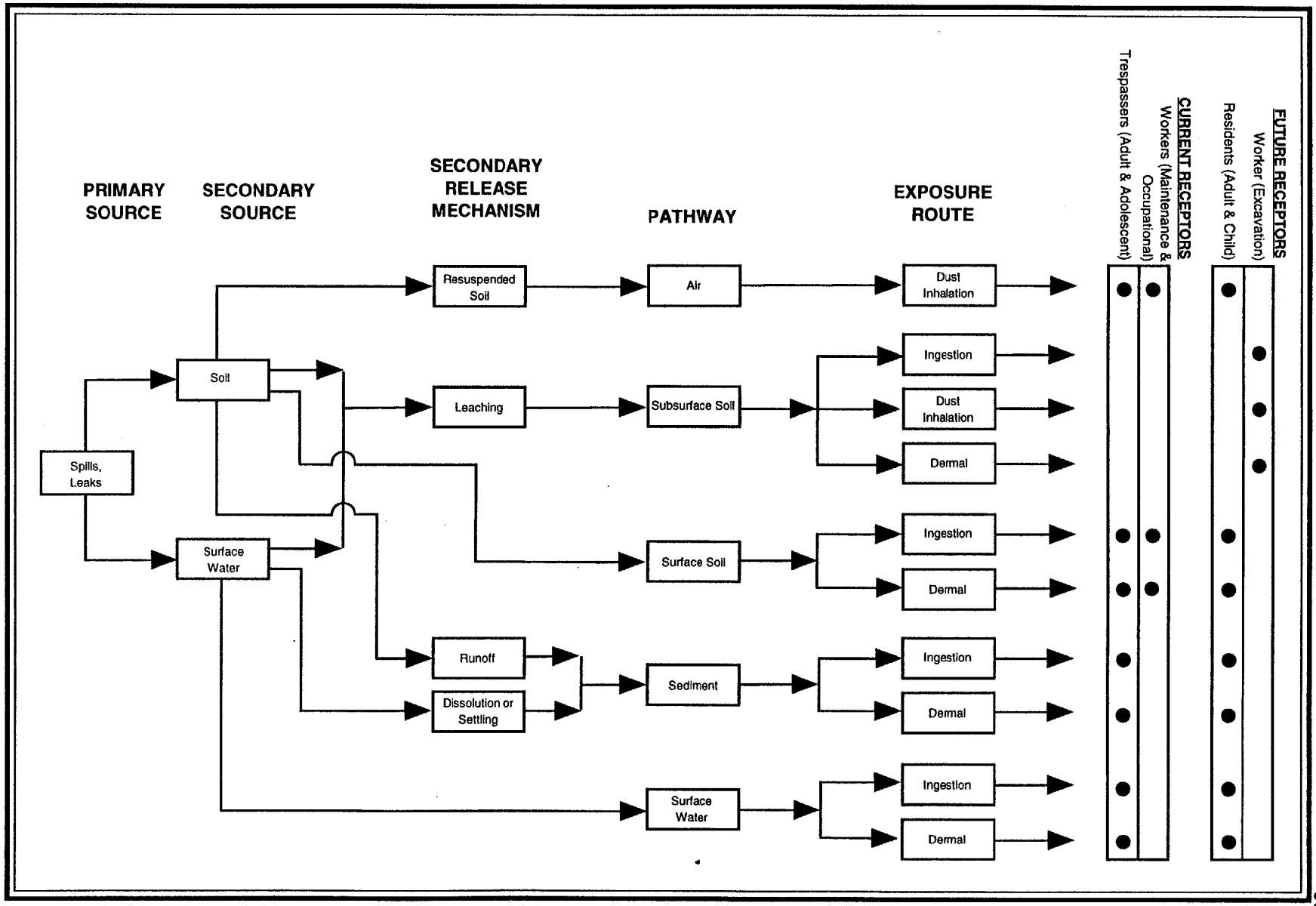
3.2.4.4 Conceptual Site Model

The conceptual site model for NAS Key West incorporates information of the potential chemical sources, affected media, release mechanisms, routes of migration, and known or potential human receptors. The purpose of the conceptual site model is to provide a framework in which to identify potential exposure pathways occurring at the sites. Information provided on site characterization, chemical characterization, local land and water uses, and potential receptors is used to identify potential exposure pathways for the SWMU. The general conceptual site model for NAS Key West is presented in Figure G.3-1.

3.2.4.5 Exposure Estimates

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a; EPA, 1995a). Exposure estimates (in the form of chemical intake) associated with each exposure route are presented below. All exposure scenarios incorporate the representative concentrations in the estimation of intakes.

Noncarcinogenic risks are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. This is used with the "averaging time," which converts the daily exposure frequency and duration to an annual exposure by dividing by 365 days per year of exposure. Noncarcinogenic risks for some exposure routes (e.g., soil) are generally greater for children than for adults because of the much lower body weights of children and their similar or higher ingestion rates. Carcinogenic risks, on the other hand, are calculated as an incremental lifetime risk and, therefore, incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years).



7046-1PC

Figure G.3-1. General Conceptual Site Model for NAS Key West SWMUs 1, 2, 3, and 9.

3.2.4.5.1 Surface Soil Exposure

Three potential exposure routes are associated with direct exposure to surface soil at the NAS Key West SWMUs. These exposure routes include ingestion, dermal contact, and inhalation of fugitive dust. The methods used to assess these routes of exposure are discussed in the following text.

Incidental soil ingestion, dermal contact, and inhalation of fugitive dust exposure is estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}\,(mg / kg) / day = \frac{CS * IR_{soil} * FI * CF * EF * ED}{BW * AT * 365\ {}^{days}/_{year}}$$

$$INTAKE_{DERMAL}\,(mg / kg) / day = \frac{DA_{event} * SA * EF * ED}{BW * AT * 365\ {}^{days}/_{year}}$$

$$DA_{event} = CS * AF * ABS_{dermal} * CF$$

$$INTAKE_{INHALATION}\,(mg / kg) / day = \frac{CA * IR_{air} * ET * EF * ED}{BW * AT * 365\ {}^{days}/_{year}}$$

where:

CA	=	Chemical concentration in air (mg/m^3)
CS	=	Chemical concentration in soil (mg/kg or µg/kg soil)
IR_{soil}	=	Soil ingestion rate (mg soil/day)
IR_{air}	=	Inhalation rate (m^3/hr)
FI	=	Fraction ingested from contaminated source (unitless)
ET	=	Exposure time (hr/day)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (years)

BW	=	Body weight (kg)
AT	=	Averaging time (days)
CF	=	Conversion factor (1×10^{-6} kg/mg for inorganics; 1×10^{-9} kg/mg for organics)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil-to-skin adherence factor (mg/cm^2)
ABS_{dermal}	=	Absorption fraction (unitless)

A sample calculation for the occupational worker is provided in Appendix A of the Supplemental RFI/RI Report for ingestion of, dermal contact with, and inhalation of fugitive dust exposure pathways. The input parameters for these exposure routes, along with the rationale for the selection of each value, are presented in Tables G.3-5 through G.3-8. As discussed in Section 3.2.4.2, the potential receptors for this scenario were current trespassers, current occupational workers, current maintenance workers, and future residents. EPA or conventional values were selected for all input parameters.

For the dermal pathway, It was assumed that the primary areas of skin available for contact would be 25 percent of the total body surface area of adult residents and maintenance workers, 10 percent of the total body surface area of occupational workers, and the arms, hands, and legs of adolescents.

Absorption factors for the dermal pathway were assumed to be as follows (EPA, 1992a, 1995h): PCBs (6 percent), chlorinated dioxins (3 percent), cadmium (1 percent), arsenic (3.2 percent), ethylbenzene (3 percent), toluene (3 percent), xylenes (3 percent), PCE (3 percent), pesticides (10 percent), and pentachlorophenol (24.4 percent). If no chemical-specific data were available the following absorption factors were assumed (EPA, 1995a): 1 percent for organics and 0.1 percent for inorganics.

Exposure to fugitive dust emissions can be calculated by first estimating the rate of distribution and COPC emission from the SWMU and then translating this to the exposure rate for the receptors. The derivation of the CA term in the inhalation equation is rather lengthy and complicated; explanation of the derivation of this term is provided in Appendix A of the Supplemental RFI/RI Report. The input parameters were generally those provided in the Cowherd model (Cowherd et al. 1985), which allows limited parameter choices for area and distance to the SWMU.

TABLE G.3-5

INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS
FUTURE RESIDENT
NAS KEY WEST

Parameter	Child (0-6 yrs)	Adult	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	200	100	mg/day	USEPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	350	350	days/year	USEPA, 1991a
ED	6	24	years	USEPA, 1991a
ET	16	16	hours/day	Assumption
AT_{cancer}	70	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	6	24	years	USEPA, 1991a
SA	See Appendix A	5,750*	cm^2	USEPA, 1992a
IR_{air}	0.833	0.833	m^3/hour	USEPA, 1991a
BW	15	70	kg	USEPA, 1991a
AF	1	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	USEPA, 1995a USEPA,1995h
CA	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of Supplemental RFI/RI Report

*25% of total body surface

TABLE G.3-6

**INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS
CURRENT ADOLESCENT AND ADULT TRESPASSERS
NAS KEY WEST**

Parameter	Adolescent	Adult	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	100	100	mg/day	USEPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	30	24	days/year	USEPA, 1991a
ED	11	19	years	ABB, 1995a
ET	4	4	hours/day	Assumption
AT_{cancer}	70	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	11	19	years	USEPA, 1991a
SA	See Appendix A	5,750*	cm^2	USEPA, 1992a
IR_{air}	0.833	0.833	m^3/hour	USEPA, 1991a
BW	40	70	kg	USEPA, 1991a ABB, 1995a
AF	1	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	USEPA, 1995a USEPA, 1995h
CA	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of Supplemental RFI/RI Report

*25% of total body surface

TABLE G.3-7

INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS
SITE MAINTENANCE WORKER
NAS KEY WEST

Parameter	Maintenance Worker	Units	Source
CS	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	118	mg/day	Assumption (ABB, 1995a)
FI	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	kg/mg	
$CF_{organics}$	1E-09	kg/µg	
EF	12	days/year	Assumption (ABB, 1995a)
ED	25	years	USEPA, 1991a
ET	8	hours/day	Assumption
AT_{cancer}	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	25	years	USEPA, 1991a
SA	5,750*	cm^2	USEPA, 1992a
IR_{air}	0.833	m^3/hour	Hawley, 1985
BW	70	kg	USEPA, 1991a
AF	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	unitless	USEPA, 19915a USEPA, 1995h
CA	Chemical Specific	mg/m^3	See Appendix A of Supplemental RFI/RI Report

*25% of body surface

TABLE G.3-8

INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS
INDUSTRIAL WORKER
NAS KEY WEST

Parameter	Industrial Worker	Units	Source
CS	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	50	mg/day	USEPA, 1991a
FI	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	kg/mg	
$CF_{organics}$	1E-09	kg/µg	
EF	250	days/year	USEPA, 1991a
ED	25	years	USEPA, 1991a
ET	8	hours/day	Assumption
AT_{cancer}	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	25	years	USEPA, 1991a
SA	2,300*	cm^2	USEPA, 1992a
IR_{air}	2.5	m^3/hour	USEPA, 1991a
BW	70	kg	USEPA, 1991a
AF	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	unitless	USEPA, 1995a USEPA, 1995h
CA	Chemical Specific	mg/m^3	See Appendix A of the Supplemental RFI/RI Report

*10% of total body surface

3.2.4.5.2 Subsurface Soil Exposure

Three potential exposure routes are associated with direct exposure to subsurface soil (as future surface soils) at the NAS Key West SWMUs: ingestion, dermal contact, and inhalation of fugitive dust. The methods used to assess these routes of exposure are the same as the equations for surface soil presented in the previous section. The potential receptor for this pathway is a future excavation worker and the assumptions for subsurface soil exposure are presented in Table G.3-9.

3.2.4.5.3 Sediment Exposure

Two potential exposure routes are associated with direct contact with sediment at the NAS Key West SWMUs: ingestion and dermal contact. The methods used to assess these routes of exposure are discussed in the following text. These scenarios were evaluated in the same way as ingestion and dermal exposures for surface soil, which were explained above. Incidental sediment ingestion and dermal contact exposure are estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}(mg/kg)/day = \frac{CS * IR_{sediment} * FI * CF * EF * ED}{BW * AT * 365^{days}/_{year}}$$

$$INTAKE_{DERMAL}(mg/kg)/day = \frac{DA_{event} * SA * EF * ED}{BW * AT * 365^{days}/_{year}}$$

$$DA_{event} = CS * AF * ABS_{dermal} * CF$$

where:

CS	=	Chemical concentration in sediment (mg/kg or µg/kg sediment)
$IR_{sediment}$	=	Sediment ingestion rate (mg soil/day)
FI	=	Fraction ingested from contaminated source (unitless)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)

TABLE G. 3-9

INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SUBSURFACE SOIL
SITE EXCAVATION WORKER
NAS KEY WEST

Parameter	Excavation Worker	Units	Source
CS	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	118	mg/day	USEPA, 1991a
FI	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	kg/mg	
$CF_{organics}$	1E-09	kg/µg	
EF	30	days/year	USEPA, 1991a
ED	1	years	USEPA, 1991a
ET	8	hours/day	Assumption
AT_{cancer}	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	25	years	USEPA, 1991a
SA	5,750*	cm^2	USEPA, 1992a
IR_{air}	2.5	m^3/hour	USEPA, 1991a
BW	70	kg	USEPA, 1991a
AF	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	unitless	USEPA, 1995a USEPA, 1995h
CA	Chemical Specific	mg/m^3	See Appendix A of the Supplemental RFI/RI Report

*25% of total body surface

AT = Averaging time (days)

CF = Conversion factor (1×10^{-6} kg/mg for inorganics; 1×10^{-9} kg/µg for organics)

SA = Skin surface area available for contact (cm^2/day)

AF = Soil-to-skin adherence factor (mg/cm^2)

ABS_{dermal} = Absorption factor (unitless)

A sample calculation for the adult trespasser is provided in Appendix A for the ingestion of and dermal contact with sediment. The input parameters for these exposure routes, along with the rationale for the selection of each value, are presented in Tables G.3-10 and G.3-11. As discussed in Section 3.2.4.2, the potential receptors for this scenario were current trespassers and future residents. EPA or conventional values were selected for all input parameters.

For the dermal pathway, it was assumed that the primary areas of skin available for contact would be 25 percent of the total body surface area of adult residents and adult trespassers and workers and the arms, hands, and legs of child residents and adolescent trespassers. Absorption factors for the dermal pathway were assumed to be as follows (EPA, 1992a, 1995h): PCBs (6 percent), chlorinated dioxins (3 percent), cadmium (1 percent), arsenic (3.2 percent), ethylbenzene (3 percent), toluene (3 percent), xylenes (3 percent), PCE (3 percent), pesticides (10 percent), and pentachlorophenol (24.4 percent). If no chemical-specific data were available, the following absorption factors were assumed (EPA, 1995a): 1 percent for organics and 0.1 percent for inorganics.

3.2.4.5.4 Surface Water Exposure

Two potential exposure routes are associated with surface water exposure at the NAS Key West sites: ingestion and dermal contact during wading. The methods used to assess these routes of exposure are discussed in the following text. Incidental ingestion and dermal contact exposure are estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}(mg/kg)/day = \frac{CW * IR_{surface\ water} * CF_1 * EF * ED}{BW * AT * 365\ {}^{days}/_{year}}$$

TABLE G.3-10

INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SEDIMENT (WADING SCENARIO)
FUTURE RESIDENT
NAS KEY WEST

Parameter	Child (0-6 yrs)	Adult	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
$IR_{sediment}$	200	100	mg/day	USEPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	100	100	days/year	USEPA, 1991a
ED	6	24	years	USEPA, 1991a
AT_{cancer}	70	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	6	24	years	USEPA, 1991a
SA	See Appendix A of the Supplemental RFI/RI Report	5,750*	cm^2	USEPA, 1992a
IR_{air}	0.833	0.833	m^3/hour	USEPA, 1991a
BW	15	70	kg	USEPA, 1991a
AF	1	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	USEPA, 19915a USEPA, 1995h

*25% of total body surface

TABLE G.3-11

**INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SEDIMENT (WADING SCENARIO)
CURRENT ADOLESCENT AND ADULT TRESPASSERS
NAS KEY WEST**

Parameter	Adolescent	Adult	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	
$IR_{sediment}$	100	100	mg/day	USEPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	45	45	days/year	USEPA, 1991a
ED	11	19	years	USEPA, 1991a
AT_{cancer}	70	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	11	19	years	USEPA, 1991a
SA	See Appendix A of the Supplemental RFI/RI Report	5,750*	cm^2	USEPA, 1992a
IR_{air}	0.833	0.833	m^3/hour	USEPA, 1991a
BW	40	70	kg	USEPA, 1991a
AF	1	1	mg/cm^2 per event	USEPA, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	USEPA, 1995a USEPA, 1995h

*25% of total body surface

$$INTAKE_{DERMAL}\,(mg / kg) / day = \frac{DA_{event} * SA * EF * ED * EV}{BW * AT * 365\ {}^{days}/_{year}}$$

$$DA_{event} = PC_{event} * CW * CF_1 * CF_2$$

where:

CW	=	Concentration of contaminant in surface water (µg/L)
$IR_{surface\ water}$	=	Surface water ingestion rate (l/day)
CF_1	=	Conversion factor (mg/10^3 µg)
CF_2	=	Conversion Factor (l/10^3 cm^3)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
EV	=	Event frequency (events/day)
AT	=	Averaging time (years)
SA	=	Surface area (cm^2)
BW	=	Body weight (kg)
PC_{event}	=	Diffusion depth per event (cm/event); See Appendix A of the Supplemental RFI/RI Report for further explanation

A sample calculation for the adult trespasser is provided in Appendix A of the Supplemental RFI/RI Report for the ingestion of and dermal contact with surface water. The input parameters for these exposure routes, along with the rationale for the selection of each value, are presented in Tables G.3-12 and G.3-13. As discussed in Section 3.2.4.2, the potential receptors for this scenario were current trespassers and future residents. EPA or conventional values were selected for all input parameters.

For the dermal pathway, It was assumed that the primary areas of skin available for contact would be 25 percent of the total body surface area of adult residents and adult trespassers, and the arms, hands, and legs of child residents and adolescent trespassers. Permeability constants and derivation of the

TABLE G.3-12

INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SURFACE WATER (WADING SCENARIO)
FUTURE RESIDENTS
NAS KEY WEST

Parameter	Child (0-6 yrs)	Adult	Units	Source
CW	Chemical Specific	Chemical Specific	µg/L	Analysis
$IR_{surface\ water}$	0.13	0.13	liters/day	USEPA, 1988
CF1	0.001	0.001	mg/µg	
CF2	0.001	0.001	liters/cm^3	
EF	100	100	days/year	USEPA, 1991a
EV	0.25	0.33	min/hr	
ED	6	24	years	USEPA, 1991a
AT_{cancer}	70	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	6	24	years	USEPA, 1991a
SA	See Appendix A	5,750*	cm^2	USEPA, 1992a
BW	15	70	kg	USEPA, 1991a
PC_{event}**	Chemical Specific	Chemical Specific	cm/event	USEPA, 1992a

*25% of total body surface
**See Appendix A of the Supplemental RFI/RI Report for a derivation of PC for each COPC.

TABLE G.3-13

**INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SURFACE WATER (WADING SCENARIO)
CURRENT ADOLESCENT AND ADULT TRESPASSERS
NAS KEY WEST**

Parameter	Adolescent	Adult	Units	Source
CW	Chemical Specific	Chemical Specific	µg/L	Analysis
$IR_{surface\ water}$	0.13	0.13	liters/day	USEPA, 1988
CF1	0.001	0.001	mg/µg	
CF2	0.001	0.001	liters/cm^3	
EF	45	45	days/year	USEPA, 1991a
ED	11	19	years	USEPA, 1991a
EV	1	1	event/day	
AT_{cancer}	70	70	years	USEPA, 1991a
$AT_{non\text{-}cancer}$	11	19	years	USEPA, 1991a
SA	See Appendix A	5,750*	cm^2	USEPA, 1992a
BW	40	70	kg	USEPA, 1991a
PC_{event}**	Chemical Specific	Chemical Specific	cm/event	USEPA, 1992a

*25% of total body surface
**See Appendix A of the Supplemental RFI/RI Report for derivation of PC for each COPC.

dermal exposure pathway are shown in Appendix A of the Supplemental RFI/RI Report. The exposure time is 2 hours for both the residential and the trespasser scenario.

3.2.4.6 Blood-Lead Modeling

As outlined in OSWER directive 9355.4-12 (EPA, 1994a), EPA has implemented an approach to evaluating lead risks that recognizes the multimedia nature of lead exposures, incorporating absorption and pharmacokinetic information. Research has been done concerning lead intake and resultant blood-lead levels. Determinations of lead uptake from soil, sediment, drinking water, and surface water were considered. For the purposes of this risk assessment, each pathway was evaluated separately so that the contribution of lead from each source and each exposure route could be evaluated. Potential blood-lead level increases were estimated and are discussed, along with the potential implications of blood-lead results for each SWMU. The following paragraphs present information that is useful in estimating lead exposure.

No threshold has been defined for effects related to blood-lead increases. The estimated increases at these SWMUs are well below the concentrations at which effects such as anemia and neuropathy occur (40 µg/dL and above) (Doull et al. 1986). Effects below 10 µg/dL are difficult to define. Inhibition of certain enzymes involved in red blood cell metabolism has been reported to occur at 10 to 15 µg/dL and possibly lower (EPA, 1991c). Small increases in blood pressure have been related to adults with blood-lead levels down to 7 µg/dL (EPA, 1991c). Probably the subpopulation most sensitive to effects at the 3 to 7 µg/dL range (where the concentrations estimated for this study area would fall) would be infants, whose early neurological development can be affected by blood-lead concentrations reportedly down to 5 µg/dL (EPA, 1991c). Lead is also a fairly common environmental contaminant and, for this reason, typical blood-lead levels in the population at large may already exceed the concentrations discussed here.

For drinking water exposure, children 0 through 6 months old are expected to experience blood lead increases at the rate of 0.26 µg/dL per µg/L lead in water up to 15 µg/L and at the rate of 0.04 µg/dL for every µg/L lead in water above 15 µg/L (EPA, 1991c). For older children, the ratio is 0.12 µg/dL blood lead per µg/L lead in water up to 15 µg/L and 0.06 µg/dL for every µg/L lead in water above 15 µg/L (EPA, 1991c). For adults, the ratio is approximately 0.06 µg/dL blood lead per µg/L in water (EPA, 1991c).

Dietary intake of lead is assumed to produce increases of 0.02 to 0.04 µg/dL blood lead per µg/day ingested by adults and 0.16 µg/dL blood lead per µg/day ingested by infants (EPA, 1986a).

Blood-lead levels are estimated to increase by 0.6 to 6.8 µg/dL per 1,000 mg/kg lead in soil (EPA, 1986a).

Estimates of blood-lead levels in residential children (age 0 through 6 years) were made using the Integrated Exposure and Uptake Biokinetic (IEUBK) Model (version 0.99) developed by EPA. The model was applied to each SWMU where at least one of the media (surface soil, subsurface soil, or groundwater) was sampled and at least one detection of lead was present. The output for each run of the IEUBK Model is a histogram that presents the estimated percentage of residential children (age 0 through 6 years) with a blood lead level above 10 µg/dL (considered to be the significance cutoff level above which adverse effects cannot be ruled out). When the percentage of the population estimated to have blood levels above 10 µg/dL is greater than five percent, then EPA considers the potential for adverse effects to be significant (EPA, 1994h). These histograms, along with input information particular to each run of the IEUBK model, are presented in Appendix A of the Supplemental RFI/RI Report. The estimated percentage of residential children (age 0 through 6 years) with a blood-lead level above 10 µg/dL is also presented in the SWMU-specific text contained in subsequent sections of this report. Uncertainties associated with the IEUBK model are discussed in Section 3.2.6.4.

3.2.5 Risk Characterization

Potential human health risks resulting from the exposures outlined in the preceding sections are characterized on a quantitative and qualitative basis in this section. Quantitative risk estimates are generated based on risk assessment methods outlined in current EPA guidance (EPA, 1989a; EPA, 1995a).

Noncarcinogenic risk estimates are presented in the form of Hazard Quotients (HQs) and Hazard Indices (HIs) that are determined through integration of estimated intakes with published RfDs. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on SFs.

Estimated human intakes were developed for each of the specific exposure routes discussed in the preceding sections. Both carcinogenic and noncarcinogenic risks are summarized for each exposure route on a series of tables in this section.

3.2.5.1 Carcinogenic Risks

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated intakes and published SFs, as follows:

$$\text{Risk} = \text{Intake} * \text{SF}$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$\text{Risk} = 1 - e^{-(\text{Intake}*\text{SF})}$$

The risk determined using these equations is a unitless expression of an individual's increased likelihood of developing cancer as a result of exposure to carcinogenic chemicals. An incremental cancer risk of 1E-06 indicates that the exposed receptor has a one in a million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. The calculated cancer risks should be recognized as upper-limit estimates. SFs are the upper 95 percent confidence limit of a dose-response curve generally derived from animal studies. Actual human risk, while not identifiable, is not expected to exceed the upper limit based on the SFs and may, in fact, be lower.

EPA has generally defined risks in the range of 1E-04 to 1E-06 or less as being acceptable for most hazardous waste facilities addressed under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). For CERCLA activities, residual risks on the order of 1E-06 are the primary goal but are often modified by such regulatory requirements as MCLs or chemical-specific clean-up goals.

3.2.5.2 Noncarcinogenic Risks

Noncarcinogenic risks are estimated using the concept of HQs and HIs. The HQ is the ratio of the estimated intake and the RfD for a selected chemical of concern, as follows:

$$\text{HQ} = \frac{\text{Intake}}{\text{RfD}}$$

HIs are the sums of the individual HQs for the COPCs. If the value of the HQ or the HI exceeds unity (1.0), the potential for noncarcinogenic health risks associated with exposure to that particular chemical or particular chemical mixture, respectively, cannot be ruled out (EPA, 1986b). If the individual HQs are less than 1.0 and the HI is greater than 1.0, particular attention should be paid to the target organ(s) affected by each chemical because these are generally the organ(s) associated with RfD-derived effects, and toxicity for different organs is not truly additive. The HI is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

3.2.5.3 Lead Risks

EPA's approach to evaluating lead risks goes beyond providing a single point estimate output and incorporates absorption and pharmacokinetic properties. Section 3.2.4.6 discusses background information related to blood-lead estimation methods. Soil and groundwater concentrations for lead were assessed for each applicable SWMU.

3.2.5.4 Receptor Risks

Receptor risks are presented for each NAS Key West SWMU in the form of tables and summary text. Each of these sections includes summaries of risks estimated by the exposure scenarios. It should be noted that, in each risk summary table where HQs are reported as "N/A," the HQs were not calculable because no RfD has been established. Usually in such cases, carcinogenicity is considered to be more important, since carcinogenicity will generally be seen at lower doses than noncarcinogenic effects. Cancer risks of zero or "N/A" generally indicate that the chemical is not carcinogenic or that an SF has not yet been developed.

3.2.6 Uncertainty Analysis

There are uncertainties associated with each aspect of risk assessment, from data evaluation through risk characterization. Significant uncertainties in the risk assessment for NAS Key West are noted in the following sections.

3.2.6.1 Data Evaluation

The chemical-analytical database has some limitations that add to the uncertainty of the risk assessment. Data were collected over several years at all four SWMUs. The contaminant concentrations could have changed at the SWMU based on migration or physical removal of contaminated media. Therefore uncertainty exists in using historical data because current conditions may not be represented by historical data. Areal extent of the samples (including the number collected and location of the sampling points) in a particular medium at a SWMU was one such uncertainty. Every effort was made to collect samples that reflect actual SWMU conditions. However, biased sampling may have occurred if an unknown area of contamination at a particular SWMU was under- or over-sampled. Established data validation procedures were applied to define uncertainties in terms of qualifying data as inaccurate or imprecise and eliminate data points that are unusable for risk assessment. This treatment does not eliminate all uncertainty but focuses attention on potential areas of concern regarding accuracy, precision, and data gaps.

After the data have been selected for use in the risk assessment, uncertainties exist regarding selection of a concentration for input into the quantitative risk assessment. The use of the representative concentration to estimate risk is generally regarded as a conservative estimate since this entails using either the upper 95 percent confidence limit on the arithmetic mean (based on lognormal data distribution) or the maximum concentration. The choice of the representative concentration as the value for input into the risk assessment generally lowers the chances of under estimation of the actual risk present in a pathway at a particular SWMU to a potential receptor. However, the use of the representative concentration may overestimate the actual risk present in an exposure pathway at a particular SWMU.

The use of current subsurface soil concentrations to represent future subsurface excavation exposure concentrations assumes two things that add to the uncertainty of this risk assessment. First, this exposure scenario assumes that soil would be excavated to the sampling depth. Second, this exposure scenario assumes that once the soil is excavated to the subsurface soil sampling depth, no degradation of the chemicals in the subsurface soil would have taken place and/or no additional contamination would be transported to the soils. These uncertainties may cause either an under- or over-estimation of the exposure at a particular SWMU.

Uncertainties associated with the lack of groundwater modeling and soil to groundwater loading at each SWMU include the assumption that current conditions are indicative of future concentrations of contaminants. Contaminants may increase (due to migration, loading, or chemical transformation) or decrease (due to migration or transformation) over time and vary from SWMU to SWMU and within the mixing zone. This does not add uncertainty to the quantitative risk; rather, it adds uncertainty to media concentrations which are inputs to the risk assessment.

The chemical-specific parameters such as K_{oc} were literature-derived values that are measured under conditions that may or may not be representative of on-site conditions. Parameters such as vapor pressure and solubility were not always obtainable at the desired temperature.

The use of unfiltered monitoring well data for the evaluation of groundwater inorganics provides in all probability an overestimation of exposure and risk.

3.2.6.2 Toxicity Assessment

There is uncertainty associated with the RfDs and SFs. The uncertainty results from the extrapolation of animal data to humans, the extrapolation of carcinogenic effects from the laboratory high-dose to the environmental low-dose scenarios, and interspecies and intraspecies variations in toxicological endpoints

caused by chemical exposure. The use of EPA SF values is generally considered to be conservative because the doses are based on no-effect or lowest-observed-effect levels and then further reduced with uncertainty factors to increase the margin of safety. The RfDs and SFs of some chemicals have not been established, and therefore toxicity could not be quantitatively assessed. In most cases, where RfDs were unavailable for carcinogens, the carcinogenic risk is considered to be much more significant since carcinogenic effects usually occur at much lower doses.

3.2.6.3 Exposure Assessment

Exposure assumptions can add uncertainty into the risk assessment process based on input values selected for each exposure route. For example, not all people weigh 70 kilograms, drink 2 liters of water per day, and live at the same residence for 30 years. The rationale for each assumption was provided in each table of input parameters. Receptor characteristics, such as age and body weight, were based on published values. Land use and activity patterns in the area were limited to the observations made during the field investigation and known land uses in the surrounding area. Conservative values (based on reasonable maximum exposure or professional judgment) were used in most exposure equations, except where average values were expected to better correspond to actual SWMU conditions.

In addition to activity patterns and receptor characteristics, uncertainties are also associated with chemical-specific properties and chemical transport modeling assumptions. For example, dermal exposure to soil and sediment assumes constant factors for absorption from soil for each class of compounds under all conditions. As estimated by EPA (1992a), the absorbed dermal dose could vary by as much as a factor of 50 from the model estimates, even presuming that activity patterns lead to the exposure duration applied in the model. Exposure to fugitive dust emissions conservatively assumes that residents and workers will be exposed to the same concentration indoors as outdoors, that soils within an area have unlimited erosion potential, that emissions can be estimated from mean annual windspeed and vegetative cover, and that dispersion concentrations can be estimated from source area, downwind distance to receptors, and region-wide meteorological factors. Uncertainties exist in the exposure model for the inhalation of volatiles during showering such as chemical-specific rates of volatilization, droplet size, and droplet residence time in the shower. Most of the inputs into the models were considered conservative; therefore, the output may overestimate the exposure for these routes.

3.2.6.4 Risk Characterization

From a toxicological standpoint, it is not strictly correct to add HQs for a total HI, because RfDs are based on effects to various target organs. However, if the HI is less than or equal to 1.0, this demonstrates that,

even when this conservative calculation is performed, the noncarcinogenic HI does not indicate a hazard for a particular exposure pathway. This is a conservative approach that will generally overestimate the HI for a particular pathway. The SWMU-specific text for each NAS Key West SWMU with an exposure pathway HI greater than 1.0 presents additional information that may indicate whether HQs for different chemicals can be truly additive within a particular pathway. The target organs affected by those chemicals that significantly contribute to the pathway-specific HI are indicated. This information will give an indication of whether two or more chemicals that significantly contribute to the HI can affect the same target organs.

These models also assumed that chemicals did not interact synergistically (a possible underestimate of the actual risk) or antagonistically (a possible overestimate of the actual risk). Finally, degradation was not taken into account; this is generally a conservative approach.

The IEUBK model accounts for the multimedia nature of lead exposure, incorporates absorption and pharmacokinetic information, and allows the risk manager to consider the potential distributions of exposure and risk likely to occur at a SWMU (the model goes beyond providing a single point estimate output). Although uncertainties are associated with blood lead modeling using the IEUBK model, these uncertainties are considered lower than those that conceivably would result from similar lead evaluations performed using a traditional toxicity slope-based approach. Important uncertainties and limitations in the use of the IEUBK model follows.

The IEUBK model is predictive of blood lead for residential children in the range of 6 months to 7 years of age, which typically is considered to be a more sensitive subpopulation than adults. The model does not apply to adults in either residential or occupational settings. In addition, the IEUBK model does not predict the blood lead levels of pregnant women and does not include an exposure component based on the transfer of lead from the mother's blood to the fetus before birth, although a significant potential exists for adverse effects of prenatal lead exposure on neurobehavioral and physical development (EPA, 1994h).

The IEUBK model uses a default of 30 percent lead absorption from soil. However, the bioavailability of lead from different sources may be variable due to differences in lead speciation, particle size, and mineral matrix and may also vary as a function of physiological parameters such as age, nutritional status, gastric pH, and transit time. For example, lead absorption from paint chips in soil may be different than lead absorption from other chemical forms.

Blood lead variability in the IEUBK model is characterized by a single number, the geometric standard deviation, which is set to a default value of 1.6. This value represents the aggregate uncertainty in all

sources of population variability, including biological, uptake, exposure, sampling, and analytical components.

Child blood lead level predictions obtained using the IEUBK model reflect only the contributions of sources entered into the model and do not take into account any existing body burden that may be the result of prior exposures or any exposures that may have taken place at alternate locations away from the household or neighborhood level, such as parks or daycare centers.

3.2.7 Remedial Goal Options

This section presents the methods for selecting chemicals of concern (COCs) for exposure pathways at each SWMU and determining, for these COCs, a range of possible remedial clean-up goals for consideration by risk managers in the Feasibility Study and the Proposed Plan for the Corrective Measures Study. Remedial Goal Options (RGOs) for COCs are adopted from media-specific ARARs and TBCs and are also derived from risk-based remediation goals as estimated threshold acceptable concentrations of hazardous chemicals which are protective of human health under a receptor exposure scenario.

The subset of chemicals considered for RGO evaluation consists of a portion of the COPCs chosen in Section 3.2.2 for baseline risk calculations. Based on the following criteria, a list of COCs is developed for each receptor and medium considered under a land use scenario:

- COCs are included that exceed a state or Federal chemical-specific ARAR or TBC.
- RGO analysis also includes COPCs that individually contribute a risk of greater than 1E-06 towards a cumulative cancer risk (considering all pathways, media and routes of exposure) of greater than 1E-04.
- COCs are also included that provide a non-carcinogenic HQ contribution greater than 0.1 towards a cumulative (across pathways) HI for a particular target organ of greater than 1.0.
- COCs are not included for any receptor exposure scenario where the cumulative cancer risk (across pathways) is less than 1E-04 and the cumulative hazard index for each target organ is less than or equal to 1.0.

Media-specific TBCs include surface water (Table G.3-14) and sediment (Table G.3-15) ecological criteria. Florida Water Quality Standards, Federal Ambient Water Quality Criteria (AWQCs), and EPA Region III and IV ecological screening values are considered relevant RGOs because surface water at Key West is classified according to Florida FAC 62-302, as Class III Waters (defined as "recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife"). Class III waters are designated for fish and aquatic life, not as a drinking water source; therefore, the water quality standards for protection of fish and aquatic life are the TBCs for the surface water medium. Table G.3-15 presents appropriate sediment criteria (Florida Sediment Quality Guidelines, ORNL screening levels, and EPA Sediment Quality Benchmarks, etc.), which are also based upon ecological concerns.

Several types of media-specific RGOs protective of human health are applicable to exposure pathways associated with soil and sediment (the latter under the presumption that sediment may become future surface soil). These include the following:

- The Florida Department of Environmental Protection (FDEP, 1994) Soil Cleanup Goals (SCGs) are presented in each site-specific RGO section. These RGOs are risk-based levels that have been calculated (FDEP, 1995) for residential and industrial receptors under generalized exposure assumptions. Although FDEP recommends that site-specific soil characteristics such as porosity, carbon content, moisture content, and dry bulk density are needed to refine SCGs for a site, the generalized assumptions represent a conservative approximation of exposure conditions and are useful as an initial benchmark in considering whether any type remedial action should be further investigated. The FDEP SCGs consider incidental soil ingestion, dermal contact, and inhalation of COCs volatilized from soil or present in fugitive dust emissions and were derived by rearranging generic risk equations to solve for the concentration term.

- RCRA Corrective Action Levels (CALs), which are presented in each site-specific RGO section, are risk-based levels calculated to be protective of incidental ingestion of soil/sediment. CALs are used to evaluate contamination for deciding whether a RCRA-regulated site requires a Corrective Measure Study (CMS). EPA has established procedures for determining CALs under Subpart S of 40 CFR 264 for Solid Waste Management Units (SWMU) at Hazardous Waste Management Facilities. CALs are based on generalized exposure assumptions; however, the CAL approach is somewhat less rigorous and comprehensive relative to other soil risk-based RGOs presented for NAS Key West sites. In particular, it should be noted that CALs consider only the incidental soil ingestion pathway under a residential exposure scenario and generally do not include modifications for combining child plus adult aggregate lifetime cancer risk.

TABLE G.3-14

SURFACE WATER BENCHMARK VALUES
NAS KEY WEST

Ecological Contaminant of Potential Concern	Benchmark Value (µg/L)	Source*
HERBICIDES		
2,4-D	100	Florida Water Quality Standard for freshwater (FDEP, 1995)
INORGANICS		
Aluminum	1500	Florida Water Quality Standard (FDEP, 1995)
Antimony	4300	Florida Water Quality Standard (FDEP, 1995)
Arsenic	50	Florida Water Quality Standard (FDEP, 1995)
Barium	10,000	EPA Region III BTAG screening level (USEPA, 1995f)
Beryllium	0.13	Florida Water Quality Standard (FDEP, 1995)
Cadmium	9.3	Florida Water Quality Standard (FDEP, 1995)
Copper	2.4	Ambient Water Quality Criterion (USEPA, 1996)
Cyanide	1	Florida Water Quality Standard (FDEP, 1995)
Lead	5.6	Florida Water Quality Standard (FDEP, 1995)
Manganese	10	EPA Region III BTAG screening level (USEPA, 1995f)
Mercury	0.025	Florida Water Quality Standard (FDEP, 1995)
Nickel	8.2	Ambient Water Quality Criterion (USEPA, 1996)
Silver	0.012	EPA Region IV screening level (USEPA, 1995e)
Thallium	6.3	Florida Water Quality Standard (FDEP, 1995)
Tin	0.01	EPA Region III BTAG screening level (USEPA, 1995f)
Vanadium	10,000	EPA Region III BTAG screening level (USEPA, 1995f)
Zinc	86	Florida Water Quality criterion (FDEP, 1995)
PESTICIDES/PCBs		
4,4'-DDD	0.025	EPA Region IV screening level (USEPA, 1995e)
4,4'-DDT	0.0006	Florida Water Quality Standard (FDEP, 1995)
Aldrin	0.00014	Florida Water Quality Standard (FDEP, 1995)
Beta-BHC	0.046	Florida Water Quality Standard (FDEP, 1995)
Heptachlor	0.00021	Florida Water Quality Standard (FDEP, 1995)
SEMIVOLATILE ORGANIC COMPOUNDS		
Bis(2-ethylhexyl)phthalate	360	EPA Region III BTAG screening level (USEPA, 1995f)
Chrysene	31	Florida Surface Water Quality Standard (FDEP, 1995)
Di-n-butyl phthalate	3.4	EPA Region III BTAG screening level (USEPA, 1995f)
Fluoranthene	370	Florida Water Quality Standard (FDEP, 1995)
Pyrene	11000	Florida Water Quality Standard (FDEP, 1995)
VOLATILE ORGANIC COMPOUNDS		
Acetone	9.0E+06	EPA Region III BTAG screening value for freshwater (USEPA, 1995f)
Carbon disulfide	2	EPA Region III BTAG screening level (USEPA, 1995f)

*All values are for salt water unless otherwise noted

TABLE G.3-15

SEDIMENT BENCHMARK VALUES
NAS KEY WEST

Ecological Contaminants of Potential Concern	Benchmark Value	Source
INORGANICS (mg/kg)		
Antimony	12	USEPA Region IV screening level (USEPA, 1995e)
Arsenic	7.24/70	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Barium	40	Baudo et al. (1990)
Cadmium	0.676/9.6	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Chromium	52.3	Florida Sediment Quality Guideline (FDEP, 1994)
Cobalt	50	Threshold for soils (Direction des Substances Dangerous, 1988)
Copper	18.7/270	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Cyanide	0.1	ORNL sediment screening level (Hull and Suter, 1994)
Lead	30.2/218	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Manganese	460	Ontario sediment quality guideline (OME, 1992)
Mercury	0.13/0.71	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Nickel	15.9	Florida Sediment Quality Guideline (FDEP, 1994)
Silver	0.733/3.7	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Zinc	124/410	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
PESTICIDES/PCBs (µg/kg)		
4,4'-DDD	3.3/46	USEPA Region IV screening value (USEPA, 1995e)/ER-M (USEPA, 1996)
4,4'-DDE	1.22/27	Florida Sediment Quality Guideline (FDEP, 1995)/ER-M (USEPA, 1996)
4,4'-DDT	2.07/46	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Beta-BHC	5	Ontario sediment quality guideline (OME, 1992)
Delta-BHC	3	Ontario sediment quality guideline (OME, 1992)
Dieldrin	0.715/95	Florida Sediment Quality Guideline (FDEP, 1994)/USEPA Sediment Quality Criterion (USEPA, 1996)
Endosulfan I	5.4	USEPA Sediment Quality Benchmark (USEPA, 1996)
Endosulfan II	5.4	USEPA Sediment Quality Benchmark (USEPA, 1996)
Endrin	3.3/3.5	USEPA Region IV screening level (USEPA, 1995e)/USEPA Sediment Quality Criterion (USEPA, 1996)
Heptachlor	4.9	ORNL sediment screening level (Hull and Suter, 1994)
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)		
Benzo(a)pyrene	88.8/1600	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Benzo(b)fluoranthene	330/1700	ER-L/ER-M (USEPA, 1996)
Benzo(g,h,i)perylene	330/1700	ER-L/ER-M (USEPA, 1996)
Bis(2-Ethylhexyl)phthalate	182/8.9E+08	Florida Sediment Quality Guideline (FDEP, 1994)/ORNL sediment screening level (Hull and Suter, 1994)
Chrysene	384/2800	ER-L/ER-M (USEPA, 1996)
Di-n-butyl phthalate	11,000	USEPA Sediment Quality Benchmark (USEPA, 1996)
Dibenzo(a,h)anthracene	6.22/260	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Fluoranthene	113/5100	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (USEPA, 1996)
Indeno(1,2,3-cd)pyrene	655/9600	USEPA Sediment Quality Criterion (USEPA, 1996)/ER-M (USEPA, 1996)
Phenanthrene	86.7/330	Florida Sediment Quality Guidelines (FDEP, 1994)/USEPA Region IV Sediment Screening Valve (USEPA, 1995e)
Pyrene	153/2600	Florida Sediment Quality Guidelines (FDEP, 1994)/ER-M (USEPA, 1996)
VOLATILE ORGANIC COMPOUNDS (µg/kg)		
Acetone	64	ORNL sediment screening level (Hull and Suter, 1994)
Carbon disulfide	13	ORNL sediment screening level (Hull and Suter, 1994)
Cis-1,2-Dichloroethene	23	ORNL sediment screening level (Hull and Suter, 1994)
Methylene chloride	427	ORNL sediment screening level (Hull and Suter, 1994)
Tetrachloroethene	530	USEPA Sediment Quality Benchmark (USEPA, 1996)
Toluene	670	USEPA Sediment Quality Benchmark (USEPA, 1996)
Xylenes (total)	25	USEPA Sediment Quality Benchmark (USEPA, 1996)

- Each RGO section also presents comprehensive, site-specific RGOs for soil and sediment, which account for all of the same exposure pathways and intake scenarios applied in the baseline risk assessment for each site. For the residential and industrial receptors, site-specific RGOs were developed for each soil and sediment COC by altering the representative concentration that was used in the calculation of baseline cancer risk or HQ by the required proportion to yield a concentration with a target risk equal to the designated threshold of acceptable risk (1E-06 cancer risk or HQ of 1.0). These calculations incorporate current EPA toxicity factors (IRIS and HEAST, 1995) as well as appropriate site-specific intake assumptions, and were generated as follows:

$$RGO_{chemical1} = \frac{EPC_{chemical1} * TR}{CRisk_{chemical1}}$$

where:

$EPC_{chemical1}$ = Representative Concentration of a Chemical (in appropriate units: mg/kg or µg/kg)

TR = Target Risk (either a carcinogenic risk of 1E-04, 1E-05, or 1E-06; or an HQ of 0.1, 1.0, or 3.0, unitless).

$CRisk_{chemical1}$ = Calculated risk due to a Chemical (presented in Appendix A, unitless).

$RGO_{chemical1}$ = Remedial Goal (in appropriate units: mg/kg, µg/kg, or µg/L).

Each SWMU-specific RGO section contains tables providing a range of clean-up levels for carcinogenic COCs based on $1x10^{-4}$, $1x10^{-5}$, and $1x10^{-6}$ risk levels and a range of cleanup levels for noncarcinogenic COCs based on HQs of 0.1, 1.0, and 3.0. EPA (1995a) has adopted an HQ range of 0.1 to 3.0 to account for uncertainty inherent in the RfD derivation process (EPA, 1989a). The presentation of RGOs based on multiple risk levels allows the risk manager to address any site-specific factors where the use of various target risk levels within this range may be justified (for example, more conservative RGOs may apply when multiple carcinogens are present or when non-cancer effects are potentially additive, affecting the same target organs).

In comparing the usefulness of the different soil RGOs, it should be noted that all TBC values are risk-based values, but the sophistication involved in deriving the various types of TBC values varies considerably. Overall, the RCRA CAL values are the least sophisticated, considering only one route of exposure (incidental soil ingestion) and receptor (future resident). The site-specific RGOs are considered the most sophisticated and comprehensive TBC value, providing the risk manager with different values for

residential versus industrial scenarios and indicating concentrations corresponding to both non-cancer and cancer risks at three potential target risk levels. For the evaluation of sediment exposure, site-specific RGOs consider a recreational (wading) exposure scenario, while the FDEP SCGs and CAL criteria treat only surface soil exposure. For the evaluation of soil, the FDEP SCGs are of nearly comparable sophistication as the site-specific RGOs, but are not as versatile for the risk manager in the form presented because only one risk level is indicated, which is either an HQ of 1.0 or a cancer risk of 10^{-6}, whichever occurs at a lower soil concentration. Although the FDEP generic SCGs lack the use of site-specific VOC and particulate emission variables, they address the same soil exposure pathways, are based on recent toxicity data for COCs, and include different variable default values for the general worker versus resident. In addition, the resident is further divided into child and aggregate resident (part of the time as a child and part of the time as an adult), which is done in the baseline risk assessment.

Residential and industrial TBC values are relevant for SWMU 1 and 2, for which the baseline risk assessment evaluated both receptors. However, the industrial TBCs are probably more relevant for SWMU-1 and SWMU-2. The commercial and industrial worker scenarios were considered suitable because the Navy has indicated that there is little likelihood of the base being closed in the near future. SWMUs 1 and 2 are located at the airfield on Boca Chica Key, so it is not likely that the property at or near these SWMUs would be designated for residential use even if the base was unexpectedly closed.

3.3 ECOLOGICAL RISK ASSESSMENT METHODOLOGY

Ecological receptors on NAS Key West, such as aquatic and terrestrial biota, may be at risk from contaminants released from SWMUs 1, 2, 3, and 9. Accordingly, an ecological risk assessment (ERA) was performed to characterize the potential risks from SWMU-related contaminants to ecological receptors that inhabit the installation. The ERA was based on the laboratory analyses of surface soil, surface water, and sediment samples collected from each SWMU; toxicity tests performed on surface water and sediment collected from each SWMU and on soil collected from SWMU 1; on the laboratory analyses of fish collected from SWMUs 1, 2, and 3; and on the laboratory analyses of oysters collected from SWMU 9.

This section provides an outline of the general approach that was taken to assess the impacts of site contamination on aquatic biota, terrestrial biota, and the habitats that support these organisms. This assessment generally followed a two-step process, as follows:

Step 1: Preliminary Problem Formulation (Section 3.3.1.1) and Ecological Effects Characterization (Section 3.3.1.2)

- Preliminary Problem Formulation - This is the first phase of an ERA, which discusses the goals, breadth, and focus of the assessment. It includes general descriptions of NAS Key West SWMUs with emphasis on the habitats and ecological receptors present. This phase also involves characterization of contaminant sources and migration routes, evaluation of routes of contaminant exposure, and selection of ecological contaminants of potential concern (ECPCs). Assessment and measurement endpoints that will be evaluated are also selected. Finally, a conceptual model is developed that describes how contaminants associated with the four SWMUs may come into contact with ecological receptors.

- Ecological Effects Characterization - In this component, medium-specific ecological benchmarks for each ECPC (i.e., concentrations of each contaminant above which adverse effects to ecological receptors may occur) are identified. Contaminant intake doses above which potential risks may occur for selected ecological receptors are also identified or derived. This step is undertaken concurrently with the exposure assessment described below.

Step 2: Preliminary Exposure Assessment (Section 3.3.2.1) and Risk Characterization (Section 3.3.2.2)

- Preliminary Exposure Assessment - This portion of the ERA includes the identification of the data used to represent concentrations of contaminants to which ecological receptors may be exposed in various media and the actual selection of exposure point concentrations from those data. Contaminant doses are also estimated for representative species on the station.

- Risk Characterization - In this step, exposure concentrations are compared to benchmarks in order to characterize potential risk to ecological receptors of concern from contaminant exposure. Also, estimated contaminant doses are compared to doses above which adverse effects may occur. ECPCs found to pose potential risk after these comparisons are placed on a list of ecological contaminants of concern (ECCs). Toxicity testing and biological sampling performed in the ERA are also discussed and interpreted in this step. Furthermore, toxicity profiles are established that summarize the toxic effects and environmental fate of all ECCs.

When these two steps are completed, the results can be interpreted and the uncertainties associated with the ERA can be addressed. The above process, described in further detail below, represents the general approach recommended in EPA guidance (EPA, 1994b), which served as the basis for the ERA methodology (Figure G.3-2). Furthermore, the ERA was conducted in accordance with other available ERA guidance documents (EPA, 1992b; Wentsel et al. 1994), and recent publications (Suter, 1993; Calabrese and Baldwin, 1993). Due to the potential complexity of ERAs, they are often conducted using a tiered approach and punctuated with Scientific/Management Decision Points (SMDPs; G.3-2), which are

meetings involving the risk assessors, risk managers, and client to control costs, prevent unnecessary analyses, and ensure that the ERA is proceeding in an efficient, timely manner. Information analyzed in one tier is evaluated to determine whether the objectives of the study have been met and then may be used to identify the data required for the next tier, if necessary.

Screening-level risk assessments, or Tier 1 assessments, were conducted for three of the four SWMUs (SWMUs 1, 2, and 3) investigated in this ERA (IT Corporation, 1994). Based on those assessments, potential risks at SWMUs 1 and 2 were categorized as "high" and potential risks at SWMU 3 were categorized as "low." Based on the screening-level assessments and all other pertinent data and information, additional ecological study was performed in this ERA for SWMUs 1, 2, and 3. In addition, SWMU 9, the Jet Engine Test Cell, was assessed in this ERA. No previous ecological work has been performed at SWMU 9. Therefore, the screening-level risk assessments previously performed can be viewed as a Tier 1 assessment, and for the most part, the analyses in this Phase II ERA can be viewed as a Tier 2 assessment. Tier 2 and Tier 3 assessments are more focused studies that incorporate the initial screening but also encompass detailed laboratory and field studies or extensive modeling.

3.3.1 Preliminary Problem Formulation and Ecological Effects Characterization

Section 3.3.1.1 discusses the components of preliminary problem formulation, and Section 3.3.1.2 discusses the components of ecological effects characterization.

3.3.1.1 Preliminary Problem Formulation

The goal of preliminary problem formulation in this ecological risk assessment is to define a number of factors including the ecological setting, habitat types and ecological receptors, contaminant sources, contaminant release mechanisms, contaminant migration pathways, exposure routes, ecological contaminants of potential concern, assessment and measurement endpoints, and the conceptual model. These factors are all addressed in the following subsections.

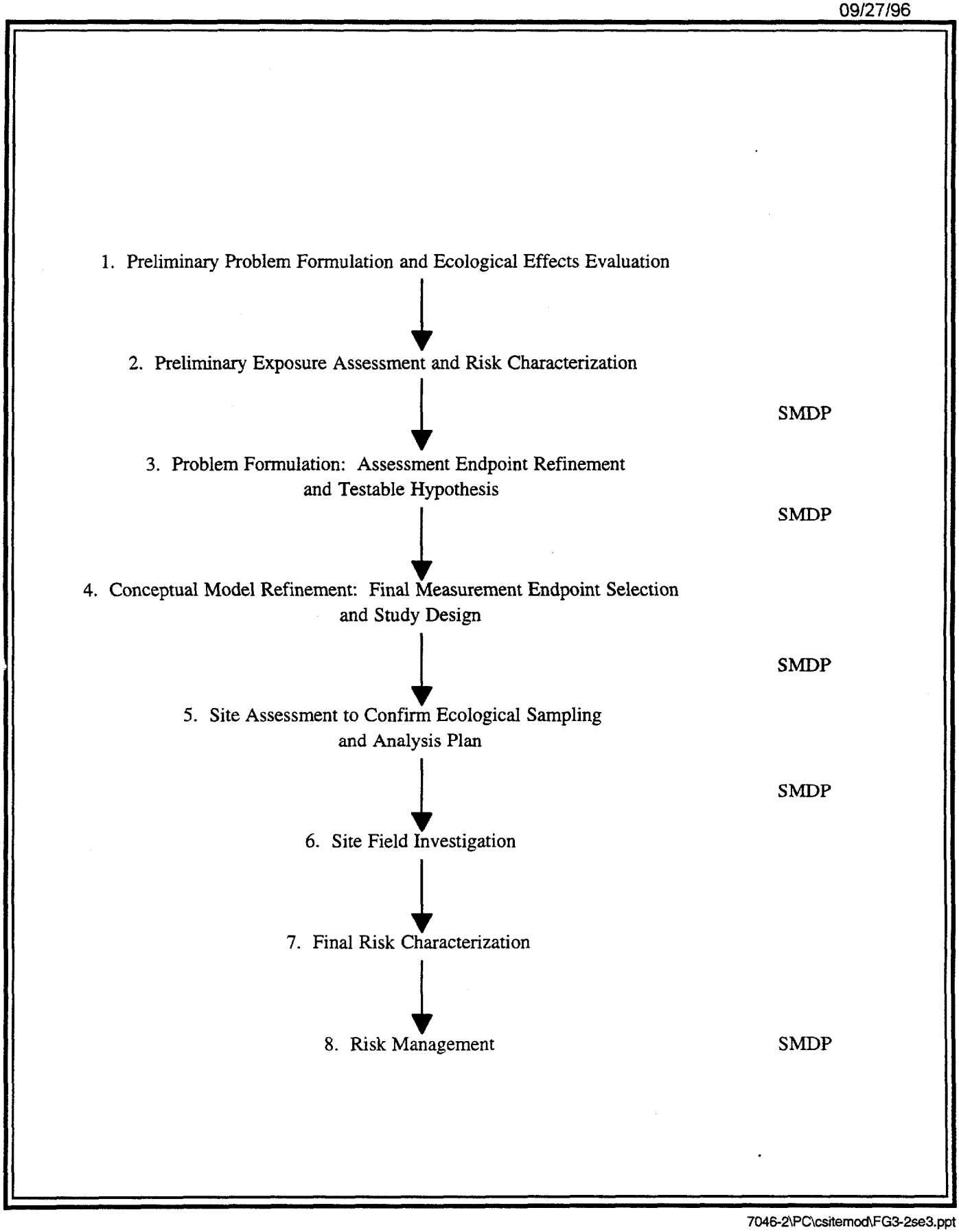


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Figure G.3-2. Steps in the Ecological Risk Assessment Process, NAS Key West, Boca Chica Key, Florida

3.3.1.1.1 Ecological Setting

The first step in preliminary problem formulation is a general NAS Key West ecological description, or site characterization, specifically detailing the ecological setting and natural resources on NAS Key West. This includes a physiographic description of the station as it relates to the overall ecological setting on the station. This description of the ecological setting at NAS Key West, specifically Boca Chica Key, is provided in Section 3.8 of the Supplemental RFI/RI Report.

3.3.1.1.2 Habitat Types and Ecological Receptors

ERAs were conducted for SWMUs 1, 2, 3, and 9 on Boca Chica Key, NAS Key West. As a result, site-specific descriptions of habitat types and ecological receptors were composed. These encompass aquatic and terrestrial habitats at each site. An evaluation of threatened and endangered species and wetlands on and around each SWMU is also provided, in accordance with Endangered Species Act (ESA) and Clean Water Act (CWA) requirements, which are applicable or relevant and appropriate requirements (ARARs). ARARs pertinent to this assessment are listed below:

- Executive Order 11988, Protection of Floodplains
- Executive Order 11990, Protection of Wetlands
- Clean Water Act, as amended (33 USC 1251 et seq.)
- Migratory Bird Treaty Act (16 USC 703 et seq.)
- Fish and Wildlife Coordination Act (16 USC 661 et seq.)/Endangered Species Act (16 USC 1531 et seq.)
- Federal Water Quality Criteria and State Water Quality Standards

3.3.1.1.3 Contaminant Sources, Release Mechanisms, and Migration Pathways

The unique nature of the four SWMUs presents several different contaminant sources, release mechanisms, and migration pathways. These items were investigated on a site-specific basis. In general, release pathways that were evaluated on the installation include combustion, volatilization, wind erosion, overland runoff, and infiltration of contaminants. Constituents in the site soil may volatilize from surficial material or become airborne via resuspension. Contaminated fugitive dust may also be generated during ground-disturbing activities, such as construction or excavation. These contaminants are dispersed in the

surrounding environment and transported to downwind locations where they may re-partition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition.

Precipitation runoff may carry constituents to nearby surface waters, sediments, and soils. Infiltrating precipitation may cause the contamination of subsurface soil and groundwater. Contaminants with a stronger tendency to adsorb to organic matter in a soil are expected to migrate at a slower rate. Upon infiltrating the soil column and reaching the water table, a contaminant may be carried with the flow of groundwater to downgradient locations. Groundwater from the site may eventually discharge to surface water; contaminants may be subsequently deposited in sediment or they may accumulate in the tissues of aquatic organisms.

3.3.1.1.4 Exposure Routes

The unique nature of the four SWMUs also results in the presence of several possible contaminant exposure routes. A brief description of general exposure routes that were investigated on a site-specific basis at NAS Key West is provided below.

Terrestrial receptors at the four SWMUs (e.g., terrestrial plants and animals) may be exposed to soil contaminants via incidental ingestion of soil and ingestion of contaminated food items. Animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation may be exposed to contaminants via direct aerial deposition and root translocation. Terrestrial receptors may also come into contact with contaminants in surface water by using surface water for drinking water, although this exposure route represents a negligible portion of total exposure for most receptors. Exposure to contaminants in the soil via dermal contact may occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize transfer of contaminants across dermal tissue.

Volatile constituents are present in some site soils, soil-bound contaminant resuspension may occur, and combustion may release contaminants into the air at some SWMUs. However, inhalation does not represent a significant exposure pathway because air contaminant concentrations are assumed to be quite low, even for burrowing wildlife. In addition, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Aquatic and terrestrial organisms inhabiting the NAS Key West area may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and

consumption of contaminated food items. Aquatic and semi-aquatic organisms may also be exposed to constituents from contaminated groundwater that flows into surface water.

3.3.1.1.5 Selection of Ecological Contaminants of Potential Concern

ECPCs were all contaminants detected in RFI/RI Phase II surface water, groundwater, sediment, and surface soil sampling at SWMUs 1, 2, 3, and 9. However, calcium, iron, magnesium, potassium, and sodium were excluded as ECPCs in all media since they are essential nutrients that are toxic only in extremely high concentrations. In addition, inorganic contaminants whose maximum detected concentration is less that two times the average background concentration were excluded as ECPCs. This comparison to background is recommended by EPA (1996) since concentrations of inorganics can be elevated naturally and not caused by base-related contaminant releases.

3.3.1.1.6 Assessment and Measurement Endpoints

As discussed in EPA (1994b) and Wentsel et al. (1994), one of the major tasks in problem definition is the selection of assessment and measurement endpoints. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (EPA, 1994b). Measurement endpoints are "measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint" (EPA, 1994b). For this ERA, the most appropriate assessment endpoint was the maintenance of aquatic and terrestrial receptor populations. Therefore, the specific objectives of this assessment were to determine if exposure to contaminants present in the surface water, sediment, and soil on and near the SWMUs are likely to result in declines in ecological receptor populations. Declines in populations could result in a shift in community structure and possible elimination of resident species from aquatic, semi-aquatic, and terrestrial environments.

As indicated above, measurement endpoints are related to assessment endpoints, but these endpoints are more easily quantified or observed. In essence, measurement endpoints serve as surrogates for assessment endpoints. While declines in populations and shifts in community structure can be quantified, studies of this nature are generally time-consuming and difficult to interpret. However, measurement endpoints indicative of observed adverse effects on individuals are relatively easy to measure in toxicity studies and can be related to the assessment endpoint. For example, contaminant concentrations that lead to decreased reproductive success or increased mortality of individuals in toxicity tests could, if found in the environment, result in shifts in population structure, potentially altering the community composition associated with the four SWMUs investigated in this ERA.

For surface water, and indirectly for groundwater, the measurement endpoints will be contaminant concentrations in surface water associated with adverse effects on growth, survival, and reproduction of aquatic organisms (surface water benchmark values), and survival and growth of aquatic organisms in surface water toxicity tests. For sediments, the measurement endpoints will be contaminant concentrations in sediment associated with adverse effects on growth, survival, and reproduction of aquatic (benthic) organisms (sediment benchmark values), and survival and growth of benthic organisms in sediment toxicity tests. For surface soils at the four SWMUs, the measurement endpoints will be contaminant concentrations in soils associated with adverse effects on growth, survival, and reproduction of terrestrial invertebrates (surface soil benchmark values), and survival and growth of terrestrial invertebrates in toxicity tests at SWMU 1. In addition, another measurement endpoint for surface soils will be the contaminant concentrations in surface soils associated with adverse effects on growth, reproduction, and survival of terrestrial plants. Furthermore, for the Lower Keys marsh rabbit (terrestrial receptor) the measurement endpoint will be the total contaminant dose associated with adverse effects on growth, survival, and reproduction. Finally, the measurement endpoint for piscivorous birds and mammals will be the contaminant concentrations in fish (prey) associated with potential adverse effects on growth, reproduction, and survival.

3.3.1.1.7 Conceptual Site Model

The conceptual model is designed to identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the SWMUs were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. Conceptual ERA models for each SWMU are presented in site-specific sections.

3.3.1.2 Ecological Effects Assessment

For this ERA, ecologically based benchmarks, concentrations of contaminants in various media protective of ecological receptors, were selected to screen exposure point concentrations of ECPCs in surface water, sediment, and soil to determine if they qualify as ECCs. In addition, modeling of contaminant intake doses for the Lower Keys marsh rabbit was also performed, and estimated doses were compared to derived reference doses (RfDs), which are doses above which potential risks may be present. Methods used for the selection of media-specific benchmarks and derivation of reference doses are provided below.

3.3.1.2.1 Selection of Surface Water Benchmarks

Actual exposures of NAS Key West aquatic receptors to ECPCs were assumed to be primarily chronic (long-term) exposures, usually at sublethal concentrations. For this ERA, benchmark values used to identify surface water ECCs were chronic screening values, primarily Federal AWQCs (EPA, 1996), Florida Water Quality Standards (FDEP, 1995), and EPA Region IV surface water screening levels (EPA, 1995e). Due to the saltwater influence on the station surface waters, saltwater benchmarks from these sources were utilized. These benchmarks are ARARs and are protective of a wide variety of sensitive species. Surface water ecological thresholds (ETs) used in this ERA and their sources are presented in Table G.3-14.

3.3.1.2.2 Selection of Groundwater Benchmarks

Although groundwater-to-surface water migration of groundwater and groundwater contaminants is possible at NAS Key West, especially since groundwater on the station is shallow, ecological receptors are not directly exposed to groundwater. Groundwater contaminant concentrations will also be diluted upon discharge to surface waters. As a result, no groundwater benchmarks have been developed based on ecological concerns. However, for this ERA, groundwater contaminant concentrations at all four SWMUs were conservatively compared to surface water benchmark values. Since groundwater at the base is, for the most part, fresh, freshwater benchmarks were utilized. Benchmarks used were primarily Florida Water Quality Standards (WQS). If WQSs were not available for some contaminants, values were gathered from EPA Region IV screening levels (EPA, 1995e) and EPA AWQC (EPA, 1996). The results of this process are presented in Table G.3-16.

3.3.1.2.3 Selection of Sediment Benchmarks

Ecological screening levels for sediment-dwelling organisms were gathered from the most widely accepted guidance. Florida Sediment Quality Guidelines (FDEP, 1994) and EPA Region IV sediment screening levels (EPA, 1995e) were preferentially used. When values were not available from these sources for some contaminants, benchmarks were obtained from most recent EPA guidance (1996), which includes EPA sediment quality criteria (SQC), EPA sediment quality benchmarks (SQB) calculated using equilibrium partitioning methods (EPA, 1996), and Effects-Range Low (ER-L) and Effects-Range Medium (ER-M) values from NOAA guidance (Long et al. 1995; Long and Morgan, 1991). Sediment benchmarks used in this assessment are presented in Table G.3-15.

TABLE G.3-16

GROUNDWATER BENCHMARK VALUES
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Benchmark Value (µg/L)	Source
HERBICIDES		
Methyl parathion	0.04	Florida Water Quality Standard for freshwater (FDEP, 1995)
INORGANICS		
Aluminum	87	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Antimony	4,300	Florida Water Quality Standard for freshwater (FDEP, 1995)
Arsenic	50	Florida Water Quality Standard for freshwater (FDEP, 1995)
Barium	3.9	Tier 2 value (USEPA, 1996)
Beryllium	0.13	Florida Water Quality Standard for freshwater (FDEP, 1995)
Cadmium	0.66	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Chromium	11	Florida Water Quality Standard for freshwater (FDEP, 1995)
Copper	6.54	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Cyanide	5.2	Florida Water Quality Standard for freshwater (FDEP, 1995)
Lead	1.32	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Manganese	80	Tier 2 value (USEPA, 1996)
Mercury	0.012	Florida Water Quality Standard for freshwater (FDEP, 1995)
Nickel	87.7	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Selenium	5.0	Florida Water Quality Standard for freshwater (FDEP, 1995)
Silver	0.07	Florida Water Quality Standard for freshwater (FDEP, 1995)
Thallium	6.3	Florida Water Quality Standard for freshwater (FDEP, 1995)
Vanadium	19	Tier 2 value (USEPA, 1996)
Zinc	58.9	USEPA Region IV screening level for freshwater (USEPA, 1995)
PESTICIDES/PCBs		
4,4'-DDT	0.00059	Florida Water Quality Standard for freshwater (FDEP, 1995)
4,4'-DDD	0.0064	Florida Water Quality Standard for freshwater (FDEP, 1995)
4,4'-DDE	10.5	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Aldrin	0.00014	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Alpha-BHC	500	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Beta-BHC	0.046	Florida Water Quality Standard for freshwater (FDEP, 1995)
Delta-BHC	500	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Gamma-BHC(lindane)	0.08	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Dieldrin	0.0019	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Endrin	0.0023	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Endosulfan I	0.056	Florida Water Quality Standard for freshwater (FDEP, 1995)
Heptachlor	0.0038	USEPA Region IV screening level for freshwater (USEPA, 1995e)
SEMIVOLATILE ORGANIC COMPOUNDS		
1,4-dichlorobenzene	15	Tier 2 value (USEPA, 1996)
1,2-dichlorobenzene	15.8	USEPA Region IV screening level for freshwater (USEPA, 1995e)
1,2,4-trichlorobenzene	44.9	USEPA Region IV screening level for freshwater (USEPA, 1995e)
1,3-dichlorobenzene	50.2	USEPA Region IV screening level for freshwater (USEPA, 1995e)
2,4-dimethylphenol	21.2	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Bis(2-ethylhexyl)phthalate	0.3	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Acenapthene	17	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Benzo(a)pyrene	0.014	Tier 2 value (USEPA, 1996)
Chloromethane	470.8	Florida Water Quality Standard for freshwater (FDEP, 1995)
Dibenzofuran	20	Tier 2 value (USEPA, 1996)
Diethylphthalate	521	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Fluoranthene	39.8	USEPA Region IV screening level for freshwater (USEPA, 1995e)

TABLE G.3-16

GROUNDWATER BENCHMARK VALUES
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Benchmark Value (µg/L)	Source
SEMIVOLATILE ORGANIC COMPOUNDS (Cont)		
Fluorene	3.9	Tier 2 value (USEPA, 1996) T2
Napthalene	62	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Phenanthrene	6.3	Ambient Water Quality Criterion (USEPA, 1996)
VOLATILE ORGANIC COMPOUNDS		
1,1,1-trichloroethane	62	Tier 2 value (USEPA, 1996)
1,1,2,2-tetrachloroethane	10.8	Florida Water Quality Standard for freshwater (FDEP, 1995)
1,1,2-trichloroethane	62	Tier 2 value (USEPA, 1996)
1,1-dichloroethane	2000	USEPA Region IV screening level for freshwater (USEPA, 1995e)
1,1-dichloroethene	3.2	Florida Water Quality Standard for freshwater (FDEP, 1995)
Benzene	71.28	Florida Water Quality Standard for freshwater (FDEP, 1995)
Bromoform	293	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Carbon tetrachloride	4.42	Florida Water Quality Standard for freshwater (FDEP, 1995)
Chlorobenzene	195	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Chloroform	289	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Cis-1,3-dichloropropene	24.4	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Ethylbenzene	453	USEPA Region IV screening level for freshwater (USEPA, 1995e)
m-Xylene	1.8	Tier 2 value (USEPA, 1996)
o+p-Xylene	1.8	Tier 2 value (USEPA, 1996)
Methylene chloride	1930	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Tetrachloroethene	8.85	Florida Water Quality Standard for freshwater (FDEP, 1995)
Toluene	130	Tier 2 value (USEPA, 1996)
Trans-1,3-dichloropropene	24.4	USEPA Region IV screening level for freshwater (USEPA, 1995e)
Trichloroethene	80.7	Florida Water Quality Standard for freshwater (FDEP, 1995)
Xylenes, Total	1.8	Tier 2 value (USEPA, 1996)

Most commonly used and widely accepted sediment benchmarks are designed to represent a very low level of risk and subsequently are inherently conservative. Therefore, a risk range was established using less conservative benchmarks when sediment contaminant concentrations exceeded the most conservative benchmarks available. For example, Effects Range-Low (ER-L) screening levels obtained from Long et al. (1995) as presented by EPA (1996) were used as most conservative benchmark values, when available. However, an ER-L is defined as the concentration below which adverse ecological "effects would rarely be observed" (Long et al. 1995). The Effects Range-Medium (ER-M) is the point below which adverse effects "would occasionally occur" (Long et al. 1995). Therefore, ascribing risk to a sediment contaminant detected in a concentration which exceeds the ER-L but is below the ER-M can be misleading. Hence, as stated above, when contaminant concentrations exceed the most conservative benchmarks available, concentrations were also compared to less conservative benchmarks, such as ER-Ms, when available, to obtain a risk range.

3.3.1.2.4 Selection of Surface Soil Benchmarks

Widely accepted and comprehensive sets of benchmark values for screening risk to terrestrial invertebrates from surface soil contaminants do not exist. While many sources have identified conservative, "safe" soil contaminant levels from a human health perspective, only a few have developed soil benchmark values with protection of ecological receptors as a goal. When available, soil benchmark values that consider impacts to ecological receptors (invertebrates) were used. The primary source of surface soil benchmark values for inorganics used in this assessment was Oak Ridge National Laboratory (ORNL) surface soil screening levels for soil invertebrates (Will and Suter, 1994a). Surface soil benchmark values for organics were primarily EPA Region III Biotechnical Assistance Group (BTAG) screening levels for terrestrial invertebrates (EPA, 1995f). Surface soil ETs utilized in this ERA are presented in Table G.3-17.

3.3.1.2.5 Selection of Terrestrial Plant Benchmarks

Benchmark values for initial screening of risk from soil contaminants to terrestrial plants were obtained from Will and Suter (1994b). However, terrestrial plant screening levels for several organics were not available from any source. The terrestrial plant benchmarks used in this ERA are presented in Table G.3-18.

TABLE G.3-17

SURFACE SOIL BENCHMARK VALUES
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminant of Potential Concern	Benchmark Value	Source
INORGANICS (mg/kg)		
Aluminum	600	ORNL soil screening level (Will and Suter, 1994)
Arsenic	60	ORNL soil screening level (Will and Suter, 1994)
Barium	440	USEPA Region III BTAG screening level (USEPA, 1995f)
Cadmium	20	ORNL soil screening level (Will and Suter, 1994)
Chromium	0.4	ORNL soil screening level (Will and Suter, 1994)
Cobalt	200	USEPA Region III BTAG screening level (USEPA, 1995f)
Copper	50	ORNL soil screening level (Will and Suter, 1994)
Cyanide	0.005	USEPA Region III BTAG screening level (USEPA, 1995f)
Lead	500	ORNL soil screening level (Will and Suter, 1994)
Manganese	100	ORNL soil screening level (Will and Suter, 1994)
Mercury	0.1	ORNL soil screening level (Will and Suter, 1994)
Nickel	200	ORNL soil screening level (Will and Suter, 1994)
Selenium	70	ORNL soil screening level (Will and Suter, 1994)
Silver	50	ORNL soil screening level (Will and Suter, 1994)
Tin	0.89	USEPA Region III BTAG screening level (USEPA, 1995f)
Vanadium	20	ORNL soil screening level (Will and Suter, 1994)
Zinc	200	ORNL soil screening level (Will and Suter, 1994)
PESTICIDES/PCBs (µg/kg)		
4,4'-DDD	100	USEPA soil screening level (USEPA, 1995e)
4,4'-DDE	100	USEPA soil screening level (USEPA, 1995e)
4,4'-DDT	100	USEPA soil screening level (USEPA, 1995e)
Aldrin	100	USEPA soil screening level (USEPA, 1995e)
Dieldrin	100	USEPA soil screening level (USEPA, 1995e)
Endosulfan I	100	USEPA soil screening level (USEPA, 1995e)
Endosulfan II	100	USEPA soil screening level (USEPA, 1995e)
Endosulfan sulfate	100	USEPA soil screening level (USEPA, 1995e)
Endrin	100	USEPA soil screening level (USEPA, 1995e)
Endrin aldehyde	100	USEPA soil screening level (USEPA, 1995e)
Endrin ketone	100	USEPA soil screening level (USEPA, 1995e)
Gamma-BHC (lindane)	100	USEPA soil screening level (USEPA, 1995e)
Heptachlor epoxide	100	USEPA soil screening level (USEPA, 1995e)
Methoxychlor	100	USEPA soil screening level (USEPA, 1995e)
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)		
Anthracene	100	USEPA soil screening level (USEPA, 1995e)
Benzo(a)anthracene	100	USEPA soil screening level (USEPA, 1995e)
Benzo(a)pyrene	100	USEPA soil screening level (USEPA, 1995e)
Benzo(b)fluoranthene	100	USEPA soil screening level (USEPA, 1995e)
Benzo(g,h,i)perylene	100	USEPA soil screening level (USEPA, 1995e)
Benzo(k)fluoranthene	100	USEPA soil screening level (USEPA, 1995e)
Chrysene	100	USEPA soil screening level (USEPA, 1995e)
Dibenzo(a,h)anthracene	100	USEPA soil screening level (USEPA, 1995e)
Fluoranthene	100	USEPA soil screening level (USEPA, 1995e)
Indeno(1,2,3-cd)pyrene	100	USEPA soil screening level (USEPA, 1995e)
Pyrene	100	USEPA soil screening level (USEPA, 1995e)

TABLE G.3-17

SURFACE SOIL BENCHMARK VALUES
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminant of Potential Concern	Benchmark Value	Source
VOLATILE ORGANIC COMPOUNDS (µg/kg)		
1,1,2,2-tetrachloroethane	300	USEPA soil screening level (USEPA, 1995e)
Cis-1,2-dichloroethene	300	USEPA soil screening level (USEPA, 1995e)
Ethylbenzene	100	USEPA soil screening level (USEPA, 1995e)
Methylene chloride	300	USEPA soil screening level (USEPA, 1995e)
Toluene	100	USEPA soil screening level (USEPA, 1995e)
Trans-1,4-dichloro-2-butene	100	USEPA soil screening level (USEPA, 1995e)
Xylenes (total)	100	USEPA soil screening level (USEPA, 1995e)

TABLE G.3-18
TERRESTRIAL PLANT BENCHMARK VALUES
NAS KEY WEST

Ecological Contaminant of Potential Concern (ECPC)	Benchmark Value (mg/kg)	Source
INORGANICS		
Aluminum	50	Will and Suter (1994)
Antimony	5	Will and Suter (1994)
Arsenic	10	Will and Suter (1994)
Barium	500	Will and Suter (1994)
Beryllium	10	Will and Suter (1994)
Cadmium	3	Will and Suter (1994)
Chromium	1	Will and Suter (1994)
Cobalt	20	Will and Suter (1994)
Copper	100	Will and Suter (1994)
Lead	50	Will and Suter (1994)
Manganese	500	Will and Suter (1994)
Mercury	0.3	Will and Suter (1994)
Nickel	30	Will and Suter (1994)
Selenium	1	Will and Suter (1994)
Silver	2	Will and Suter (1994)
Tin	50	Will and Suter (1994)
Vanadium	2	Will and Suter (1994)
Zinc	50	Will and Suter (1994)
PESTICIDES/PCBs		
Aroclor 1260	40	Will and Suter (1994)
SEMIVOLATILE ORGANIC COMPOUNDS		
Di-n-butyl phthalate	200	Will and Suter (1994)
VOLATILE ORGANIC COMPOUNDS		
Toluene	200	Will and Suter (1994)
Xylene	100	Will and Suter for plants in solution (1994)

3.3.1.2.6 Derivation of Reference Doses (RfDs)

As mentioned above, potential risks to terrestrial receptors were also evaluated by modeling the potential risks to receptors in the terrestrial foodchain. These potential risks were evaluated by estimating the total potential dose received by receptor organisms and comparing these doses to contaminant concentrations protective of these receptors (RfDs). Information on the toxicity of environmental contaminants to terrestrial wildlife is generally limited. Most information generated to date involves impacts of agricultural contaminants on non-target wildlife species; little information exists on the impact of industrial chemicals and other contaminants on ecological receptors (Opresko et al. 1994). Furthermore, much of the data that are available reflect acute effects (e.g., mortality), and interpretation of the potential effects that long-term, chronic exposure to a contaminant might have on wildlife populations is difficult. Because of these and other data limitations, species-specific NOAELs (no-observed-adverse-effects levels) for chronic exposures to a given contaminant must be derived from the results of toxicity tests performed on different species of wildlife or, more frequently, on laboratory animals.

When possible, NOAELs and LOAELs (lowest-observed-adverse-effects levels) for surrogate species were obtained from the primary literature, EPA review documents, and secondary sources such as the Registry of Toxic Effects of Chemical Substances (RTECS), the Integrated Risk Information System (IRIS) and Opresko et al. (1994). NOAELs and LOAELs represent daily contaminant dose levels normalized to the body weight of the test animals. To reduce the need to extrapolate between data and to limit the uncertainty associated with deriving NOAEL values, emphasis was placed on those studies in which reproductive and developmental endpoints were considered (i.e., toxicity test endpoints indicative of potential population-level effects). Non-sensitive endpoints are primarily non-reproductive or non-development endpoints, such as decreased organ weights or histological anomalies.

Although toxicity test data that reflected potential long-term (chronic) impacts to test organisms were preferentially sought, these types of data were not uniformly available. In order to derive NOAEL values for each of the representative ecological receptors considered in this risk assessment, a series of "Uncertainty Factors" (UFs) were applied to the available toxicity data. UFs are designed to account for the uncertainty associated with extrapolating from toxicity data experimentally obtained from one organism in order to estimate the potential toxic impact on another receptor organism, and account for the uncertainty associated with differences in test endpoints, types, parameters, as described below. The

UFs used in this ERA were based on recommended values employed by Opresko et al. (1994), and Calabrese and Baldwin (1993). The following UFs were developed to account for the uncertainty associated with:

- Extrapolating chronic endpoints from the results of acute toxicity tests (UF = 10).
- Deriving chronic endpoints from the results of tests conducted over subchronic exposure periods (UF = 10).
- Deriving endpoints that were reflective of chronic, reproductive effects from toxicity tests that used non-sensitive endpoints (UF = 10).
- Deriving NOAEL values from test results reported in terms of LOAEL values (UF = 10).
- Extrapolations of toxicity test data generated on test organisms to receptors with the same class (UF = 10).
- Extrapolations of toxicity test data generated on test organisms to receptors belonging to a different class (UF = 100).

Although no clear guidance has been developed to define what constitutes a subchronic exposure, Opresko et al. (1994) consider exposure periods of less than 50 percent of a species' lifespan to represent a subchronic exposure period for mammalian species. This same definition of subchronic exposure was used in this ERA. The derivation of RfDs for each ECPC and the receptor species considered in this ERA are summarized in Table G.3-19. These tables list the ECPC, surrogate species used in each laboratory test evaluated, the endpoint used to quantify the toxic response of the surrogate organisms, and the laboratory test result [expressed as a dose (mg/kg/day)]. The UF values applied to these test results are also listed. Using the following formula, a "total uncertainty factor," defined as the product of the reciprocals of all applicable UFs, was calculated:

$$\text{Total Uncertainty Factor (TUF)} = (1/UFa \times 1/UFb \times 1/UFc \times \ldots 1/UFx)$$

Receptor-specific RfD values were then derived by multiplying the laboratory test result by the contaminant-specific total uncertainty factor:

$$\text{Receptor-Specific RfD (mg/kg/day)} = \text{TUF} \times \text{Laboratory Test Result (mg/kg/day)}$$

TABLE G.3-19

DERIVATION OF REFERENCE DOSE (RfD) VALUES FOR THE LOWER KEYS MARSH RABBIT
NAS KEY WEST
PAGE 1 OF 3

Chemical	Test Species	Endpoint	Lab Test Result (mg/kg/day)	Acute to Chronic UF	Sub-Chronic Exposure UF	Non-Sensitive Endpoint UF	LOAEL to NOAEL UF	Species to Species UF	*Total Uncertainty Factor	**Derived NOAEL (mg/kg/day)	Source of Lab Test Result
INORGANICS											
Aluminum	Rat	Reprod.; NOAEL	5.00E+01	1	1	1	1	10	1.00E-01	5.00E+00	1
Antimony	Mouse	Longevity; LOAEL	1.25E+00	1	1	10	10	10	1.00E-03	1.25E-03	1
Arsenic	Mouse	Reprod.; LOAEL	1.26E+00	1	1	1	10	10	1.00E-02	1.26E-02	1
Barium	Rat	Growth; NOAEL	5.06E+00	1	1	10	1	10	1.00E-02	5.06E-02	1
Beryllium	Rat	Reprod.; NOAEL	6.60E-01	1	1	1	1	10	1.00E-01	6.60E-02	1
Cadmium	Mouse	Reprod.; LOAEL	2.52E+00	1	1	1	10	10	1.00E-02	2.52E-02	1
Chromium	Mouse	Reprod.; LOAEL	4.60E+00	1	1	1	10	10	1.00E-02	4.60E-02	1
Cobalt	Rat	Liver damage; LOAEL	1.57E+02	1	1	10	10	10	1.00E-03	1.57E-01	2
Copper	Rat	Reprod.; NOAEL	6.60E+01	1	1	1	1	10	1.00E-01	6.60E+00	1
Cyanide	Rat	Reprod.; LOAEL	6.87E+01	1	1	1	10	10	1.00E-02	6.87E-01	3
Lead	Rat	Kidney Damage; NOAEL	8.00E+00	1	1	1	1	10	1.00E-01	8.00E-01	1
Manganese	Rat	Reprod.; NOAEL	8.80E+01	1	1	1	1	10	1.00E-01	8.80E+00	1
Mercury	Mouse	Reprod.; NOAEL	1.32E+01	1	1	1	1	10	1.00E-01	1.32E+00	1
Nickel	Rat	Reprod.; NOAEL	4.00E+01	1	1	1	1	10	1.00E-01	4.00E+00	1
Selenium	Mouse	Reprod.; LOAEL	7.50E-01	1	1	1	10	10	1.00E-01	7.50E-02	1
Silver	Rat	Mortality; LOAEL	1.81E+02	1	10	10	10	10	1.00E-04	1.81E-02	4
Tin	Rat	Immunotox; LOAEL	5.0E+00	1	1	1	10	10	1.00E-02	5.00E-02	IRIS 1996
Vanadium	Rat	Reprod.; NOAEL	1.14E+01	1	1	1	1	10	1.00E-01	1.14E+00	3
Zinc	Rat	Reprod.; NOAEL	1.60E+02	1	1	1	1	10	1.00E-01	1.60E+01	1
PESTICIDES/PCBs											
4,4'-DDD	Rat	Reprod.; NOAEL	8.00E-01	1	1	1	1	10	1.00E-01	8.00E-02	1
4,4'-DDE	Rat	Reprod.; NOAEL	8.00E-01	1	1	1	1	10	1.00E-01	8.00E-02	1
4,4'-DDT	Rat	Reprod.; NOAEL	8.00E-01	1	1	1	1	10	1.00E-01	8.00E-02	1
Aldrin	Rat	Reprod.; NOAEL	2.00E-01	1	1	1	1	10	1.00E-01	2.00E-02	3
Alpha-BHC	Mink	Reprod.; LOAEL	1.37E-01	1	1	1	10	10	1.00E-02	1.37E-03	1
Aroclor-1260	Mouse	Reprod.; LOAEL	1.35E+00	1	1	1	10	10	1.00E-02	1.35E-02	3
Beta-BHC	Mink	Reprod.; LOAEL	1.37E-01	1	1	1	10	10	1.00E-02	1.37E-03	1
Delta-BHC	Mink	Reprod.; LOAEL	1.37E-01	1	1	1	10	10	1.00E-02	1.37E-03	1
Dieldrin	Rat	Reprod.; LOAEL	2.00E-01	1	1	1	10	10	1.00E-02	2.00E-03	

TABLE G.3-19

DERIVATION OF REFERENCE DOSE (RfD) VALUES FOR THE LOWER KEYS MARSH RABBIT
NAS KEY WEST
PAGE 2 OF 3

Chemical	Test Species	Endpoint	Lab Test Result (mg/kg/day)	Acute to Chronic UF	Sub-Chronic Exposure UF	Non-Sensitive Endpoint UF	LOAEL to NOAEL UF	Species to Species UF	*Total Uncertainty Factor	**Derived NOAEL (mg/kg/day)	Source of Lab Test Result
PESTICIDES/PCBs (cont.)											
Endosulfan I	Rat	Reprod.; NOAEL	1.50E+00	1	10	1	1	10	1.00E-02	1.50E-02	1
Endosulfan II	Rat	Reprod.; NOAEL	1.50E+00	1	10	1	1	10	1.00E-02	1.50E-02	1
Endosulfan sulfate	Rat	Reprod.; NOAEL	1.50E+00	1	10	1	1	10	1.00E-02	1.50E-02	1
Endrin	Mouse	Reprod.; LOAEL	9.20E-01	1	1	1	10	10	1.00E-02	9.20E-03	3
Endrin aldehyde	Mouse	LOAEL	9.20E-01	1	1	1	10	10	1.00E-02	9.20E-03	3
Endrin ketone	Mouse	LOAEL	9.20E-01								
Gamma-BHC (lindane)	Rat	Reprod.; NOAEL	8.00E+00	1	1	1	1	10	1.00E-01	8.00E-01	4
Heptachlor epoxide	Rat	Reprod.; NOAEL	8.00E-01	1	1	1	1	10	1.00E-01	8.00E-02	1
Methoxychlor	Rat	Reprod.; NOAEL	4.00E+00	1	1	1	1	10	1.00E-01	4.00E-01	1
Toxaphene	Rat	Reprod.; NOAEL	8.00E+00	1	1	1	1	10	1.00E-01	8.00E-01	1
SEMIVOLATILE ORGANIC COMPOUNDS											
Acetophenone		NA									
Anthracene	Mouse	No effects; NOAEL	1.00E+03	1	10	1	10	10	1.00E-03	1.00E+00	5
Benzo(a)anthracene		NA									
Benzo(a)pyrene	Mouse	Reprod.; LOAEL	1.00E+00	1	1	1	10	10	1.00E-02	1.00E-02	1
Benzo(b)fluoranthene		NA									
Benzo(g,h,i)perylene		NA									
Benzo(k)fluoranthene		NA									
Bis(2-ethylhexyl)phthalate	Mouse	Reprod.; NOAEL	1.83E+01	1	1	1	1	10	1.00E-01	1.83E+00	1
Chrysene		NA									
Dibenzo(a,h)anthracene		NA									
Di-n-butyl phthalate	Mouse	Reprod.; NOAEL	5.50E+02	1	1	1	1	10	1.00E-01	5.50E+01	1
Fluoranthene	Mouse	Reprod.; NOAEL	1.25E+02	1	1	1	1	10	1.00E-01	1.25E+01	6
Hexachlorophene	Rat	Reprod.; NOAEL	1.00E+00	1	1	1	1	10	1.00E-01	1.00E-01	IRIS 1996
Indeno(1,2-cd)pyrene		NA									
Pyrene	Mouse	Kidney Lesions; NOAEL	7.50E+01	1	10	10	1	10	1.00E-03	7.50E-02	7
VOLATILE ORGANIC COMPOUNDS											
1,1,2,2-tetrachloroethane		NA									
2-butanone	Rat	Birth weights; NOAEL	1.77E+03	1	1	10	1	10	1.00E-02	1.77E+01	IRIS 1996
2-hexanone		NA									

TABLE G.3-19

DERIVATION OF REFERENCE DOSE (RfD) VALUES FOR THE LOWER KEYS MARSH RABBIT
NAS KEY WEST
PAGE 3 OF 3

Chemical	Test Species	Endpoint	Lab Test Result (mg/kg/day)	Acute to Chronic UF	Sub-Chronic Exposure UF	Non-Sensitive Endpoint UF	LOAEL to NOAEL UF	Species to Species UF	*Total Uncertainty Factor	**Derived NOAEL (mg/kg/day)	Source of Lab Test Result
VOLATILE ORGANIC COMPOUNDS (cont.)											
Acetone	Rat	Liver/kidney: NOAEL	1.00E+02	1	1	1	1	10	1.00E-01	1.00E+01	1
Acetonitrile		NA									
Bis(2-chloroisopropyl)ether		NA									
Chlorodibromomethane	Rat	Liver hist.; NOAEL	3.00E+01	1	1	10	1	10	1.00E-02	3.00E-01	IRIS 1996
Cis-1,2-dichlorethene	Mouse	Hepatic func.; NOAEL	4.52E+02	1	10	1	1	10	1.00E-02	4.52E+00	1
Ethylbenzene	Rat	Liver hist.; LOAEL	4.08E+02	1	1	10	10	10	1.00E-03	4.08E-01	IRIS 1996
Methylene chloride	Rat	Liver hist.; NOAEL	5.00E+00	1	1	10	1	10	1.00E-02	5.00E-02	1
Toluene	Mouse	Reprod.; NOAEL	2.60E+02	1	1	1	1	10	1.00E-01	2.60E+01	3
Trans-1,4-dichloro-2-bute		NA									
Xylene	Mouse	Reprod.; NOAEL	2.06E+00	1	1	1	1	10	1.00E-01	2.06E-01	1

NA = Not Available
NT = Oral values not listed

1 Opresko et al. (1994)
2 ATSDR (1991)
3 Will and Suter (1994)
4 ATSDR (1990)
5 Calculated from IRIS (1995)
6 IRIS (1990)
7 USEPA (1989e)

UFa = Acute to Chronic
UFb = Subchronic Exposure
UFc = Non-sensitive Endpoint
UFd = LOAEL to NOAEL
UFe = Species to Species; 10 within class, 100 between classes

*Total Uncertainty Scaling Factor = (1/UFa*1/UFb*1/UFc*1/UFd*1/UFe)
**Derived Wildlife RfD = Lab Test Endpoint * Scaling Factor

3.3.2 Preliminary Exposure Assessment and Risk Characterization

Section 3.3.2.1 describes the components of preliminary exposure assessment, and Section 3.3.2.2 describes the components of risk characterization.

3.3.2.1 Preliminary Exposure Assessment

In order to perform a preliminary exposure assessment, exposure point contaminant concentrations are determined and then used in dose calculations. These elements of the preliminary exposure assessment are described below.

3.3.2.1.1 Exposure Point Contaminant Concentrations

Data used to obtain contaminant concentrations in environmental media used for this ERA were those generated from 1996 RFI/RI Phase II and previous sampling activities for SWMUs 1, 2, 3, and 9. Background data are presented for comparative purposes and were obtained from facility-wide background sampling. Facility-wide background sampling is described in detail in Appendix J of the Supplemental RFI/RI Report.

3.3.2.1.2 Dose Calculations

As discussed in Section 3.3.1.2, the potential risks to ecological receptors resulting from exposure to SWMU-related contaminants were also evaluated by estimating the total contaminant doses that organisms inhabiting the SWMU areas might receive and comparing them to doses above which adverse effects may occur. Soil contaminant concentrations were used to estimate transfer of soil contaminants to plants and plant-to-herbivore contaminant transfer. Therefore, although all relevant exposure routes are evaluated, the model is, for the most part, based on contaminant concentrations in surface soil. Generally foodchain modeling of this type is performed since soil screening benchmarks are scarce and most benchmarks available are based on potential risks to soil invertebrates. Foodchain modeling was performed for SWMUs 1 and 2 but was not performed at SWMUs 3 and 9. SWMUs 1 and 2 have sufficient terrestrial habitat, and potentially contaminated surface soil, such that receptor use of the areas could potentially be long enough to result in significant contaminant exposure. However, SWMU 3 does not contain significant terrestrial habitat, and hence, terrestrial receptor use of the area is negligible. In addition, SWMU 9 is characterized by a few solvent and fuel spills in a relatively small area of mowed grass. As a result, the area of contaminated soil is quite limited and in an area of marginal habitat, and

subsequent exposure to contaminated surface soils would be insignificant. For these reasons, terrestrial foodchain modeling at SWMUs 3 and 9 was inappropriate and unnecessary.

Criteria considered in the selection of representative terrestrial species used in the foodchain model included the relationship of the representative species to species or guilds associated with the site, consistency of potential exposure pathways with the species being selected, the recreational or aesthetic value of the species, and the probability that these representative species might be maximally exposed to site contaminants. The Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*) was selected as an herbivorous receptor species for foodchain modeling. This subspecies is listed as endangered by the Florida Game and Fresh Water Fish Commission and the U.S. Fish and Wildlife Service, and a management plan to stabilize the rabbit's population is being implemented. Historically, marsh rabbits were found from Big Pine Key to Key West, encompassing a linear distance of approximately 30 miles (Layne, 1974; Hall, 1981). At present the marsh rabbit is found on 36 patches of habitat on Big Pine Key, Saddlebunch/Sugarloaf Key, and Boca Chica Key, and the total population numbers between 150 and 400 rabbits (USFWS, 1994). The home range of this small mammal averages about 1.21 ha (USFWS, 1994). Exposure parameters used in the model are presented in Table G.3-20.

The preferred habitat of the Lower Keys marsh rabbit is an ecotonal mixture of trees and shrubs known as the buttonwood transition zone, an area dominated by grasses and sedges, with buttonwood (*Conocarpus erectus*) the dominant tree. Other habitats, such as low marsh, mangrove-dominated areas, and beach berms are also utilized. Most of these habitat types are present on and near SWMUs 1 and 2. Seashore dropseed (*Sporobolus virginicus* and *Sporobolus spartinae*), comprises the majority of the rabbit's diet, and white and red mangrove and shrub sea daisy are also common food items (USFWS, 1994); these plants are found on and near SWMUs 1 and 2. Rabbit scat was observed near both of these SWMUs during November 1995 and January 1996 site visits by B&R Environmental. Since the marsh rabbit spends most of its life in close proximity to the ground and its home range is small, it could potentially spend a significant amount of time on SWMUs 1 and 2 and could be in contact with potentially contaminated surface soil.

Generally, one or more herbivorous receptors and at least two predators (one avian, one carnivorous mammal) are selected as representative species for terrestrial foodchain modeling. However, native carnivorous mammals at Key West are limited to the raccoon (an omnivore). Additionally, avian predators that feed primarily on terrestrial species are largely absent from the Keys. For example, red-tailed hawks are rare migrants during the winter and are absent during the breeding season, and red-shouldered hawks are uncommon in the Keys. Thus, the lack of terrestrial predators precludes the use of foodchain

TABLE G.3-20

EXPOSURE PARAMETERS FOR THE LOWER KEYS MARSH RABBIT (*SYLVILAGUS PALUSTRIS HEFNERI*) NAS KEY WEST

Parameter	Value	Reference
Body Weight	1,224 grams	U.S. Fish and Wildlife Service (1994)
Water Ingestion	110.0 grams/day	Estimated from Calder and Braun (1983)
Food Ingestion	95.9 grams/day	Estimated from Nagy (1987)
Soil Ingestion	6.3% of diet	Based on jackrabbit diet (USEPA, 1993b)
Home Range	1.21 ha	U.S. Fish and Wildlife Service (1994)

modeling of this guild. For this reason, the Lower Keys marsh rabbit was the only terrestrial receptor chosen as a representative species for foodchain modeling. The relatively depauperate mammal species diversity at NAS Key West is discussed in detail in Section 3.8.2 of the Supplemental RFI/RI Report.

For the model utilized in this ERA, contaminant concentrations in vegetation were first estimated from soil contaminant concentrations. The concentration of a contaminant in vegetation is a function of both aerial deposition on the plant surfaces and the root uptake of contaminant from soil. Airborne contamination was not considered to be a factor on the station. Therefore, only concentrations of contaminants measured in soil were used to estimate plant contaminant concentrations. Maximum soil contaminant concentrations were used as conservative exposure point contaminant concentrations. However, since the use of maximum concentrations may tend to overestimate risk, mean measured concentrations in soil were also used to estimate plant contaminant concentrations to obtain a risk range.

The concentration of a contaminant in vegetation due to root uptake is a function of the soil concentration and a contaminant-specific soil-to-plant biotransfer factor (partitioning coefficient). Methods developed by the California Air Pollution Control Officers' Association (CAPCOA, 1993) were adapted to calculate uptake of contamination by plants from soil through the following formula:

$$PC_{vegetation} = C_{soil} \times BF$$

where:

$PC_{vegetation}$	=	Predicted concentration in vegetation
C_{soil}	=	Concentration in soil
BF	=	Soil-to-plant Biotransfer Factor

Contaminant concentrations in vegetation predicted with these models were used to represent potential contaminants present in the food items of the Lower Keys marsh rabbit.

3.3.2.1.2.1 Calculating Dose Received from the Ingestion of Vegetation

Transport of contaminants through the food chain to terrestrial ecological receptors is a potential concern at this facility. The equation used to estimate contaminant intake from ingestion of contaminated food items is as follows:

$$PD_{ingestion\ of\ vegetation} = \frac{PC_{vegetation} \times F \times FV \times FI \times AF}{WR \times CF}$$

where:

PD = Predicted dose from ingestion of food items (vegetation; mg/kg/day)

PC = Predicted contaminant concentration (vegetation; mg/kg)

F = Food consumed (mg/day)

FV = Vegetation as a fraction of diet

FI = Fractional intake (percent of home range that overlaps impacted area; assumed to equal 100 percent)

AF = Absorption fraction (unitless)

WR = Weight of receptor (kg)

CF = Conversion factor (kg to mg)

In addition, an absorption fraction of 80 percent was used (i.e., 80 percent of the ingested contaminant was absorbed) for the intake dose calculations described below. Actual absorption fractions range widely for most animal species (Bonaccorsi et al. 1984). Once ingested, the bioavailabilty of a contaminant depends upon a variety of factors, including physiochemical properties of the contaminant, the physiological characteristics of the organism, and other general factors such as age, sex, or disease state of the individual (Hrudey et al. 1996). Although limited, available data for oral exposure to rabbits indicate that absorption of metals can be as low as 24 percent (arsenic; Freeman et al. 1993) and absorption of organics have been reported at levels of 48 percent for phenol (Capel et al. 1972) and 29 to 68 percent for TCDD (Bonaccorsi et al. 1984). Thus, based on available data, the absorption factor of 80 percent used for the Lower Keys marsh rabbit in this assessment is probably still a conservative value for this parameter.

3.3.2.1.2.2 Calculating Dose Received from the Incidental Ingestion of Soil

The estimation of intake of contaminants in soil was determined using the maximum and mean measured soil concentration of a given contaminant. Daily intake of contaminants as a result of ingestion of soil was determined using the following equation:

$$PD_{ingestion\ of\ soil} = \frac{PC_{soil} \times FI \times SA \times AF \times F}{WR \times CF}$$

where:

PD = Predicted dose from ingestion of soil (mg/kg/day)

PC = Predicted contaminant concentration in soil (mg/kg)

FI = Fractional intake (percent of home range that overlaps impacted area; assumed to equal 100 percent)

SA = Percent of diet that equals soil

AF = Absorption fraction (unitless)

F = Food consumed (mg/day)

WR = Body weight (kg)

CF = Conversion factor (kg to mg)

3.3.2.1.2.3 Calculating Dose Received from the Ingestion of Water

Marsh rabbits are believed to need little fresh water to survive (USFWS, 1994). Marsh rabbits are found on several isolated islets that consist of only mangroves and small upper marsh areas, and were found to have one of the highest urinary concentrating capabilities of all mammals found in the Florida Keys (Dunson and Lazell, 1982). It is possible that marsh rabbits can survive solely on dew and herbaceous water, and perhaps brackish water. Therefore, exposure to contaminants in surface water is assumed to be negligible, and the calculation of contaminant dose from the ingestion of water was not performed.

3.3.2.2 Risk Characterization

As identified by EPA (1994b), the second step in the ecological risk assessment process compares representative exposure point contaminant concentrations with benchmarks and estimated contaminant intake doses to reference doses. Once this step was completed for this study, the results were reviewed to determine whether little or no ecological risk is associated with activities at the four SWMUs or additional information must be generated to verify that ecological receptors are at risk. The ratio of the exposure point contaminant concentration to the benchmark value or the intake dose to the RfD is called the hazard quotient (HQ), and is defined as follows:

$$HQ_i = EPC_i \text{ or } ID_i/BTV_i \text{ or } RfD_i$$

where:

HQ_i = Hazard Quotient for contaminant "i" (unitless)

EPC_i = Exposure Point Concentration for contaminant "i" (mg/L or mg/kg)

BTV_i = Benchmark Toxicity Value for contaminant "i" (mg/L or mg/kg)

ID_i = Intake Dose for contaminant "i" (mg/kg/day)

RfD_i = Reference Dose for contaminant "i" (mg/kg/day)

When the ratio of the exposure point concentration to its respective benchmark value exceeded 1.0, potential adverse impacts were considered possible, and the contaminant was retained as an ECC. The HQ value should not be construed as being probabilistic; rather, it is a numerical indicator of the extent to which an exposure point concentration exceeds or is less than a benchmark. When HQ values exceed 1.0, it is an indication that ecological receptors are potentially at risk; additional evaluation or data may be necessary to confirm with greater certainty whether ecological receptors are actually at risk, especially since most benchmarks are conservatively derived, as discussed in Section 3.3.1.2. Furthermore, other factors, such as low frequency of detection, may mitigate potential risks for an ECC with an elevated HQ value. As a result of the conservatism inherent in most benchmark derivation, EPA Region III (1994d) has suggested that HQs greater than one are indicative of low to moderate potential risk; HQs greater than 10 are indicative of moderately high potential risk; and HQs greater than 100 are indicative of high potential risk.

The use of HQs is probably the most common method used for risk characterization in ERAs. Advantages of this method, according to Barnthouse et al. (1986), include the following:

- The HQ method is relatively easy to use, is generally accepted, and can be applied to any data.
- The method is useful when a large number of contaminants must be screened.

This method of risk characterization has some inherent limitations. One primary limitation is that it is a "no/maybe" method for relating exposure to toxicity. That is, it uses single values for exposure concentrations and benchmark values and does not account for the variability in both these parameters nor for incremental or cumulative toxicity.

The comparisons described above are presented in site-specific screening tables to select ECCs in each individual SWMU assessment section. Screening tables are presented for each applicable medium at each site and watershed. Sediment screening tables present most and less conservative benchmark comparisons to exposure point concentrations if the most conservative value was exceeded and a less conservative value was available. As a result, two HQ values are presented in these instances. Due to the heavy conservatism in most benchmarks initially utilized, ECPCs were retained as ECCs if the most conservative benchmark values were exceeded but, as mentioned above, a less conservative benchmark (e.g., an ER-M for sediment) was provided for comparison, if available. When only one benchmark was available, only one HQ is presented. Background values are also presented for comparative purposes on screening tables. These values need to be taken into account when making risk management decisions, since concentrations of inorganic contaminants can be naturally elevated and exceed screening values. In these instances toxic effects may be ameliorated by site-specific physical or chemical conditions. Although contaminants were not screened out based on background concentrations in this ERA, qualitative discussion is provided when inorganic contaminants that were retained as ECCs were present in concentrations comparable to background.

Hazard quotients for foodchain modeling were summed for all exposure routes for each contaminant. Contaminant-specific HQs were then summed to obtain a hazard index (HI) for the foodchain model receptor species. Quantitatively the HI can be interpreted in much the same manner as the HQ. Results of foodchain modeling are summarized on tables for each site which present the HI value and the five ECPCs that contribute the most to the HI. These tables also present the percentage of total dose received by each exposure route.

Some contaminants were present in some media for which no suitable benchmark values were available. In these instances, these contaminants were conservatively retained as final COPCs and qualitatively assessed. Since calcium, iron, magnesium, potassium, and sodium are essential nutrients and only toxic at extremely high doses, they were initially excluded as COPCs in all media. Also, toxicity profiles describing the environmental fate, transport, and toxicities of all final COPCs in all media were developed, and are presented in Appendix D.

3.3.2.2.1 Toxicity Tests

As discussed in Section 1.4.2, toxicity tests were performed on surface water and sediment samples collected at SWMUs 1, 2, 3 and 9, and on soil samples collected at SWMU 1. The same tests were conducted on samples collected from three background sites, and on laboratory control samples.

Results of the toxicity tests suggest that all three background sites appear to have been impacted to some degree by previous activities on Boca Chica Key. Thus, to interpret the results of the toxicity tests, the test results using SWMU-related samples were compared to the results of tests conducted using laboratory controls. Test methods and results are provided in detail in Appendix F of the Supplemental RFI/RI Report.

3.3.2.2.2 Tissue Analyses

Tissue analyses were conducted on fish collected from SWMUs 1, 2, and 3, and on mangrove oysters collected from SWMU 9. Results of the tissue analyses were compared to concentrations in fish and mangrove oysters collected concurrently from three background sites on Boca Chica Key, and to values considered to be protective of piscivorous (fish eating) wildlife species.

3.3.3 Uncertainty Analysis

Uncertainty is associated with all aspects of the ERA process. This section provides a summary of the uncertainties involved in this ERA, with a discussion of how they may affect the final risk values and conclusions. Once an ERA is complete, the results must be reviewed and evaluated to identify the types and magnitudes of uncertainties involved. Relying on results from a risk assessment without consideration of uncertainties, limitations, and assumptions inherent in the process can be misleading. If numerous conservative assumptions are combined in the ERA process, the resulting calculations will propagate the uncertainties associated with each of those assumptions. The resulting bias is toward

overpredicting risks. Thus, both the results of the risk assessment and the uncertainties associated with those results must be considered when making risk management decisions.

Generally, risk assessments carry two types of uncertainty: measurement and informational. Measurement uncertainty refers to the variability inherent in measured data. The risk assessment reflects the accumulated variances of the individual values used for several different parameters. Informational uncertainty stems from the limited availability of necessary information. Often the gap between what is needed and what is available is significant; information regarding the effects of some contaminants on wildlife receptors, the biological mechanism of a contaminant, the impact of physiological differences on exposure pathways, or the behavior of a contaminant in various environmental media is often absent. Uncertainty is associated with each of the steps of the risk assessment process:

- Uncertainty in preliminary problem formulation can result from limited information regarding contaminant sources, release mechanisms, and exposure routes.
- Uncertainty in the ecological effects characterization arises from the quality of the existing benchmark values and toxicity data to support a determination of potential adverse impacts to ecological receptors.
- Uncertainty associated with the exposure assessment includes the methods used and the assumptions made to determine exposure point concentrations and calculate contaminant intake doses.
- Uncertainty in risk characterization includes that associated with the potential effects of exposure to multiple contaminants and the cumulative uncertainty from combining conservative assumptions made in earlier activities.

3.3.3.1 Uncertainty in the Preliminary Problem Formulation

Some of the SWMUs investigated in this ERA, mainly SWMUs 3 and 9, receive contaminant inputs from more than one source, although initially contaminants are assumed to stem directly from SWMU-related activities. Since contaminant concentrations may reflect inputs from many sources, uncertainties exist regarding whether risk characterized at a discrete site stems from site-related contaminants. This was of particular importance while assessing impacts to SWMUs 3 and 9. SWMU 3 is situated on a large lagoon that is partially surrounded by taxiways and runways. SWMU 9 is located on an inlet that leads directly to ocean water. As a result, contaminants detected in surface water, sediment, and biota at this site may stem from distant sources.

Uncertainty also arises when different release mechanisms are present. Contaminants at some of the SWMUs may released from their sources only during specific events (e.g., certain contaminants may be released from SWMU 1 soils only after becoming inundated with surface water). As a result, risks may be over- or under-estimated if the information regarding these parameters is scarce or unknown. Also, different sites and their contaminants may possess different contaminant exposure routes for ecological receptors. Difficulties and limitations exist in trying to obtain exposure routes for individual sites for individual receptors. Since exposure routes may be quite different for different species, risk may be over- or under-estimated if this information is not known.

3.3.3.2 Uncertainty in the Ecological Effects Characterization

A great deal of uncertainty in this risk assessment arises from the nature and quality of the available toxicity data used to derive benchmark values and reference doses. This uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose related; when postulated mechanisms of toxicity are similar for laboratory and wildlife species; and when the contaminant of concern is structurally similar to other contaminants for which the toxicity is more completely characterized. Most benchmark values are based on the most conservative assumptions possible. As such, though an inherent level of conservatism is needed in a ecological risk assessment to ensure that the most sensitive receptors are protected, these screening levels may grossly overestimate potential risks and the resulting HQ values may be misleading. As discussed earlier, both AWQC and most sediment screening values used in this assessment are based on laboratory studies that do not take into account mitigating physical and chemical properties in the environment. Therefore, uncertainty is introduced into the assessment, and the results tend to overestimate potential risks. To account for this, less conservative sediment benchmark values are presented (when available) with the most conservative benchmarks, but they cannot fully reduce the associated uncertainty.

In addition, ERAs, unlike human health risk assessments, must consider risks to many different species. However, calculation of risk values for each potential receptor species is not possible. For this ERA, conservative screening values protective of a wide range of ecological receptors were sought. The underlying assumption associated with the use of these benchmarks is that contaminant concentrations in excess of these screening levels are indicative of potential impacts to actual receptors inhabiting the area. However, species-specific physiological differences that may influence an organism's response to a contaminant or subtle behavioral differences that may increase/decrease a receptor's contact with a contaminant are seldom known. Also, some contaminants were present in some media for which no suitable screening levels were available. This was especially true for terrestrial plant benchmarks for

organic contaminants. Although plants do not generally translocate organics to the extent that they translocate metals, terrestrial plant benchmarks were only available for a few contaminants, and hence, the potential risks to plants from organics in soils could not be fully assessed. Benchmark contaminant concentrations in fish that are protective of piscivorous birds and mammals were also used in this assessment. These types of benchmarks are also scarce and must be gathered from several sources in the primary literature. Most of the benchmarks that were available were based on one or a few studies, and are generally conservatively derived. For these reasons, the use of benchmark screening values, while necessary, will introduce error into the results of an assessment.

For RfD derivation, as described above, all available data were gathered for calculating doses for all contaminants to which the Lower Keys marsh rabbit may be exposed. However, toxicological data for rabbits or other lagomorphs are scarce. As a result, extrapolations were made using toxicity data from studies which used other small mammals as a test species. Extrapolations from acute toxicity tests were also made to derive chronic toxic doses. For these and other parameters, uncertainty factors were employed to generate a sufficient level of conservatism in the foodchain model. Since toxicity data were scarce for several contaminants, a large number of uncertainty factors had to be employed. In some of these instances, the resulting risk numbers (HIs) were greatly increased. Therefore, the increased risk numbers may more a result of a lack of toxicity data than to potential risks, and potential risks may be overestimated.

3.3.3.3 Uncertainty in the Exposure Assessment

Uncertainty in the exposure assessment arises mainly in the methods used to obtain exposure point concentrations. The maximum detected contaminant concentration was used to represent contaminant concentrations to which ecological receptors might be exposed. If the samples evaluated in this ERA are representative of contaminant concentrations associated with the station, then this approach is conservative and should overestimate potential risks to ecological receptors. The maximum concentration of a contaminant in a given medium may have been collected in a "hot spot" of contamination, and may be much higher than the remaining values in the data set. This was the case for contaminants in various media at several sites. Again, although use of maximum values is appropriate for screening in an ERA, they may overpredict potential risks.

Uncertainties also exist in the calculation of contaminant intake doses for the Lower Keys marsh rabbit. To help reduce some of these uncertainties, the foodchain model was run using both maximum and mean soil contaminant concentrations. However, only single values could be used for several of the input parameters used in the model. Specifically, it was assumed that the rabbit absorbed 80 percent of all

contaminants ingested. Data do not exist regarding absorption rates of most contaminants for wildlife receptor species. The value of 80 percent for all contaminants is assumed to be sufficiently conservative based on a review of available literature, but absorption of different contaminants may vary greatly, and varies between species. Several of the contaminants used in the model may have absorption rates much less than 80 percent, which would result in an overprediction of risks. The marsh rabbit was also conservatively assumed to forage 100 percent of the time on the contaminated areas of SWMUs 1 and 2. Since portions of the SWMUs contain little or marginal habitat, and since neither of the SWMUs are not extremely large in areal extent, it is highly unlikely that the marsh rabbit spends 100 percent of its time foraging on the SWMUs. Again, this tends to overpredict risk. Moreover, some of the other input parameters, mainly soil and food ingestion rates, were only available for other rabbit species. Although the differences in parameters between these rabbit species and the marsh rabbit are not expected to be great, some uncertainty is still inherent.

The surface water, sediment, and surface soil samples used for toxicity tests in this ERA may also introduce uncertainty in the results. Samples that were collected at each SWMU were assumed to be representative of site-specific conditions. Although representative sampling sites were selected carefully, surface water, sediment, or surface soils samples could potentially have contaminant concentrations that are not representative of the SWMU-specific conditions, and would result in variability in the toxicity test results. Also, toxicity test species were chosen based on their usefulness as surrogate species for site-specific receptors. Test species that were commonly used in toxicity tests and were representative of the types of receptors at each SWMU were selected. Although the physiology of test species was not assumed to differ significantly from resident species, species-specific sensitivities to contaminants most likely exist.

3.3.3.4 Uncertainty in the Risk Characterization

Uncertainty in the risk characterization is affected by all aspects of the ERA process described in Section 3.3.2.2. Uncertainty in risk characterization also stems, in part, from the fact that this process does not consider antagonistic or synergistic effects. Little or no information is available to determine the potential for antagonism or synergism for the contaminants evaluated. For foodchain modeling HQs were summed to generate HIs, which were used to interpret total potential risk. However, the HI is only a linear, arithmetic measure of total potential risk. Additive risks may actually increase, or even decrease, geometrically based on synergistic or antagonistic effects. Additionally, contaminants that account for a large percentage of risk may be mitigated by several factors, including a low frequency of detection. For these reasons, the HI can be used a rough estimate to total risk, but contains uncertainty and must be interpreted with caution.

3.3.4 Ecological Risk Assessment Approach Summary

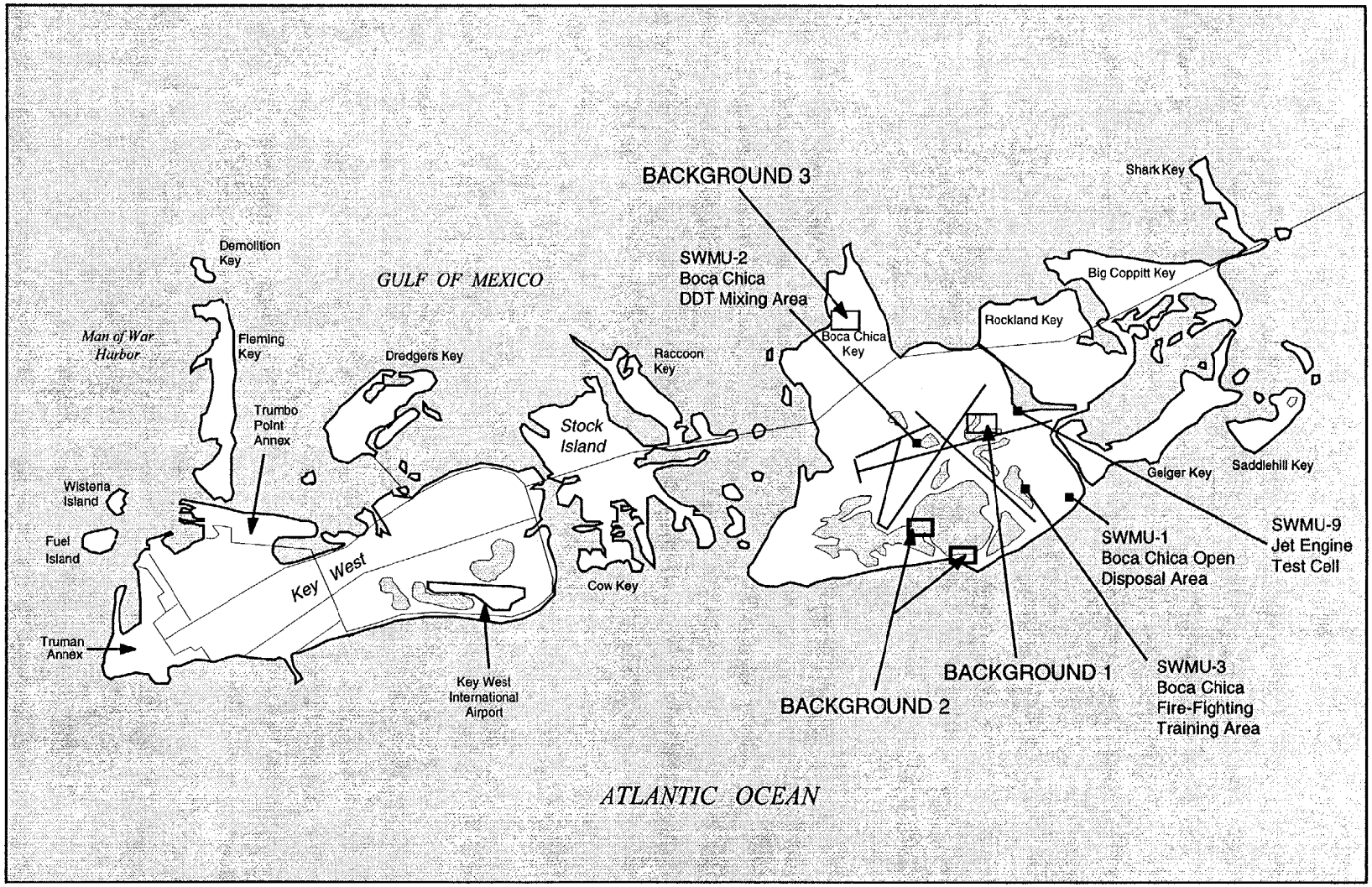
IT Corporation conducted screening-level ERAs at SWMUs 1, 2, and 3. Based on the results of those ERAs, additional RFI/RI Phase II ecological risk assessment was performed for those three SWMUs, along with SWMU 9. As part if Phase II investigations, the maximum exposure point concentrations for contaminants in surface water, groundwater, sediment, and surface soil were compared to ecological screening values that are protective of ecological receptors to assess potential risk to aquatic and terrestrial organisms. ECPCs were retained as ECCs if exposure point contaminant concentrations exceeded screening values, and the ratio of the two values is defined as the hazard quotient. In addition, modeling of contaminants in the foodchain was conducted for SWMU 1 and SWMU 2, and toxicity testing and biological sampling was performed at all SWMUs. Results are summarized for each SWMU in each individual site-specific section. Interpretation of the results and recommendations for remedial action, further ecological study, or no further study based on ecological risk concerns are also presented in those sections. A weight-of-evidence approach was used to determine the potential for risk at each SWMU using all of the analyses described above, with weighting dependent on the best use of the data, the apparent quality of the data, and the nature and magnitude of associated uncertainties.

4.0 DETERMINATION OF BACKGROUND LEVELS

This section summarizes the process used to calculate background levels by using chemical-analytical and toxicity data from the background samples collected on Boca Chica Key, Florida. Background characterization included an evaluation of soil, surface water, sediment, groundwater, and biota. The range of concentrations was evaluated using the outline specified in current EPA RCRA guidance documents. Representative base-wide background values were then calculated for use in determining whether contaminant concentrations at the sites currently under investigation exceed background at Boca Chica Key. Determining background conditions is necessary for defining the nature and extent of contamination, completing the human health and ecological risk assessments, and supporting the feasibility study of remedial alternatives. Appendix J provides a more complete discussion of the background sampling methodology and results.

Background soil, sediment, surface water, groundwater, and biological samples were collected from a number of locations to determine the natural range of inorganics found in Boca Chica Key. Figure G.4-1 shows the three background locations as BG-1, BG-2, and BG-3. Samples from these locations were analyzed for inorganics, pesticides, PCBs, herbicides, semivolatile organic compounds (SVOCs), and VOCs. The VOC analyses were used as a secondary tool to confirm that the background sample locations were not impacted by past activities at the base because it is assumed that there are no naturally occurring VOCs at Boca Chica Key. Biological samples were obtained to determine the naturally occurring concentrations of chemicals in tissue, particularly fish and oysters.

Finally, toxicity tests were conducted with surface water, sediment, and soil samples. In general, acute exposure toxicity tests expose groups of test organisms to environmental samples and laboratory controls for a specified period to assess potential impact on survival. The survival data are used to determine the relative toxicity of the samples compared to the laboratory standards and field reference sites. Chronic toxicity tests measure sublethal effects, growth, through exposing test organisms to samples during a sensitive period in the life cycle. In both acute and chronic exposure tests, analysis of the data can be carried out using Analysis of Variance techniques to determine if the test sediments and soil had a significant impact on these variables when compared to a control sediment. Surface waters were evaluated using a series of acute, 2-hour, 48-hour, and 96-hour assays conducted with mysid shrimp (*Mysidopsis bahia*), silverside minnow (*Menidia beryllina*), mussel (*Mytilus edulis*), and sea urchin (*Strongylocentrotus franciscana*). Sediments were evaluated by conducting a 14-day assay using mysid shrimp (*Mysidopsis bahia*) and an amphipod (*Hyalella azteca*). Soils were evaluated using earthworms (*Eisenia foetida*).



Brown & Root Environmental

0 1.5 3.0

Scale in Miles (Approximate)

FIGURE G4-1. NAS KEY WEST HIGH PRIORITY INSTALLATION RESTORATION SITES

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: LHO	SCALE:	DATE: 02/06/97	REV.
CHECKED BY:	CONTRACT NO.:	FILE NAME: 7046-28PC/Mod-0BG\FG4-1NKW.cdr	

Toxicological and analytical protocols used in this background study followed procedures outlined in *Methods for Measuring the Acute Toxicity of Effluent and Receiving Water to Freshwater and Marine Organisms. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (EPA 1994c), *Protocol for Short Term Toxicity Screening of Hazardous Waste Site* (EPA 1989c), *Aquatic Toxicology and Risk Assessment: Thirteenth Volume* (Ingersoll & Nelson, 1990), *Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates* (ASTM 1991), and *Standard Methods for the Examination of Water and Wastewater* (APHA 1989). These procedures provide standard approaches for the evaluation of acute and chronic toxicological effects of surface waters and sediments on aquatic organisms and for the analysis of water samples. Additional information regarding the toxicity testing performed during the Supplemental RFI/RI is contained in Appendix F.

4.1 TECHNICAL APPROACH

The background values were calculated using several different statistical operations to derive a single background value for each analyte of interest. The methodologies described in this section are based on three EPA guidance documents: Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance (EPA, 1989d); Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance (EPA, 1992c); and Statistical Training Course for Groundwater Monitoring Data Analyses (EPA, 1992e). Although these statistical documents are intended as guidance for RCRA compliance monitoring, they contain statistical methods that are appropriate for determining a single-point representative background concentration for each chemical evaluated. In addition, Statistical Methods for Environmental Pollution Monitoring (Gilbert, 1987) describes the data distribution tests that were used.

The statistical reference documents suggest constructing a one-sided tolerance interval that estimates the upper bound on a large fraction of the concentration distribution. This Upper Tolerance Limit (UTL) is referenced in the RCRA groundwater guidance documents as an approved method for comparing background monitoring data to compliance wells. This method is also applicable to determining representative concentrations from the background data sets. For both soil and groundwater the UTL was used to predict the upper range of background concentrations from a relatively small data set. A number of procedures and tests were used to calculate the UTL. The UTL was designed for use on data that consist mainly of positive detections, so nondetect data were evaluated first and then manipulated in one of three ways, depending upon the percentage of nondetects within the sample population. The UTL assumes an underlying normal or lognormal distribution; therefore, all data were tested for normality (after screening for nondetects) before calculation of the UTL. Section 4.1.1 through 4.1.4 describe specific procedures used to evaluate the background data.

4.1.1 Upper Tolerance Limit

QA/QC samples were collected during the background sampling to ensure that DQOs were met. Included in these QA/QC samples were duplicates for some of the borings and wells. Duplicate samples represent valid measurements at a site, but using both an environmental sample and its duplicate as separate data points would bias the UTL to that one location. The background samples, therefore, were averaged with their duplicates, and the average value was used as a single data point in calculating the background values.

The percentage of nondetect values (data with "U" or "UJ" qualifiers) was calculated for each data set to determine the statistical method used to obtain the background value. It should be noted that rejected values (values reported with "R" data qualifiers) were excluded from all calculations. The following procedures were followed for handling nondetects:

- If fewer than 15 percent of all samples of a data set were nondetects, each nondetect was replaced by half its detection limit. The distribution of each data set was then determined. Depending on the distribution, the UTL was then calculated for either the original data or the log-transformed data.
- If the percentage of nondetects was between 15 percent and 50 percent, the Cohen's adjustment was made to the sample mean and standard deviation so as to continue with a parametric UTL.
- If the percentage of nondetects was between 50 percent and 100 percent, a nonparametric UTL (i.e., a tolerance limit not based on a normal or lognormal distribution) was used. The greatest detected value observed in the data set was used as the nonparametric tolerance limit.
- If 100 percent of all samples were nondetects, a nonparametric UTL was also used. The highest detection limit observed in the data set was used as the nonparametric tolerance limit. The result was marked with a footnote to indicate that it represented a detection limit and not a detected value.

4.1.2 Testing of Data Distribution

The Shapiro-Wilk test was used for testing the normality of a data set. The Shapiro-Wilk test is based on the premise that if a set of data is normally distributed, the ordered values should be highly correlated with corresponding quintiles taken from a normal distribution (Gilbert, 1987). The Shapiro-Wilk test statistic, W, will tend to be large when a probability plot of the data indicates a nearly straight line. Only when the plotted data show significant bends or curves will the test statistic be small. Normality (or lognormality of

transformed data) was rejected if the Shapiro-Wilk test statistic was too low when compared to the critical values provided in a table of Shapiro-Wilk percentage points.

Some compounds tested positive for both normal and lognormal distributions because of the relatively small sizes of the data sets. For cases in which this condition occurred, the distribution was based on the value of the test statistic, W. A higher value of W indicates a more normal distribution of the data examined (whether original data or log-transformed data), so the test with the higher value was considered to indicate the distribution that was the closer fit to the data.

4.1.3 Descriptive Statistics

A set of descriptive statistics was calculated for each parameter in each appropriate data group. Descriptive statistics included minimum values, maximum values, arithmetic mean, standard deviation, one-sided 95 percent Upper Confidence Limit (UCL), and one-sided 95 percent Upper Tolerance Limit (UTL). The formulas used to calculate each of these statistics are included in Attachment A. If the UCL exceeded the maximum detected value for a data group, then the maximum value was considered representative of the data set.

A tolerance interval was constructed from the background data set to establish a basis for determine the presence of contamination in sample that were obtained from the SWMUs. A tolerance interval establishes a concentration range that contains a specified proportion of the population with a specified confidence coefficient, Y. The proportion of the population included, P, is referred to as the coverage, and the probability with which the tolerance interval includes the proportion P percent of the population is referred to as the tolerance coefficient. Only the upper limit was calculated instead of the entire interval because contamination at another location is indicated when its concentration exceeds the upper limit of the tolerance interval.

A coverage of 95 percent was used in these calculations. This means that random observations from the same distribution as the background data would exceed the UTL less than 5 percent of the time. Similarly, a tolerance coefficient of 95 percent was used. This means that one has a confidence level of 95 percent that the UTL will contain at least 95 percent of the observations from background data.

The UTL was calculated using the equation $UTL = x^* + KS$, where x^* is the mean of the data, K is the one-sided normal tolerance factor, and S is the standard deviation. The tolerance intervals were constructed assuming that the data or the log-transformed data are normally distributed; therefore, the appropriate distribution indicated by the Shapiro-Wilk tests was used for the calculation.

Cohen's adjustment was used to adjust the means and standard deviations of data sets containing between 15 percent and 50 percent nondetects so that the parametric UTL could be calculated. The mean and standard deviation are required for this calculation, so it was necessary to estimate these values in lieu of calculating them because of the substantial number of nondetects for which the concentrations were unknown. Cohen's adjustment is a method of estimating or adjusting the mean and standard deviation. The underlying assumption of Cohen's adjustment is that all the data (detects and nondetects) come from the same normal or lognormal population, but that nondetect values have been "censored" at their detection limits. This implies that the constituent of concern is present in nondetect samples but at concentrations lower than the detection limit.

4.1.4 Evaluation of Organic Compounds

Two different background databases were compiled. The first database did not include samples with detections in the following organic compounds that were considered inappropriate for background samples: chlorinated aliphatic and aromatic compounds at any level or high concentrations of pesticides, PCBs, or PAHs, and benzene, toluene, ethylbenzene, and xylene (BTEX) compounds. A statistical run was performed on this data set. The organics were placed back into the database and a second statistical run was performed for soil and sediment because these were the only two media that differed between the two databases. The inclusion of the inappropriate organics detections did not make a significant difference in the descriptive statistical results from the two runs. Therefore, the second run containing all of the organics was considered representative of background conditions and the statistical results of this second run are presented and discussed in the background report in Appendix J.

4.2 SUMMARY OF BACKGROUND ANALYTICAL RESULTS

This section presents a summary of the results from background sampling. Details regarding the background characterization study are located in Appendix J of the Supplemental RFI/RI Report.

In general, only relatively low levels of naturally occurring metals, the pesticides DDT and parathion, PCBs and some petroleum-related compounds were found in Boca Chica Key soil, sediment, and water. Arsenic was detected in soil and sediment above generic residential RBC (EPA 1994e) but within the range of arsenic concentrations reported for soils in the eastern United States (Shacklette and Boerngen, 1984). Thallium was detected slightly above the Safe Drinking Water Act maximum contaminant level in both surface water and groundwater. All other analytes were detected below their corresponding RBC.

Fish were collected for chemical analyses from sites BG 1, BG 2, and BG 3. Three semi-volatile compounds were present in only a few samples. Concentrations of pesticides and PCBs in background fish show no evidence of being abnormally high. Concentrations of metals were generally within the range of values considered to be normal, with only a few exceptions. Overall, the tissue concentrations at all sites show no evidence of contamination problems, and the data indicate that the fish collected from these sites provide a data set that is indicative of uncontaminated background conditions at NAS Key West. Mangrove oysters were collected from site BG 3. Concentrations of analytes detected in oysters were generally similar to those in fish tissue from the three background sites. Although the data set is small (3 samples), the oyster tissue concentrations overall show no evidence of contamination problems, with the possible exception of high values of pyridine.

Toxicity tests were conducted using surface-water and sediment samples collected from sites BG 1, BG 2, and BG 3. Earthworm toxicity tests were conducted on soil samples collected at sites BG 1, BG 2, and BG 3, and S1SS-04. Earthworm survival in laboratory control samples was 85 percent. All earthworms died in BG 1 soils, while survival in BG 2 soil was 68 percent, survival in BG 3 soil was 16 percent, and survival in S1SS-04 soil was 57 percent. Although survival of earthworms in BG 2 soil was the highest of all Boca Chica Key soil samples, it was less than the laboratory control. For surface water, silverside minnow survival rate at BG 1 was equivalent to laboratory control samples, while the survival rate for minnows in surface water from BG 2 and BG 3 was greatly reduced. Mussel fertilization and development was greatly reduced in surface water from BG 2 but normal in BG 3 surface water. Sea urchin fertilization was normal at both BG 2 and BG 3. Finally, species used in sediment toxicity tests were dependent on the salinity of the overlying water samples. Survival growth of amphipods in BG 1 sediment were significantly reduced. Mysid shrimp growth and survival were normal in sediment from BG 2 and BG 3. Results of these toxicity tests were inconclusive; however, all three site-wide background sites appear to have been impacted to some extent by previous activities on Boca Chica Key.

The background data set for Boca Chica Key appears to be sufficient for accurately characterizing background conditions. Although some of the results are inconclusive (i.e., toxicity tests), there is currently sufficient background information available for supporting the NAS Key West RFI/RI at Boca Chica Key.

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APPENDIX H

AMENDMENTS AND DEVIATIONS TO THE SAMPLING AND ANALYSIS PLAN

Workplan Amendments and Deviations
NAS Key West Supplemental RFI/RI Sampling and Analysis Plan

The Supplemental RFI/RI field investigation for four high priority Solid Waste Management Units (SWMUs) at the Naval Air Station (NAS) Key West was conducted in January 1996 in accordance with the Supplemental RFI/RI Sampling and Analysis Plan (SAP) prepared by ABB in 1995. In several instances, the plan either did not detail information required to conduct the sampling, the plan contained discrepancies regarding sampling or analyses, or the plan required changes based on existing field conditions/technical decisions. These amendments or deviations are described below.

1. SWMU-9 Surface Soil vs. Subsurface Soil Locations

The ABB RFI/RI SAP text states that five surface soil and five subsurface soil samples will be collected in order to assess the extent of soil contamination by chlorinated solvents. This text also references Figure 3-18 as a source of identification of these locations. However, neither the text nor Figure 3-18 identify which of the ten soil sampling locations are surface soil or subsurface soil locations.

On January 10, 1996, Brown & Root Environmental (B&RE) contacted ABB and, per a previous conversation between Dudley Patrick (SouthDiv) and B&RE on January 10, 1996, proposed that the five subsurface soil locations be placed around the hot spots at SWMU-9. ABB concurred verbally, and the locations as shown on the attached revised Figure 3-18 were selected.

On January 11, 1996, telephone conversation between Dudley Patrick (SouthDiv), Jorge Caspary (FDEP), and Martha Berry (EPA) indicated FDEP's preference to take two shallow and three deep soil samples near the sources of contaminants. Rationale provided was that the water table is near the surface and constant flushing is occurring which is probably keeping contaminants near the surface. B&RE continuously sampled (every two feet) the selected five subsurface locations and screened all samples with field organic vapor detection equipment to determine which samples should receive chemical analysis. Both shallow and deeper samples were taken.

2. SWMU-9 Groundwater Sample Locations

Section 3.2.7, SWMU-9, of the RFI/RI SAP text states that additional groundwater samples will be collected and refers to Figure 3-20. However, Figure 3-20 states that no additional groundwater sampling is proposed, and the figure does not specify which eight of the existing twenty-four wells to sample.

On January 17, 1996, B&RE decided to sample MW-3, -4, -6, -9, -15, -17, -21, and -24 based upon past well sampling data and free product data at all twenty wells obtained on January 20, 1996. These wells were selected to bound the edges of suspected areas of contamination. MW-4 was substituted with MW-19D when free product was also observed in MW-4. These locations were discussed with Dudley Patrick (SouthDiv) the same day , and he concurred. The location of the wells sampled can be found in the attached Figure 3-20.

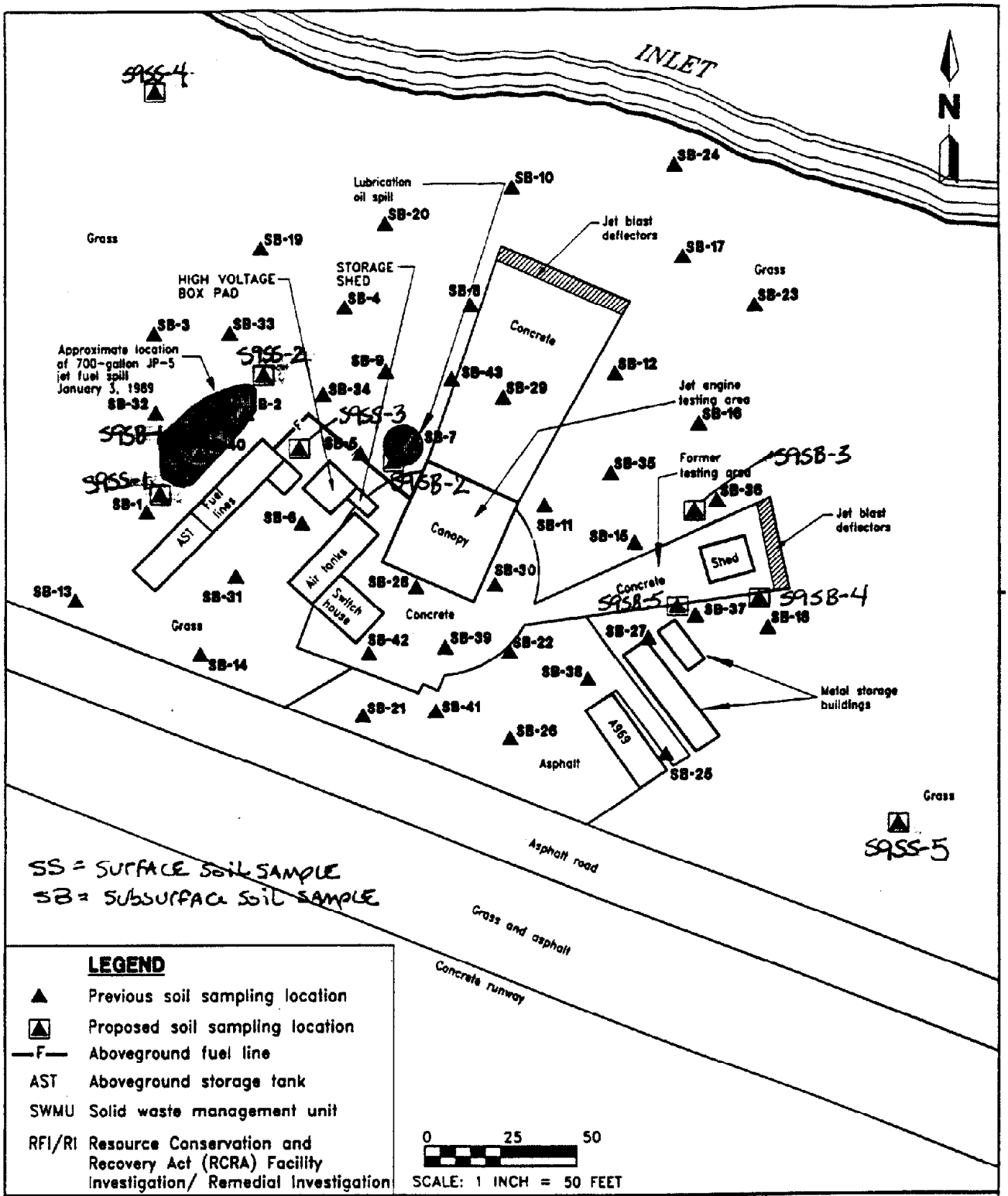


FIGURE 3-18
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
SWMU NO. 9, JET ENGINE TEST CELL

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

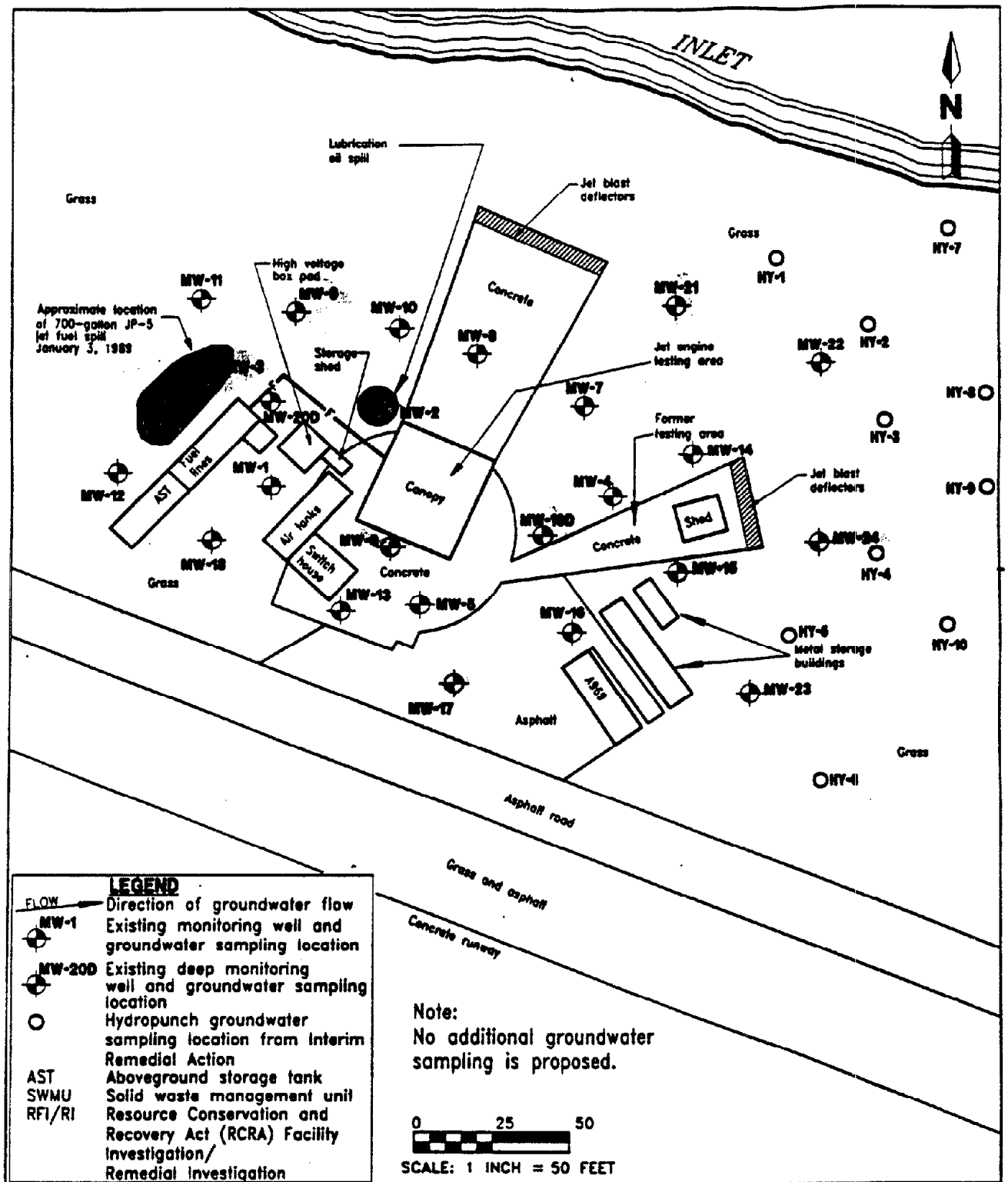


FIGURE 3-20
PRE-EXISTING MONITORING WELL AND GROUNDWATER SAMPLING LOCATIONS SWMU NO. 9, JET ENGINE TEST CELL

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

3. SWMU-1 Groundwater Analyses

Section 3.2.1 of the ABB SAP states that SWMU-1 groundwater samples will be analyzed for Appendix IX, VOCs, SVOCs, TAL metals, and cyanide; however, Table 3-2 indicates that all parameters, including pesticides/PCBs, will be analyzed.

Table 3-2 was followed in this case, and SWMU-1 groundwater samples were analyzed for all parameters.

4. SWMU-1 Surface Water and Sediment Sampling

Table 3-2 of the ABB SAP indicates that surface water samples will be analyzed at SWMU-1; however, Table 3-2, Section 3.2.1, and Figure 3-2 only provide for sediment, groundwater, and surface soil sampling at SWMU-1. The text indicated that previous sampling of surface water had been conducted. Therefore, no surface water samples were collected for chemical analyses as shown in the attached Figure 3-2.

5. Dissolved Oxygen (D.O.) Field Measurements

D.O. is one of the stabilization parameters required by B&RE's standard field procedure during purging of monitoring wells for sampling groundwater. The Horiba U-10 Water Checker utilized by B&RE read negative D.O. readings at some locations in site groundwater and surface water. The meter was calibrated successfully each day, and regular potable water D.O. readings were not negative. After a few days of these recurring equipment problems with D.O. measurement, a second Horiba U-10 Water Checker was substituted to replace the meter that was giving the negative D.O. readings. Later, a new probe was ordered for the second meter which, after being installed, also gave negative readings. Since two separate instruments and three probes were tried, it is assumed that salinity variations may have interfered with the field measurements. Contact with the vendor on January 30, 1996, indicated that the instrument may need to be internally recalibrated by the supplier.

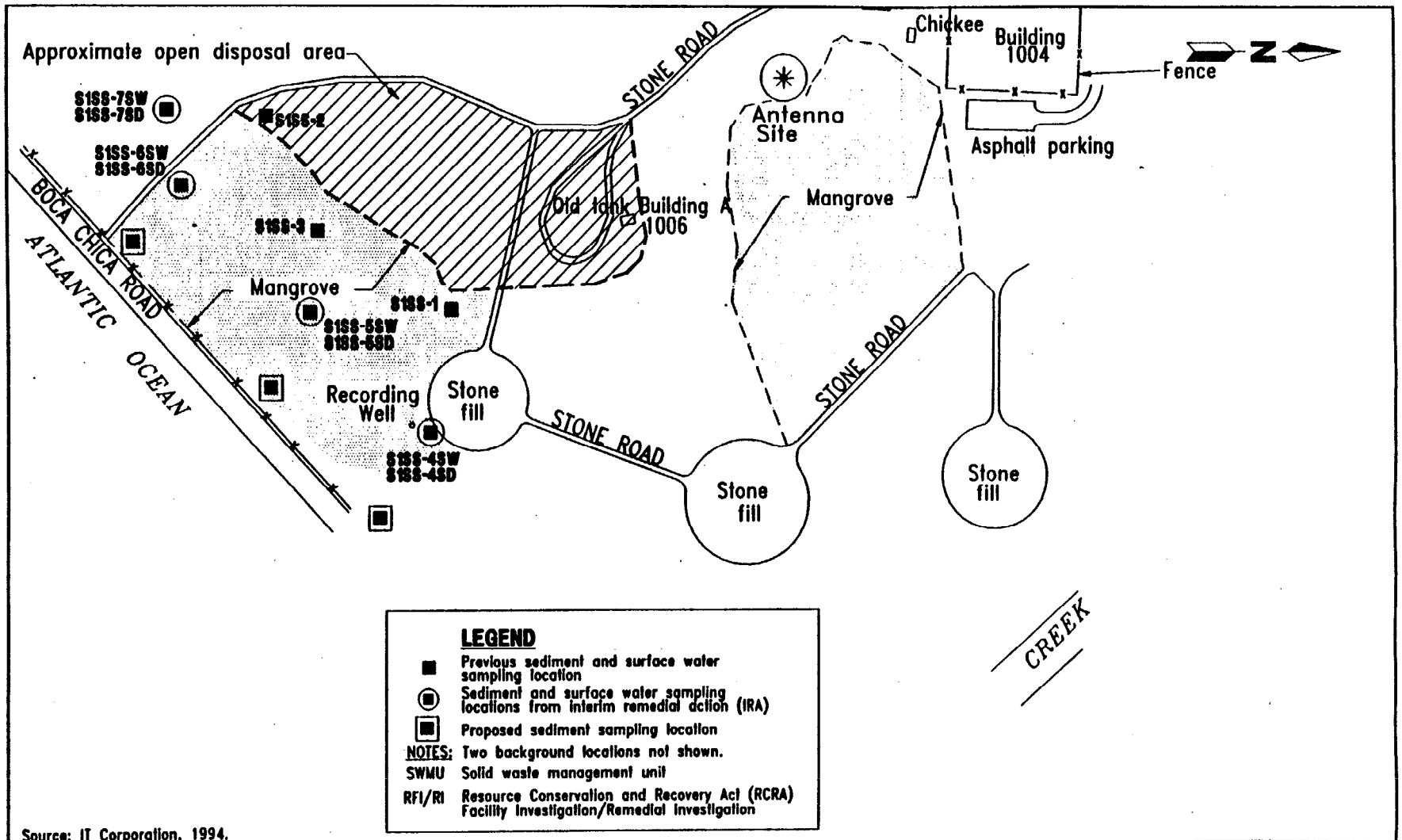
The purging and sampling of wells were continued without D.O. results since stabilization criteria for all other parameters (pH, conductivity, temperature, salinity, and turbidity) were met prior to sampling monitoring wells.

6. Herbicide Analyses

Herbicides are included in the Appendix IX list of parameters specified in the workplan; however, the RFI/RI SAP did not list herbicide methods of analysis. For completeness, herbicide sample volumes were collected for all samples when pesticide/PCB analyses were specified in the SAP.

7. SWMU-3 Well Sampling of S3MW-2 vs. MW10-1

The RFI/RI SAP specifies that two existing monitoring wells be sampled at SWMU-3. However, in the field it was observed that the MW10-1 flush mount and concrete seal had been destroyed leaving the PVC casing exposed and potentially contaminated. Upon recommendation by the



Source: IT Corporation, 1994.

0 125 250
SCALE: 1 INCH = 250 FEET

FIGURE 3-2
PREVIOUS AND PROPOSED SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS SWMU NO. 1, BOCA CHICA OPEN DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST KEY WEST, FLORIDA

H:\KEYWEST\RF-RI\202891\GLC-JC\12-4-95

B&RE geologist on site, this well was not sampled, and B&RE sampled S3MW-2, which is the closest functional well. The attached Figure 3-9 presents the locations of both of these wells.

8. Background Surface Soil Types

The SAP specified that background surface soil samples would be collected at locations facility-wide in each of the following three soil types: rockland; compacted made land; and coastal beach, dunes, and water. Per telephone conversation with ABB, it was determined the workplan intent was that, at each of three background locations, one surface soil sample of each soil type was to be collected. An attempt to do this was made in the field; however, at some background sites, all three soil types were not present. In this case, three soil samples were collected in the vicinity and in some cases more than one sample of a particular soil type was collected. The attached Figure 1 shows background sites 1, 2, and 3 (BG1, BG2, and BG3).

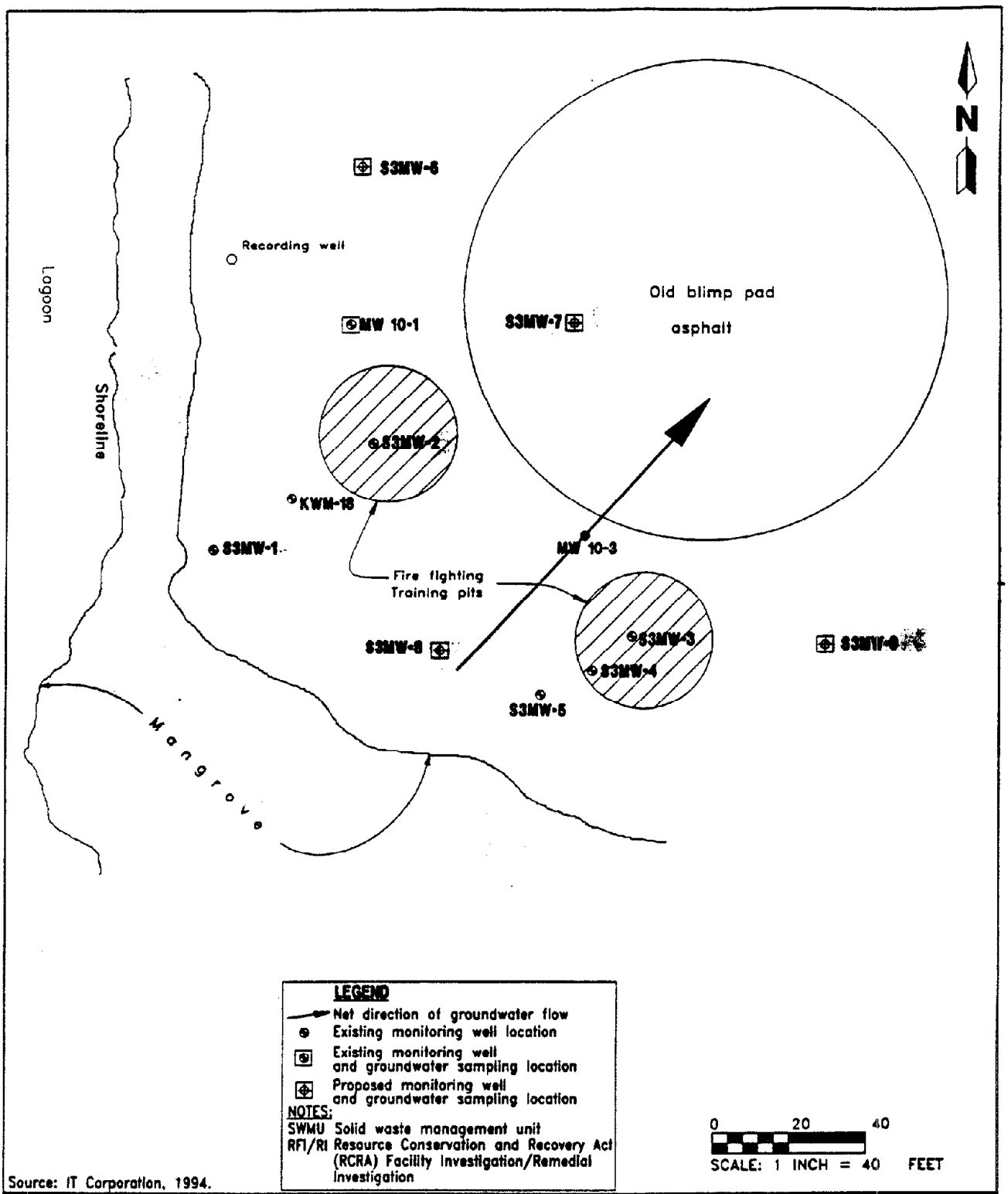
The following table shows the number of background samples within a specific soil type:

Location	Rockland	Compacted made land	Coastal beach, dunes, and water
BG1	3		
BG2		1	2
BG3	1	3	

9. Background Surface Soil Analyses

The RFI/RI SAP text indicates that only pesticide/PCB and TAL metal analyses were to be performed on soil samples from background sites; however, Table 3-2 listed all analytical parameters for background soil samples.

All background surface soil samples were therefore analyzed for all analytical parameters.



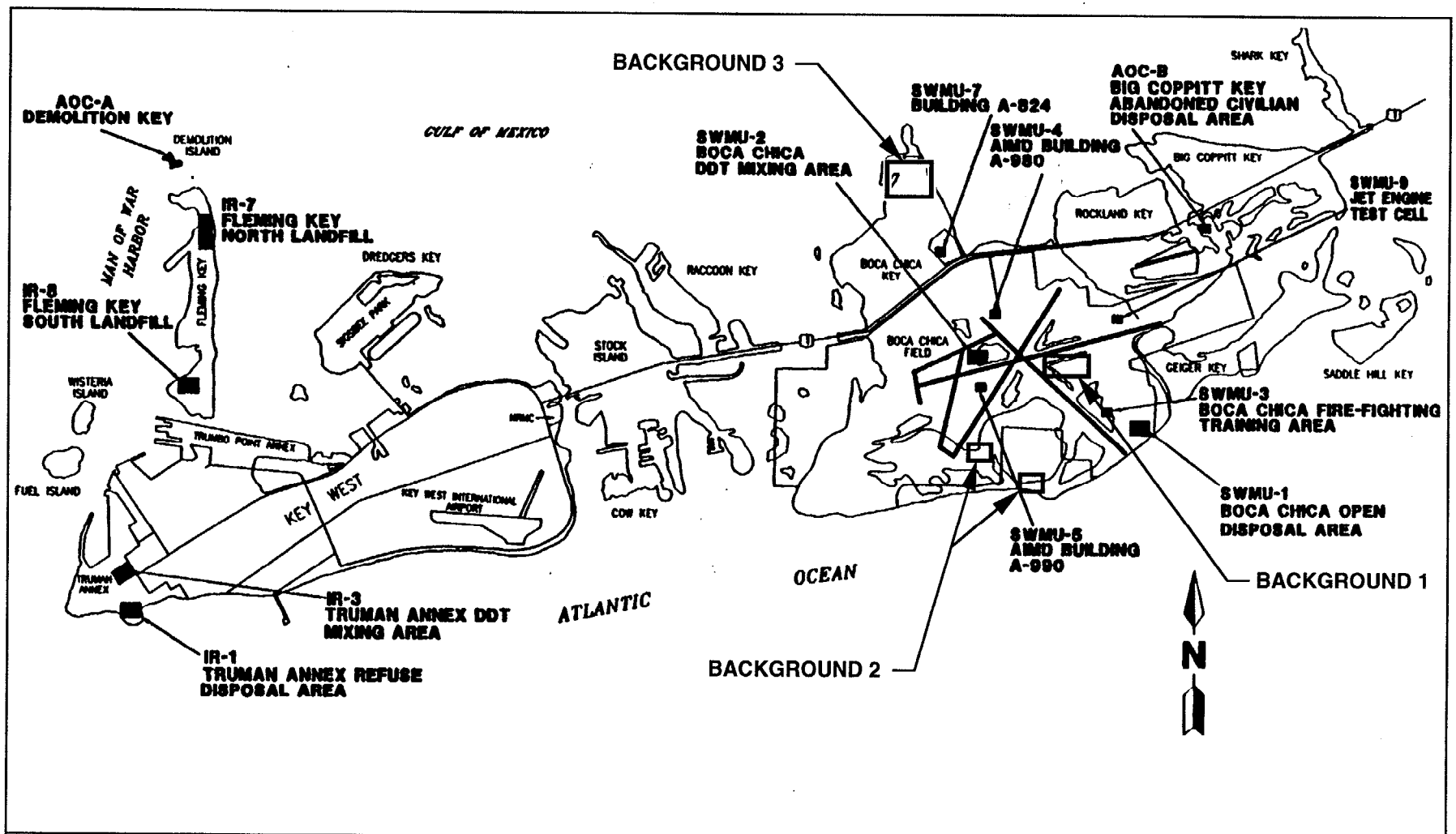
Source: IT Corporation, 1994.

FIGURE 3-9
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS, SWMU NO. 3, BOCA CHICA, FIRE FIGHTING TRAINING AREA

H:\9560\120200\2028827\GLC-JC\12-5-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Brown & Root Environmental

0 .75 1.5 MILES

SCALE: 1" = 1.5 MILES APPROXIMATE

FIGURE 1. LOCATION OF BOCA CHICA FACILITY-WIDE BACKGROUND LOCATIONS AND SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN, AND INSTALLATION RESTORATION SITES

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY:	SCALE: AS NOTED	DATE: 04/29/96	REV.: 0
CHECKED BY:	CONTRACT NO.: 7046	FILE NAME 7046-1	

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 1

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: Herbicides are included in the Appendix IX list of parameters specified in the workplan; however, the SAP did not list herbicide methods of analysis.

Reason for Change: Completeness of chemical analyses.

Recommended Disposition: Collect herbicide sample volumes for all samples for which pesticide /PCB analyses were specified in the SAP

Rachel M Layma 1/12/96

Field Operations Leader (Signature) **Date**

Disposition: Herbicide sample volumes were collected for all samples for which pesticide /PCB analyses were specified in the SAP

[illegible] 3/14/96

Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 2

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: The ABB SAP for the supplemental RFI/RI does not specify which soil sampling locations are for surface soil vs subsurface soil collection. The text states that five of each will be collected and references Figure 3-18, however this figure does not provide information for sampling. This is in regards to soil sampling at SWMU 9.

Reason for Change: Need more specific details for sampling

Recommended Disposition: Contacted project manager and ABB to decide on surface and subsurface locations

Rachel M Layman 1/14/96
Field Operations Leader (Signature) **Date**

Disposition: Agreed on sampling locations for surface vs subsurface locations shown on attached map. Dudley Patrick concurred on 1/10/96

[illegible] 3/14/96
Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

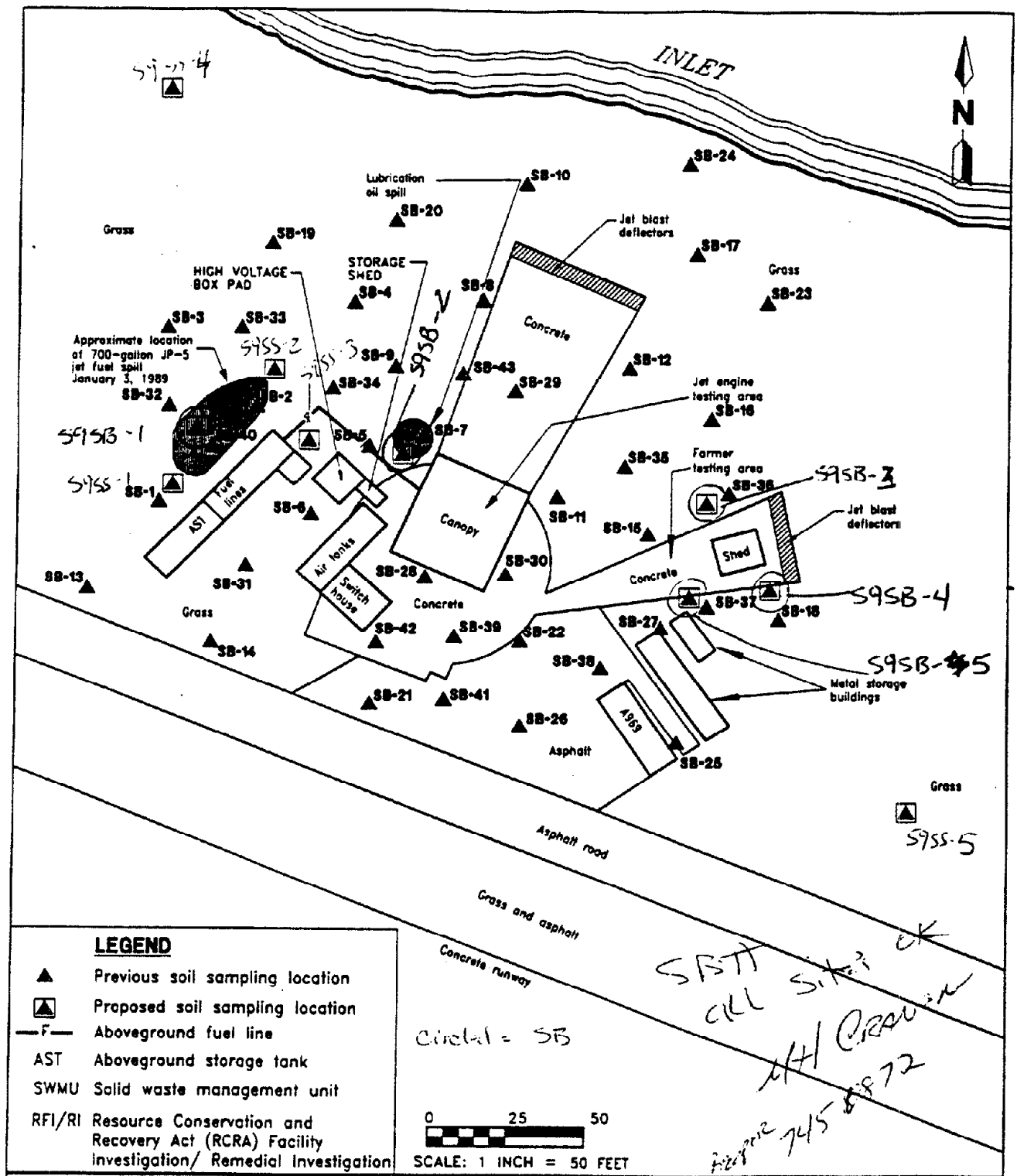


FIGURE 3-18
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
SWMU NO. 9, JET ENGINE TEST CELL

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 3

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: The RFI/RI SAP text states that additional groundwater samples will be collected and refers to Figure 3-20. However, Figure 3-20 states that no additional groundwater sampling is proposed, and the figure does not specify which of the 24 wells to sample.

Reason for Change: No change; more specific details needed

Recommended Disposition: Sample MW-3, 6, 4, 9, 15, 17, 21, 24 at SWMU-9

Rachel M Layman 1/17/96
Field Operations Leader (Signature) **Date**

Disposition: On 1/17/96, BCRE decided to sample MW-3, 4, 6, 9, 15, 17, 21, and 24 based upon past well sampling data and free product data obtained on 1/16/96. These wells were selected to bound edges of suspected areas of contamination. *

3/14/96
Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

* MW-4 was substituted with MW-19D when free product was observed in MW 4. Dudley Patrick concurred the same day. The attached revised figure presents these locations.

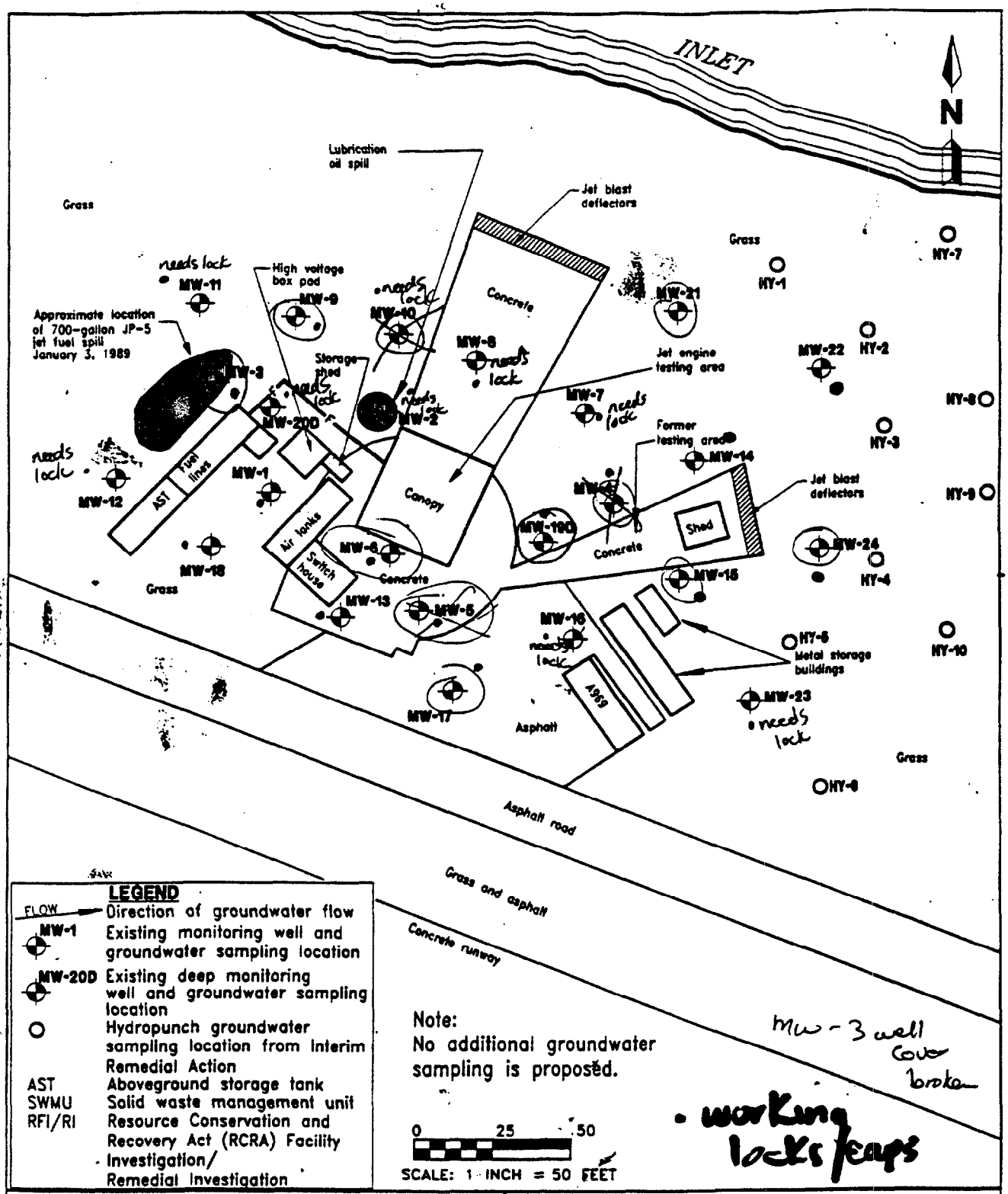


FIGURE 3-20
PRE-EXISTING MONITORING WELL AND GROUNDWATER SAMPLING LOCATIONS SWMU NO. 9, JET ENGINE TEST CELL

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 4

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: The ABB SAP Table 3-2 indicates that surface water samples will be analyzed at SWMU-1; however, Table 3-1, Section 3.2.1, and Figure 3-2 only provide for sediment, groundwater, and surface soil sampling. The text indicates that previous sampling of this media had been collected.

Reason for Change: Discrepancy in SAP.

Recommended Disposition: Only sediment, groundwater, and surface soil sampling.

Rachel M Layma 1/22/96

Field Operations Leader (Signature) **Date**

Disposition: Only sampled sediment, groundwater, and surface soil sampling per Table 3-1.

K Walker 3/14/96

Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 5

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: The ABB SAP states that SWMU-1 groundwater samples will be analyzed for Appendix IV VOCs, SVOCs, TAL metals, and cyanide; however, Table 3-2 indicates all parameters, including pesticides/PCBs (which include herbicides) will be analyzed

Reason for Change: Discrepancy in SAP.

Recommended Disposition: Analyze groundwater samples for all parameters per discussion with Project Manager

Rachel M Layman 1/30/96

Field Operations Leader (Signature) **Date**

Disposition: Groundwater sample volumes for all parameters collected for analysis.

[illegible] 3/14/96

Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 6

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: The ABB SAP specifies sampling MW10-1 as one of the existing wells to be sampled. However, the well flush mount and concrete seal has been destroyed leaving the PVC casing exposed and potentially contaminated.

Reason for Change: Cannot sample proposed well due to poor integrity of well.

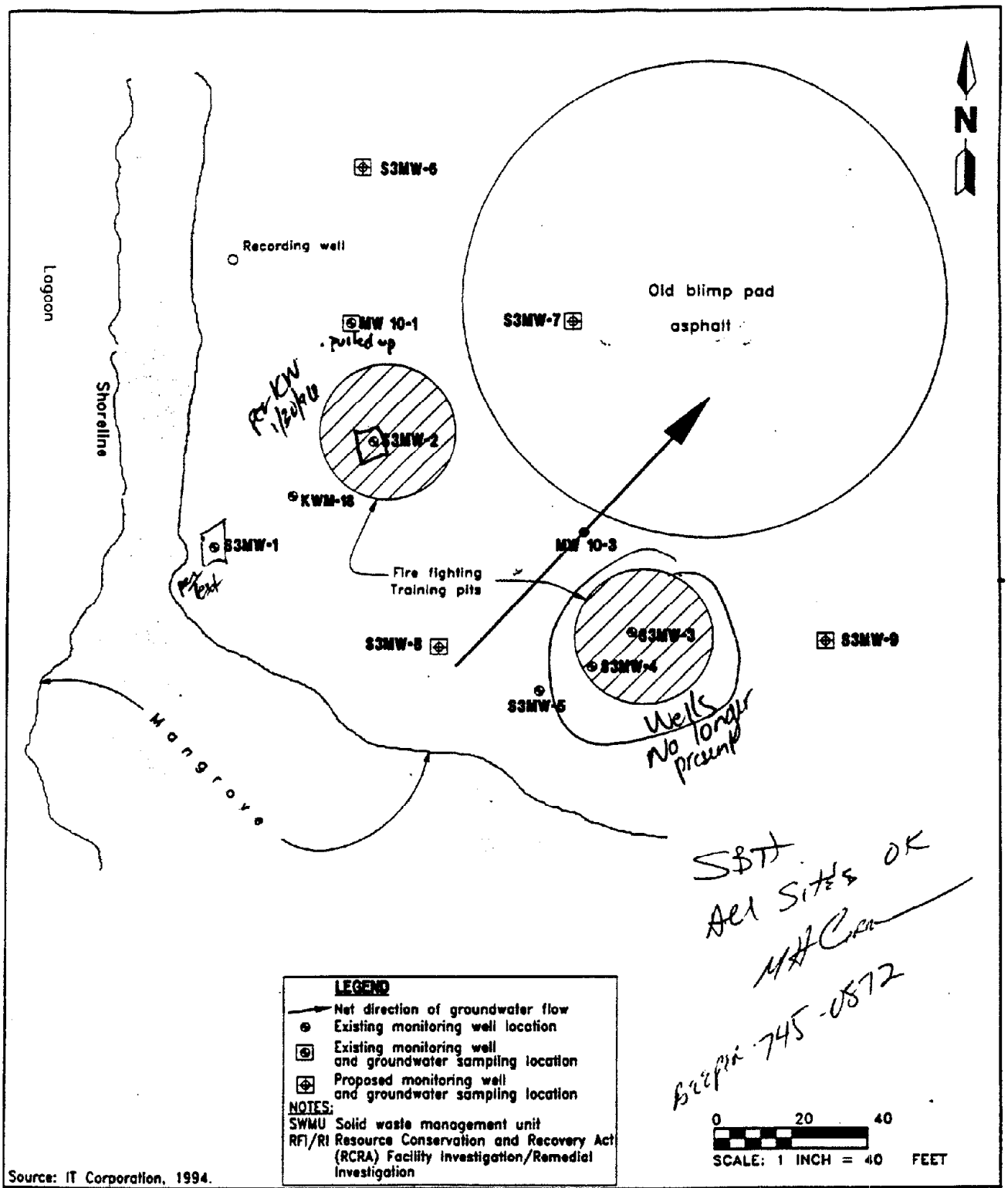
Recommended Disposition: Sample S3MW-2 shown on attached map.

Rachel M Layma 1/30/96
Field Operations Leader (Signature) **Date**

Disposition: Sampled S3MW-2 after project manager concurred.

[illegible] 3/14/96
Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader



Source: IT Corporation, 1994.

FIGURE 3-9
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS, SWMU NO. 3, BOCA CHICA, FIRE FIGHTING TRAINING AREA

H:\9560\120200\2028827\GLC-JC\12-5-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

BROWN AND ROOT ENVIRONMENTAL

TASK MODIFICATION REQUEST

Project Name: NAS Key West Supplemental RFI/RI **TMR Number:** 7

Project Number: Brown and Root Project No. 7046

Applicable Document to be Revised: NAS Key West Supplemental RFI/RI Sampling and Analysis Plan, Volume II

Description: The RFI/RI SAP text indicates that only pesticide/PCB and TAL metal analyses were to be performed; ~~on~~ soil samples from background sites; however, Table 3-2 listed all analytical parameters for background soil samples.

Reason for Change: SAP discrepancy

Recommended Disposition: Analyze all background surface soil samples for all analytical parameters.

Rachel M Layman 2/15/96

Field Operations Leader (Signature) **Date**

Disposition: All background surface soil samples were analyzed for all analytical parameters.

[illegible] 3/14/96

Project Manager **Date**

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C. 29419-9010

5090
Code 1858
4 April 1996

Ms. Martha Berry
U.S. Environmental Protection Agency, Region IV
Waste Management Division, Federal Facilities Branch
345 Courtland Street, N.E.
Atlanta, GA 30365

Subj: NAVAL AIR STATION (NAS) KEY WEST, FL:
SUPPLEMENTAL RCRA FACILITY INVESTIGATION (RFI) AND REMEDIAL INVESTIGATION (RI)

Dear Martha:

As we discussed and you approved on the telephone on February 21, 1996, the analyses of samples from the implementation of the Supplemental RFI/RI at NAS Key West do not have to include the identification of Tentatively Identified Compounds (TICs). The final workplan for the RFI/RI (ABB, December 1995) does not call for identification of TICs in the sampling and analysis plan. There is some confusion in the workplan document however, since the risk assessment addendum states that a qualitative review of TICs will be performed during the process of identifying contaminants of concern for the risk assessment. As we discussed, the contaminants of concern at NAS Key West are well known both from historical uses of the sites under investigation, and from the data resulting from the initial RFI (IT Corporation, June 1994).

Please let me know if you have any further questions concerning this issue. I can be reached at (803) 820-5541.

Sincerely,

J. DUDLEY PATRICK
Remedial Project Manager
Installation Restoration Program

Copy to:
FDEP, Jorge Caspary
NAS Key West, Ron Demes
Brown & Root, Kevin Walter
ABB, Robin Futch

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C. 29419-9010

5090
Code 1858
4 April 1996

Mr. Jorge Caspary
Division of Waste Management
Technical Review/Federal Facilities
Florida Department of Environmental Protection
Tallahassee, FL 32399-2400

Subj: NAVAL AIR STATION (NAS) KEY WEST, FL:
SUPPLEMENTAL RCRA FACILITY INVESTIGATION (RFI) AND REMEDIAL INVESTIGATION (RI)

Dear Jorge:

As we discussed and you approved on the telephone on February 21, 1996, the analyses of samples from the implementation of the Supplemental RFI/RI at NAS Key West do not have to include the identification of Tentatively Identified Compounds (TICs). The final workplan for the RFI/RI (ABB, December 1995) does not call for identification of TICs in the sampling and analysis plan. There is some confusion in the workplan document however, since the risk assessment addendum states that a qualitative review of TICs will be performed during the process of identifying contaminants of concern for the risk assessment. As we discussed, the contaminants of concern at NAS Key West are well known both from historical uses of the sites under investigation, and from the data resulting from the initial RFI (IT Corporation, June 1994).

Please let me know if you have any further questions concerning this issue. I can be reached at (803) 820-5541.

Sincerely,

J. DUDLEY PATRICK
Remedial Project Manager
Installation Restoration Program

Copy to:
USEPA, Martha Berry
NAS Key West, Ron Demes
Brown & Root, Kevin Walter
ABB, Robin Futch

APPENDIX I

BORING LOGS

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S9SB-1	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/17/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		35	200				
		83				*Water encountered*	
		125	700				
		149					
5		86	400				
		166					
		176	400			Limestone, oolitic, beige to off-white, micritic minor shell fragments, well consolidated	
		190					
		188	300				
10		166					
		70	500				
		54					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S9SB-2	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/17/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		36	50				
		79				*Water encountered*	
		158	500				
		82					
5		205	100				
		220					
		118	75			Limestone, oolitic, beige to off-white, micritic minor shell fragments, well consolidated	
		121					
		110	50				
10		135					
		51	50				
		85				*Boring terminated in this strata*	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S9SB-3	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/17/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		44	2				
		61				*Water encountered*	
		90	2				
		88					
5		78	2				
		92					
		105	2			Limestone, oolitic, well consolidated, beige to off-white, micritic with medium-grained sand in the matrix and minor shell fragments	
		107					
		73	2				
10		115					
		54	2				
		62				*Boring terminated in this strata*	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S9SB-4	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/17/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		44	1500				
		61				*Water encountered*	
		90	10				
		88					
5		78	7				
		92					
		105	30			Limestone, oolitic, well consolidated, beige to off-white, micritic with medium to fine sand in the matrix and minor shell fragments	
		107					
		73	20				
10		115					
		54	50				
		62				*Boring terminated in this strata*	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S9SB-5	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/17/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		36	ND				
		28				*Water encountered*	
		44	ND				
		54					
5		45	ND				
		70					
		80	ND			Limestone, oolitic, well consolidated, beige to off-white, micritic with medium to fine sand in the matrix and minor shell fragments	
		100					
		46	ND				
10		50					
		128	ND				
		58				*Boring terminated in this strata*	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S1MW-3	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/13/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Truck Mounted*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
						top soil	
			2			Limestone boulders and cobbles coarse sand *~ Unable to split spoon, used post-hole digger* Clayey limestone, brown to dark brown Minor sand (Coarse grained)	
		30					
		24					
		15					
5			2				
		43					
		68					
		47				Limestone, oolitic,Beige to white well consolidated, micritic	
10			ND				
		41					
		61					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S1MW-4	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/17/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Truck Mounted*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
			70			Dark brown top soil, muck, very moist *Groundwater encountered inches below surface*	
		40					
		65	ND				
		72					
5		68				Limestone boulders and cobbles, coarse sand poorly sorted *debris, metal and glass, petroleum sheen*	
		113				Limestone, oolitic, beige to white, oolitic well consolidated, micritic, porous	
		128				shell fragments	
10			ND				
		145					
		61				*Boring terminated in this strata*	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S1MW-5	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/13/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		44					
		49	80				
		48					
		58					
			70				
5		66				Limestone boulders and cobbles, coarse sand *unable to split spoon, used augers*	
		43					
		28				Limestone, oolitic, beige to light brown well consolidated, micritic, porous	
		26				shell fragments	
		28	100				
10		20					
		23					
		28				*Boring terminated in this strata*	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S1MW-6	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/13/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
						Limestone boulders, coarse sand *unable to split spoon, used post-hole digger* *encountered metal, trash, wood, etc.*	
			ND				
		58					
		82					
		28					
5			ND				
		29					
						Limestone, oolitic, beige to off-white poorly consolidated, micritic, porous	
		27					
						shell fragments	
		30					
		20					
		22					
10			ND				
		16					
		21					
		28					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S2MW-4	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/11/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		24	3				
		27				*Water encountered*	
		5					
		7					
5		13	2				
		16				Sand and limestone, oolitic, light brown to grey poorly consolidated, micritic, very porous	
		37					
		65					
		29					
10		53	ND				
		30					
		55					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S2MW-5	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/11/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		99	2			Unconsolidated mix of limestone, clay, and sand light brown to off-white	
		77					
		160					
		130					
5		62	ND			Limestone, oolitic, beige in color well consolidated, micritic, porous few shell fragments	
		58					
		73					
		59					
		27					
10		39	ND				
		29					
		43					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S2MW-6	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/11/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
						Coarse sand, brown to light brown, poorly sorted, sub-angular to angular *roots, decaying plant matter*	
		59					
		29	3			Limestone , sandy, oolitic, light brown, poorly consolidated few shell fragments	
		31					
		21				Limestone, oolitic, less sandy, well consolidated, brittle very porous	
5		35	2				
		43					
		18				Sandy limestone, oolitic well consolidated, micritic, hard	
		13					
		22					
10		30	ND				
		24					
		28					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S2MW-7	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/11/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		65				*Water encountered*	
		56	10				
		50					
		51					
5		50	2				
		62				Limestone, light brown to beige well consolidated, porous few shell fragments	
		55					
		71					
		35					
10		71	2				
		29					
		33					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S3MW-6	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/12/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
						Road base material, sand and gravel, loosely consolidated, poorly sorted	
		59	10				
		29				*Wtaer encountered*	
		31					
		21				Limestone , oolitic, light brown few shell fragments	
5		15	8				
		12					
		7					
		12					
		4				Peat, wood, in clayey limestone, dark brown	
10		5	2			Limestone, oolitic, well consolidated, light brown, clayey (20%) with coarse sand *Clay content decreases with depth*	
		6					
		8					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S3MW-7	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/12/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
		54				Road base material, white to off-white Sand and gravel	
		38	ND			*Water encountered*	
		37				Limestone, oolitic, beige to light brown, micritic porous, few shell fragments	
		38					
5		24	ND				
		48					
		34				same as above with more shell fragments and larger solution cavities	
		45					
		30					
10		51	ND				
		33					
		60					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S3MW-8	Page 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/12/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
						Road base material, poorly sorted Sand and Gravel	
		28	100				
		52				*Water encountered*	
		76					
		54				Limestone, oolitic, beige to light brown, micritic *sulphur/rotting vegetation odor*	
5		25	500				
		38					
		29					
		29					
		22				same as above with more shell fragments and larger solution cavities	
10		22	80				
		27					
		34					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S3MW-9	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *1/12/96*
DRILLING COMPANY: *Groundwater Protection, Inc.*	SURFACE ELEVATION: *N/A Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Diedrick D-120*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	FID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	WELL DIAGRAM
						Road base material, poorly sorted Sand and Gravel	
		27	ND				
		26				*Water encountered*	
		26				Sandy limestone to poorly consolidated sand, Brown sands are coarse to medium grained and poorly sorted	
		28					
5		31	ND			Limestone, oolitic, brown, well consolidated, porous abundant shell fragments *(increasing with depth)*	
		36					
		35				Fossiliferous limestone, well consolidated cavities are filled with sand brachiopods and bivalves shells and casts are abundant	
		40					
		29					
10		35	ND				
		46					
		56					
						Boring terminated in this strata	
15							
20							

JOB NUMBER: HK 7046

APPENDIX J

REPLACEMENT PAGES

AIK-OES-97-5407

BACKGROUND REPORT
FOR
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Brown & Root Environmental
661 Andersen Drive
Foster Plaza VII
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0007

July 1997
Revision 2

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TABLE OF CONTENTS

SECTION **PAGE**

TABLE OF CONTENTS ii

LIST OF TABLES iv

LIST OF FIGURES v

GLOSSARY vi

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1
- 1.1 PURPOSE 1-1
- 1.2 BRIEF SITE HISTORY 1-2
- 1.3 GEOLOGY AND HYDROGEOLOGY 1-5
- 1.4 HYDROLOGY 1-8
- 1.5 EPA GUIDANCE ON BACKGROUND CHARACTERIZATION 1-8

2.0 PREVIOUS INVESTIGATIONS 2-1
- 2.1 BECHTEL ENVIRONMENTAL, INC. DELINEATION AND CONFIRMATORY SAMPLING 2-1
- 2.2 IT CORPORATION RFI/RI 2-1
- 2.3 OTHER INVESTIGATIONS 2-2

3.0 SUPPLEMENTAL RFI/RI BACKGROUND SAMPLING 3-1

4.0 DEVELOPMENT OF THE RI BACKGROUND DATA SET 4-1
- 4.1 SELECTION OF THE BACKGROUND DATA SET 4-1
- 4.2 BACKGROUND SAMPLING LOCATIONS 4-4
- 4.2.1 Description of Site-Wide Background Locations 4-8
- 4.2.2 Soil Sampling Locations 4-9
- 4.2.3 Surface Water Sampling Locations 4-9
- 4.2.4 Sediment Sampling Locations 4-15
- 4.2.5 Groundwater Sampling Locations 4-15
- 4.2.6 Biota Sampling Locations 4-15
- 4.3 SAMPLE COLLECTION 4-17
- 4.4 ANALYTICAL PROCEDURES 4-17
- 4.5 TOXICITY TESTS 4-17

5.0 DATA SET MODIFICATIONS AND STATISTICAL ANALYSIS PROCEDURES 5-1
- 5.1 MODIFICATIONS OF THE BACKGROUND DATA SET 5-2
- 5.1.1 Treatment of Outlier Data 5-2
- 5.1.2 Field Duplicates 5-2
- 5.2 STATISTICAL ANALYSIS 5-2
- 5.2.1 Testing of Data Distribution 5-3
- 5.2.2 Descriptive Statistics 5-3
- 5.2.3 Evaluation of Organic Compounds 5-4

TABLE OF CONTENTS (con't.)

SECTION **PAGE**

6.0 SOIL CHARACTERIZATION 6-1
6.1 VOLATILE ORGANIC COMPOUNDS 6-4
6.2 SEMI-VOLATILE ORGANIC COMPOUNDS 6-4
6.3 PESTICIDES/POLYCHLORINATED BIPHENYLS 6-4
6.4 INORGANICS 6-4
6.5 TOXICITY TESTS 6-5

7.0 SURFACE WATER CHARACTERIZATION 7-1
7.1 WATER QUALITY 7-5
7.2 VOLATILE ORGANIC COMPOUNDS 7-6
7.3 SEMI-VOLATILE ORGANIC COMPOUNDS 7-6
7.4 PESTICIDES/POLYCHLORINATED BIPHENYLS 7-6
7.5 INORGANICS 7-6
7.6 TOXICITY TESTS 7-7

8.0 SEDIMENT CHARACTERIZATION 8-1
8.1 VOLATILE ORGANIC COMPOUNDS 8-3
8.2 SEMI-VOLATILE ORGANIC COMPOUNDS 8-3
8.3 PESTICIDES/POLYCHLORINATED BIPHENYLS 8-3
8.4 INORGANICS 8-3
8.5 TOXICITY TESTS 8-3

9.0 GROUNDWATER CHARACTERIZATION 9-1
9.1 VOLATILE ORGANIC COMPOUNDS 9-1
9.2 SEMI-VOLATILE ORGANIC COMPOUNDS 9-3
9.3 PESTICIDES/POLYCHLORINATED BIPHENYLS 9-3
9.4 INORGANICS 9-3

10.0 TISSUE CHARACTERIZATION 10-1
10.1 FISH 10-1
10.1.1 Volatile Organic Compounds 10-21
10.1.2 Semi-volatile Organic Compounds 10-21
10.1.3 Pesticides/PCBs 10-22
10.1.4 Inorganics (Metals) 10-24
10.1.5 Summary and Conclusions - Fish Tissue 10-27
10.2 OYSTERS 10-28
10.3 EARTHWORMS 10-30

11.0 CONCLUSIONS 11-1

REFERENCES R-1

APPENDICES

ATTACHMENT A - STATISTICAL PROCEDURES AND EQUATIONS

ATTACHMENT B - BACKGROUND SUMMARY STATISTICS (RUN 1*) FOR SOIL AND SEDIMENT

TABLE OF CONTENTS (con't.)

TABLES

NUMBER		PAGE
4-1	Background Data for Boca Chica Key	4-2
4-2	Summary of Evaluation of Potential Background Samples	4-5
6-1	Background Summary Statistics for Soil	6-2
6-2	Envirosystems Toxicity Test Results Summary	6-6
7-1	Water Quality Data Summary	7-2
7-2	Background Summary Statistics for Surface Water	7-3
8-1	Background Summary Statistics for Sediment	8-2
9-1	Background Summary Statistics for Groundwater	9-2
10-1	Number of Fish and Oyster Samples Collected for Chemical Analyses from Background Sites During January 1996	10-2
10-2	Summary Statistics for Fish at Background Sites 1, 2, and 3	10-3
10-3	Summary Statistics for Fish at Background Site 1	10-4
10-4	Summary Statistics for Fish at Background Site 2	10-5
10-5	Summary Statistics for Fish at Background Site 3	10-6
10-6	Background Site 1 Summary Statistics for Crested Goby	10-7
10-7	Background Site 1 Summary Statistics for Ladyfish	10-8
10-8	Background Site 1 Summary Statistics for Yellowfin Mojarra	10-9
10-9	Background Site 1 Summary Statistics for Sailfin Molly	10-10
10-10	Background Site 1 Summary Statistics for Striped Mullet	10-11
10-11	Background Site 1 Summary Statistics for Sheepshead Minnow	10-12
10-12	Background Site 2 Summary Statistics for Bluestriped Grunt	10-13
10-13	Background Site 2 Summary Statistics for Pinfish	10-14
10-14	Background Site 2 Summary Statistics for Sea Robin	10-15
10-15	Background Site 2 Summary Statistics for Gray Snapper	10-16
10-16	Background Site 2 Summary Statistics for Sailfin Molly	10-17
10-17	Background Site 3 Summary Statistics for Gulf Killifish	10-18
10-18	Background Site 3 Summary Statistics for Sailfin Molly	10-19
10-19	Background Site 3 Summary Statistics for Sheepshead Minnow	10-20
10-20	Background Site 3 Summary Statistics for Mangrove Oyster	10-29
10-21	Metal Concentrations (mg/kg Wet Weight) in Earthworm Tissue from Background Sites and in Laboratory Controls	10-31

TABLE OF CONTENTS (con't.)

FIGURES

NUMBER		PAGE
1-1	Facility Location Map	1-3
1-2	Boca Chica Key Site-Wide Background Locations and Hazardous Waste Sites	1-4
1-3	Geological Cross-Section of the Florida Keys	1-6
1-4	General Soils Map	1-7
3-1	Boca Chica Key Background 1 - Sampling Locations	3-2
3-2	Boca Chica Key Background 2 - Sampling Locations	3-3
3-3	Boca Chica Key Background 3 - Sampling Locations	3-4
4-1	SWMU 1 Background Sampling Locations	4-10
4-2	SWMU 2 Background Sampling Locations	4-11
4-3	SWMU 3 Background Sampling Locations	4-12
4-4	SWMU 4 Background Sampling Locations	4-13
4-5	SWMU 7 Background Sampling Locations	4-14

GLOSSARY

AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BG 1	Background Site 1
BG 2	Background Site 2
BG 3	Background Site 3
BHC	Benzene hexachloride
bls	below land surface
BRAC	Base Realignment and Closure
BTEX	Benzene, toluene, ethylbenzene, xylene
B&R Environmental	Brown & Root Environmental
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action - Navy
Cmax	Maximum concentration
EPA	U.S. Environmental Protection Agency
EPA-OSWER	U.S. Environmental Protection Agency - Office of Solid Waste and Emergency Response
FDEP	Florida Department of Environmental Protection
HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
IR	Installation Restoration
IT	International Technology (IT Corporation)
MCL	Maximum Contaminant Level
MSL	mean sea level

mS/cm	millisiemens per centimeter
NACIP	Naval Assessment and Control of Installation Pollutants Program
NAS	Naval Air Station
NCBP	National Contaminant Biomonitoring Program
NTUs	Nephelometric Turbidity Units
OSWER	(see EPA-OSWER above)
PAHs	Polynuclear Aromatic Hydrocarbons
ppb	parts per billion
ppm	parts per million
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
VSI	Visual Site Inspection

EXECUTIVE SUMMARY

This report describes background characterization performed at the Naval Air Station (NAS) Key West on Boca Chica Key. During January 1996, soil, sediment, surface water and groundwater samples were obtained for chemical analysis. In addition, fish and oysters were collected for tissue analyses. Finally, toxicity tests were performed on soil, water, and sediments collected from Boca Chica Key. Results from the background samples were combined with data obtained from previous investigations at Boca Chica Key.

The distribution of the data set (i.e., normal or lognormal), the 95 percent upper confidence limit (UCL) of the mean (which is often used as the representative concentration for risk assessments), the 95 percent upper tolerance limit (UTL) and other descriptive statistics were determined for each analyte detected in the background soil samples. However, the utility of some of the information presented (particularly the distribution designation, the UCL and the UTL) is restricted by the number of positive detections reported for some of the analytes. In soil, less than six positive inorganic detections were reported for antimony, beryllium, cadmium, mercury, selenium, and tin. Statistically, this means that the distribution for these analytes is undefined. Thus, the maximum detected concentrations for these analytes will be used as the representative concentration and as the UTL in the supplemental RFI/RI report for NAS Key West. In addition the UTL for lead in soil was higher than the EPA-OSWER clean-up standard of 400 mg/kg. Thus, the maximum detected concentration for lead will also be used as the representative concentration and as the UTL in the supplemental RFI/RI report for NAS Key West. Descriptive statistics for all other analytes detected in soils will be used in the supplemental RFI/RI report.

In general, only relatively low levels of naturally occurring metals, the pesticides DDT and parathion, polychlorinated biphenyls (PCBs) and some petroleum related compounds were found in Boca Chica Key soil, sediment, and water. Arsenic was detected in soil and sediment above generic residential risk-based concentrations (RBC) (EPA 1994a) but within the range of arsenic concentrations reported for soils in the eastern United States (Shacklette and Boerngen 1984). Thallium was detected slightly above the Safe Drinking Water Act maximum contaminant level in both surface water and groundwater. All other analytes were detected below their corresponding RBC.

Fish were collected for chemical analyses from sites BG 1, BG 2, and BG 3. Three semi-volatile compounds were present in only a few samples. Concentrations of pesticides and PCBs in background fish show no evidence of being abnormally high. Concentrations of metals were generally within the range

of values considered to be normal, with only a few exceptions. Overall, the tissue concentrations at all sites show no evidence of contamination problems, and the data indicate that the fish collected from these sites provide a data set that is indicative of uncontaminated background conditions at NAS Key West. Mangrove oysters were collected from site BG 3. Concentrations of analytes detected in oysters were generally similar to those in fish tissue from the three background sites. Although the data set is small (3 samples), the oyster tissue concentrations overall show no evidence of contamination, with the possible exception of high values of pyridine.

Toxicity tests were conducted using water and sediment collected from sites BG 1, BG 2, and BG 3. Earthworm toxicity tests were conducted on soil samples collected at BG 1, BG 2, and BG 3, and S1SS-04. Results of the toxicity tests suggest that all three site-wide background sites appear to have been impacted to some extent by previous activities on Boca Chica.

1.0 INTRODUCTION

This background report was prepared by Brown & Root Environmental (B&R Environmental) on behalf of the United States Navy Southern Division Naval Facilities Engineering Command and the Naval Air Station (NAS) Key West. This report was completed under the Comprehensive Long-Term Environmental Action - Navy (CLEAN) Contract Number N62467-94-D-0888, Contract Task Order 0007.

This report summarizes available background chemical-analytical and toxicity data on Boca Chica Key, Florida, for the characterization of background conditions at NAS Key West for Solid Waste Management Units (SWMUs) 1, 2, 3, and 9. This characterization includes an evaluation of soil, surface water, sediment, groundwater, and biota, and is necessary for defining the nature and extent of contamination, completing the human health and ecological risk assessments, and supporting the corrective measures study of remedial alternatives for SWMUs 1, 2, 3, and 9 on Boca Chica Key.

1.1 PURPOSE

Background sampling and analysis are conducted to ensure that site-related contamination can be distinguished from naturally occurring or other nonsite-related anthropogenic compounds. The presence of chemicals in background samples can be attributed to either naturally occurring ambient concentrations of chemicals in the environment (e.g., aluminum, manganese), or concentrations of chemicals that are in the environment as a result of nonsite-related human activities (e.g., industry, agriculture, automobile emissions). In general, sites that contain chemical constituents below or close to levels detected in background samples are not considered contaminated sites that require remedial action.

Background samples are collected at or near locations of potential contamination in areas that were unlikely to have received chemical releases from site activities, but have the same basic physical and geochemical characteristics as the medium of concern at the site. Knowledge of upgradient, upwind and upstream conditions is critical in the identification of background locations. The analytical results for background samples, applicable State and Federal regulatory standards and guidance criteria, and human health and ecological risk assessment techniques will provide the primary basis to evaluate analytical results for NAS Key West sites in the Supplemental RFI/RI Report.

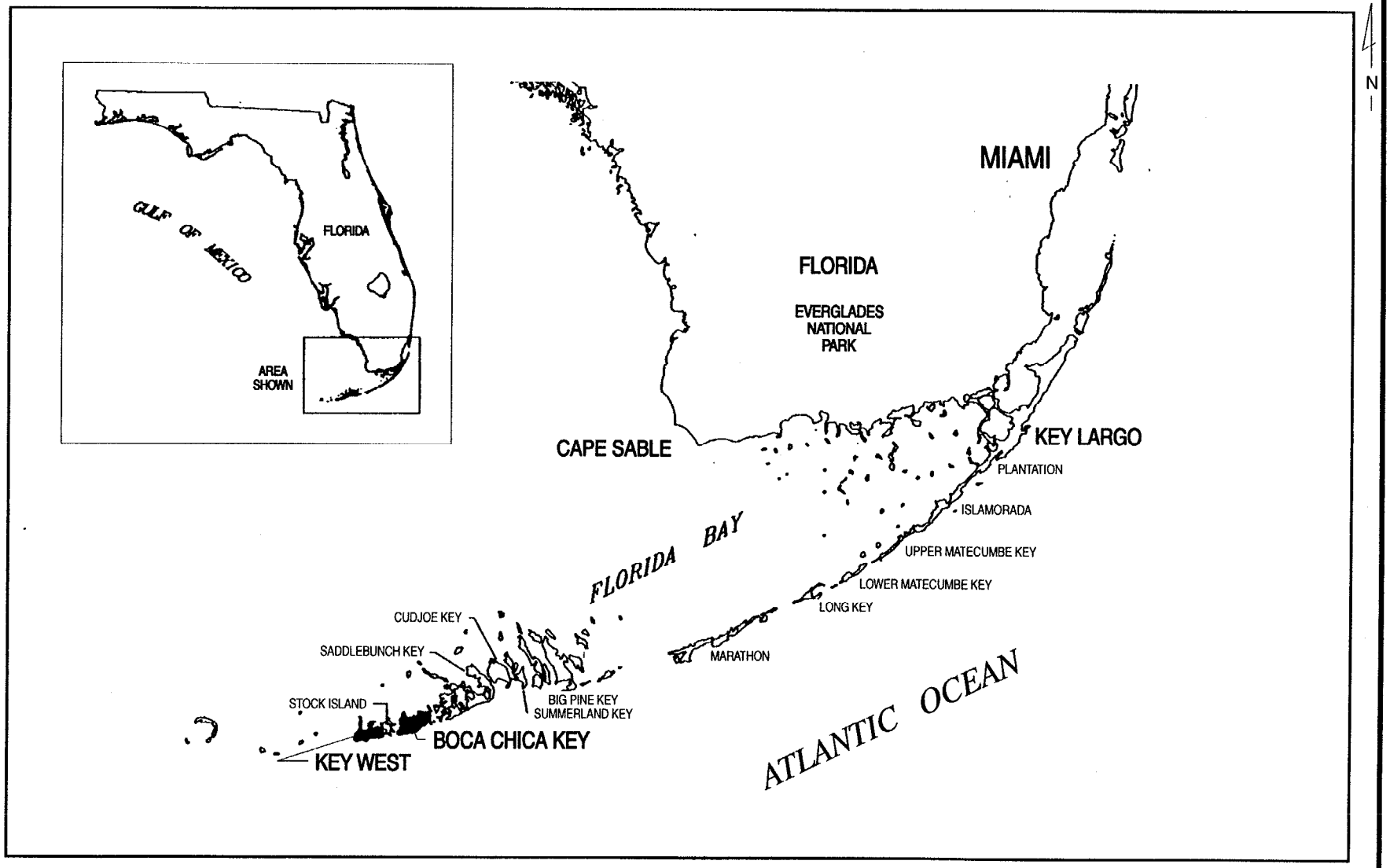
Although detailed Florida Department of Environmental Protection (FDEP) and the U.S. Environmental Protection Agency (EPA) protocol were followed, this appendix does not include these protocols, since they are thoroughly described in other sections of the supplemental RFI/RI report.

1.2 BRIEF SITE HISTORY

NAS Key West is located in southern Monroe County on Boca Chica Key, Florida. It is one of the two westernmost major islands of the Florida Keys and is situated approximately 150 miles southwest of Miami (Figure 1-1). Several naval installations located in various parts of the lower Florida Keys comprise what is known as the Naval Complex at Key West. Most of these are located in the vicinity of Key West and Boca Chica Key. The entire complex encompasses approximately 5,000 acres. Boca Chica Key is approximately 3 miles wide and 3 miles long. The air station encompasses 3,250 acres on the key. The elevations of Boca Chica Key are less than 5 feet above mean sea level (msl) except for filled areas that underlie the overseas highway (IT 1994).

B&R Environmental is performing a supplemental Phase II RFI/RI at NAS Key West under contract to the Unites States Navy. This work is being performed to supplement the RFI/RI (Phase I) conducted by IT Corporation from 1992 through 1994. The purpose of the current investigation is to further characterize the background conditions and to better delineate the nature and extent of contamination at SWMUs, Installation Restoration (IR) sites, and Areas of Concern (AOCs). Investigation of the Boca Chica-wide and site-specific background locations was conducted in conjunction with the supplemental RFI/RI for SWMUs 1, 2, 3 and 9 on Boca Chica Key. These four SWMUs were selected for the initial phase of the Supplemental RFI/RI because they are considered high-priority sites at NAS Key West. The amount of funding originally available for FY96 was only adequate to support the supplemental RFI at SWMUs 1, 2, 3, and 9. Additional funding was obtained in FY96 and investigations of the remaining SWMUs, IR sites and AOCs on Key West and nearby islands will begin in late 1996. The supplemental RFI is being conducted in accordance with the Hazardous and Solid Waste Amendments (HSWA) portion of Permit No. H044-144053 issued by EPA. B&R Environmental is conducting the investigation in accordance with the Supplemental RFI/RI Workplan prepared by ABB Environmental Services, Inc. (ABB 1995a).

Characterization of background conditions on Boca Chica Key is primarily based on the analyses of samples collected in January 1996 from three site-wide areas (Figure 1-2) that are considered to represent NAS Key West background conditions. The background characterization also includes site-specific background data from sample locations specific to SWMUs 1, 2, 3, 4, and 7 that were collected during the supplemental RFI/RI and previous investigations. Sources of background data used in this characterization are discussed in Section 2.0 and 3.0.



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0 20 40
SCALE IN MILES

FIGURE 1-1. FACILITY LOCATION MAP
NAS KEY WEST

NAS KEY WEST — KEY WEST, FLORIDA

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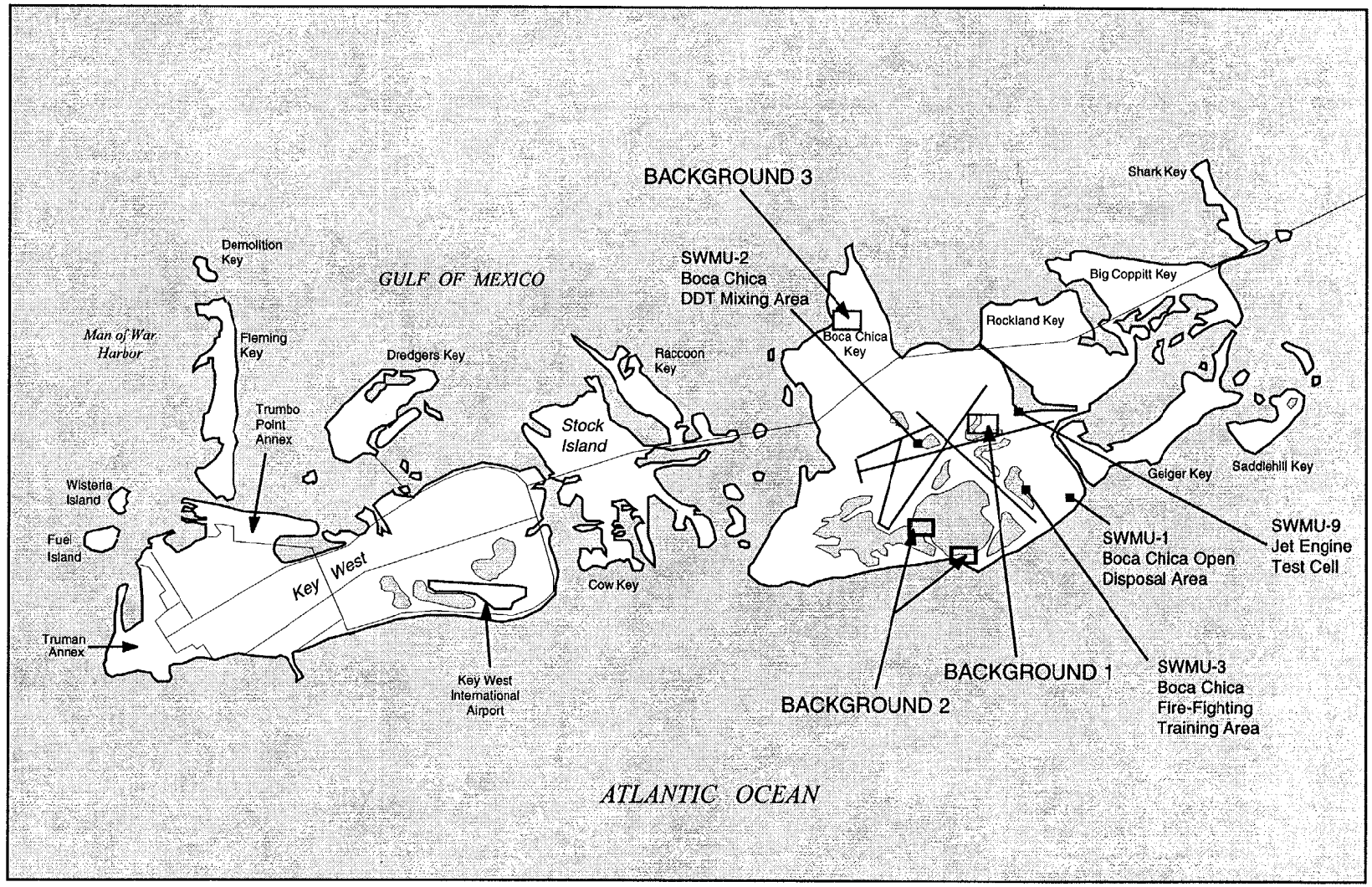

Brown & Root Environmental

0 1.5 3.0
Scale in Miles (Approximate)

FIGURE 1-2. BOCA CHICA KEY SITE-WIDE BACKGROUND LOCATIONS AND HAZARDOUS WASTE SITES

NAS KEY WEST — KEY WEST, FLORIDA

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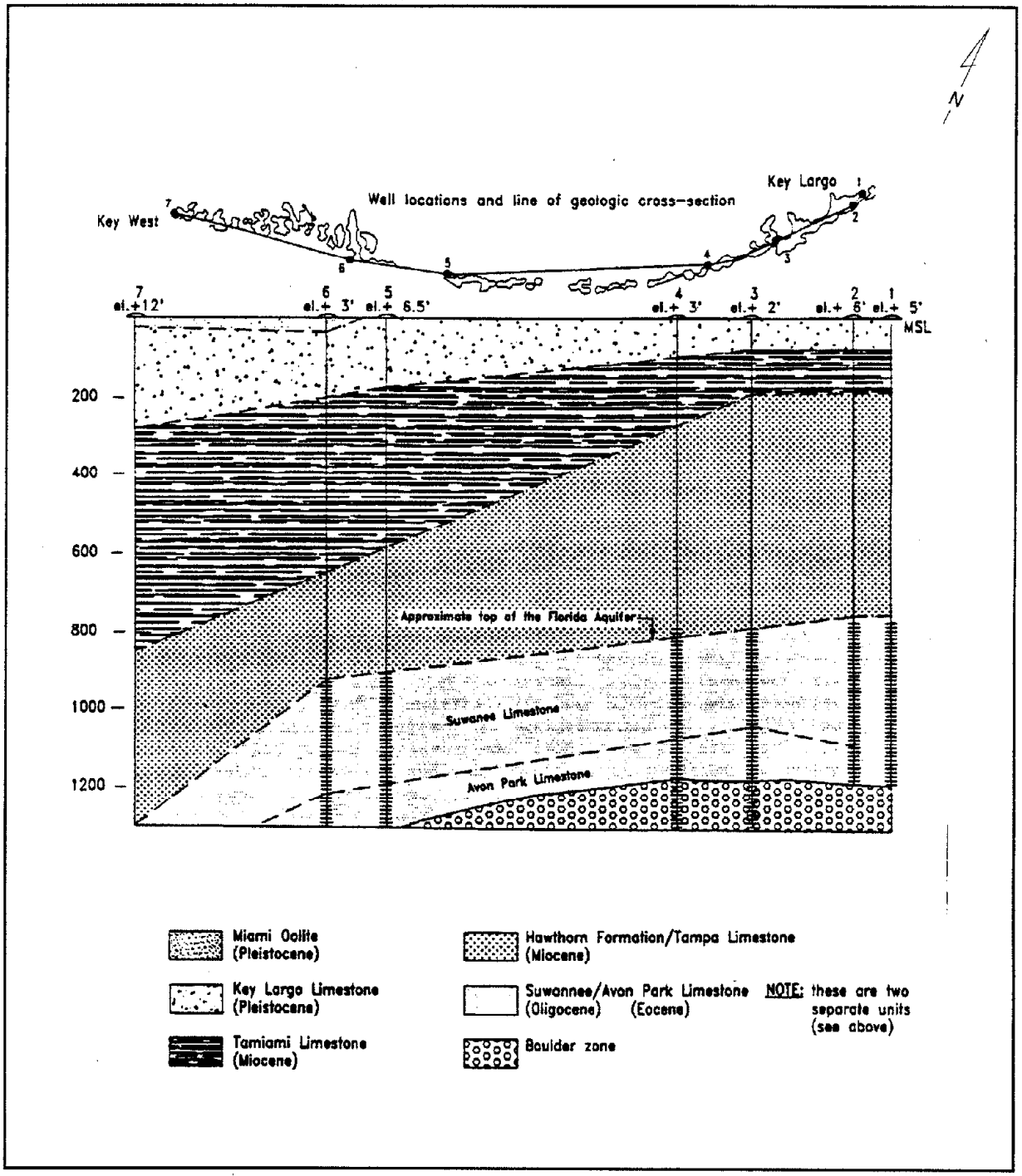
1.3 GEOLOGY AND HYDROGEOLOGY

The Lower Keys are underlain by an oolitic member of the Pleistocene Miami Limestone. The Miami Oolite consists of rock units of calcium carbonate and small spherical calcareous grains (ooids) that underlie the Miami Oolite on all the Lower Keys. It consists of cemented remains of ancient coral reefs, fossils, and shells. Hoffmeister (1974) reported that the Miami Oolite is 27 feet thick. Figure 1-3 shows a generalized geologic cross-section of the Florida Keys.

Undisturbed soil in the Keys consists of shallow marl over limestone with the substrate rock appearing at the surface on numerous outcroppings. Many areas of the Florida Keys, such as Fleming Key, have been filled and graded. The soils at Boca Chica are primarily rockland with some filled areas and mangrove swamps (Figure 1-4). Other major soil groups on Boca Chica Key are Uthorthents, which consist of gravely sand and marl, and Cudjoe, which is composed of marl and weathered bedrock (ABB 1995a).

The surficial aquifer underlying much of the Lower Keys is unconfined and is composed of the highly permeable, porous, solution-riddled Miami Oolite that allows recharge from rainfall to seep quickly into the ocean and saltwater to intrude easily into the aquifer. The surficial aquifer is the principal aquifer of concern in the area because it is used as a potable water resource to a limited extent (although not at NAS Key West) and because it exists as a groundwater-to-surface-water contaminant migration route. The water table is located at depths ranging from 0.8 to 2.4 feet bls at the center of the island and from 0.4 to 2.2 bls near the coast. The water table fluctuates diurnally as a result of tidal effects. Head differentials associated with tidal variations near the shore can further accelerate groundwater movement in the area. A reconnaissance water-quality sampling study completed in 1990 by the U.S. Geological Survey (USGS) in cooperation with the South Florida Water Management District indicates that the freshwater lens contains nonpotable water. The State of Florida classifies groundwater in unconfined aquifers which have a total dissolved solids content of 10,000 mg/l or greater as Class G-III (nonpotable water). Potable water is obtained by rainwater catchment or imported via the Florida Keys Aqueduct Authority via a 150-mile pipeline from Miami. There are no freshwater public or domestic wells at the NAS Key West facility (ABB 1995a).

The Key Largo Limestone lies below the surficial aquifer and is more than 270 feet thick in the western part of Key West. The Key Largo Limestone is generally more porous than the Miami Oolite but it contains only salt water. It is a limestone remnant reef structure that is extremely permeable, possessing many solution cavities and caverns. The Tamiami Formation lies below the Key Largo Limestone and represents a major water-producing zone in south Florida. Below the Florida Keys, the Tamiami



Brown & Root Environmental

0 16 32
SCALE IN MILES (APPROXIMATE)

FIGURE 1-3. GEOLOGIC CROSS-SECTION OF THE FLORIDA KEYS

NAS KEY WEST — KEY WEST, FLORIDA

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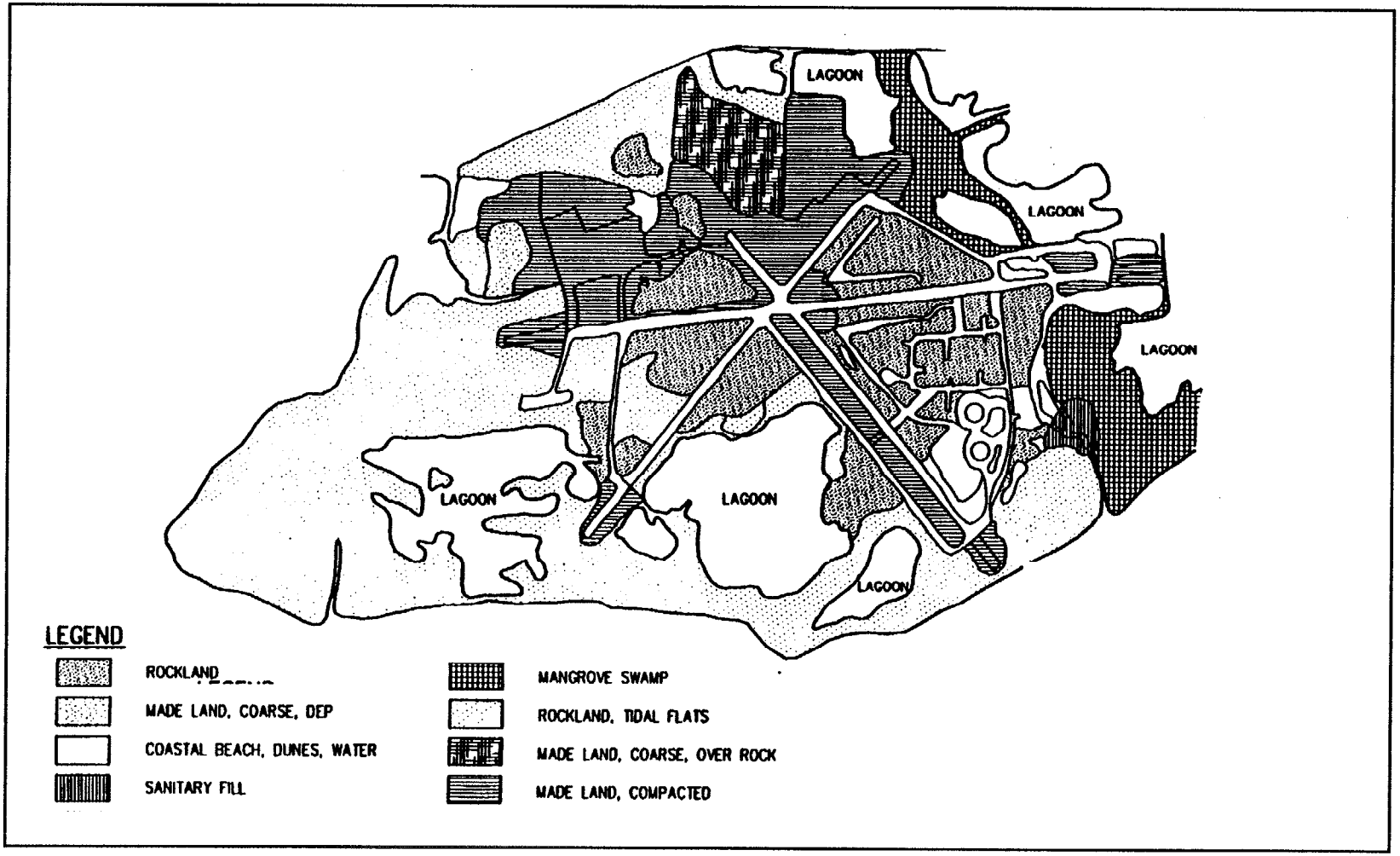

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FIGURE 1-4. GENERAL SOILS MAP
BOCA CHICA KEY

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: MDB	SCALE: -	DATE: 06/04/96	REV: 0
CHECKED BY: RML	CONTRACT NO.: -	FILE NAME: 7046-28\Mod-0-BG\F1-4GSL8.CDR	

Formation is between 300 and 900 feet below land surface (bls) and contains mineralized water that is not of adequate quality for drinking water. The Hawthorn and Tampa Formations underlie the Tamiami Formation and together act as an aquiclude confining the underlying limestones. In the Florida Keys, intermittent lenses within this layer contain water of poor drinking quality. The Suwannee Limestone, a fossiliferous limestone, represents the top of the water-producing zone in the Florida Keys. The water is of good enough quality to be used for drinking, after some treatment. The Avon Park Limestone lies 1,300 feet bls, and, although it has a higher transmissivity than the Suwannee Limestone and supplies large quantities of drinking water in central Florida, the quality of water obtained from this formation is poor in the Florida Keys (ABB 1995a).

1.4 HYDROLOGY

The surface-water regime in the Florida Keys is dominated by the surrounding saltwater bodies, the Atlantic Ocean and the Gulf of Mexico. The FDEP classifies surface water in the Florida Keys as Class III Waters - Recreational, Propagation and Management of Fish and Wildlife. In the immediate area of NAS Key West are the Great White Heron National Wildlife Refuge and the Key West National Wildlife Refuge, which are classified by FDEP as Outstanding Florida Waters and are afforded the highest protection by the State. These waters are considered to be of exceptional recreational and ecological significance to the residents of Florida (ABB 1995a).

Freshwater recharge reaches the Lower Keys directly through rainfall. The nearly flat topography and porous nature of exposed limestone allows much of this rainfall to infiltrate to shallow groundwater tables, forming freshwater lenses. Remaining rainfall is carried to tidal waters by overland flow or via storm drains found in most of the more developed areas. Accelerated runoff and increased saltwater intrusion from canals, housing, dewatering as a mosquito control measure, and marinas decrease the freshwater lens on the Florida Keys, which shortens the period that residents can draw on freshwater supplies, and affects water quality. During the dry season, freshwater tends to disappear quickly by seepage to the sea and evaporation. Evaporation exerts an important effect on the Florida Keys' hydrologic budget, with transpiration affecting a more localized and confined area on individual islands (Schomer and Drew 1982).

1.5 EPA GUIDANCE ON BACKGROUND CHARACTERIZATION

Characterization of background soil, groundwater, surface water, and sediment is necessary for RCRA site investigations. EPA has published several documents that discuss procedures to select numbers and locations of sampling points, data quality objectives, data validation procedures, statistical methods for evaluating data, and end use of background data and statistics.

The general procedures to be used in a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI are outlined in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA 1988a). This document states that sampling should be conducted in areas perceived to be upgradient from the contaminant source in order to identify background levels and to determine if there are contributions of contaminants from other sources. However, the document does not contain details about the amount of data, quality of data, or methods of data evaluation necessary for background characterization.

Details about data quality and evaluation are discussed in the document entitled "Risk Assessment Guidance for Superfund Human Health Evaluation Manual, Part A, Interim Final" (EPA 1989a). This document states that:

> "Background samples are collected at or near the hazardous waste site in areas not influenced by site contamination. They are collected from each medium of concern in these offsite areas. That is, the locations of background samples must be from areas that could not have received contamination from the site, but do have the same basic characteristics as the medium of concern at the site."

The Risk Assessment Guidance for Superfund (RAGS) suggests that statistics can be used in some cases to test the hypothesis that "there is no difference between contaminant concentrations in background areas and on site." This is referred to as the null hypothesis. If statistics are to be used, RAGS further states that "the number of background samples collected at a site should be sufficient to accept or reject the null hypothesis with a specified likelihood of error."

Guidance on background characterization for RCRA-related studies is provided in the following documents:

- "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document" (EPA 1986b)
- "Statistical Methods for Evaluating Ground-Water Monitoring from Hazardous Waste Facilities, Final Rule" (EPA 1988b)
- "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance" (EPA 1989b)
- "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance" (EPA 1992a)

RAGS suggests the following guidance for "detailed information on soil sampling locations, general soil and vegetation conditions, and sampling equipment, strategies, and techniques:"

- "Test Methods for Evaluating Solid Waste (SW-846): Physical/Chemical Methods" (EPA 1986c)
- "A Compendium of Superfund Field Operations Methods" (EPA 1987a)
- "Soil Sampling Quality Assurance Guide" (EPA Review Draft 1989c)

RAGS suggest the following documents for detailed information concerning surface water and sediment sampling, such as selecting sampling locations and sampling equipment, types, and techniques:

- "Procedures for Handling and Chemical Analysis of Sediment and Water Samples" (EPA 1981)
- "Sediment Sampling Quality Assurance User's Guide" (EPA 1984)
- "Methods Manual for Bottom Sediment Sample Collection" (EPA 1985)
- "A Compendium of Superfund Field Operations Methods" (EPA 1987a)
- "An Overview of Sediment Quality in the United States" (EPA 1987b)
- "Proposed Guide for Sediment Collection, Storage, Characterization and Manipulation" (The American Society for Testing and Materials, undated)

2.0 PREVIOUS INVESTIGATIONS

Several investigations of the sites on Boca Chica Key were performed in the past. This section provides a brief overview of the investigations from which site-specific background data were obtained, and summarizes other investigations conducted at NAS Key West.

2.1 BECHTEL ENVIRONMENTAL, INC. DELINEATION AND CONFIRMATORY SAMPLING

Bechtel Environmental, Inc. (BEI) implemented Interim Remedial Actions in 1995 and early 1996 at some NAS Key West sites (BEI 1995b). BEI collected numerous soil, sediment and surface water samples at SWMU 1, SWMU 2 and SWMU 3 before and after excavation, and treatment and disposal activities associated with interim remedial actions at these sites. These data were collected to delineate limits of excavation and to confirm that impacted soils were in fact removed. Some samples from SWMU 1 and SWMU 2 are used in the background characterization of Boca Chica Key as site-specific background samples.

2.2 IT CORPORATION RFI/RI

IT Corporation conducted soil, surface water, sediment, and groundwater sampling at all SWMUs and IR sites as part of the original RFI/RI sampling program. These activities were reported in the RFI/RI Final Report (IT 1994).

During the RFI/RI (Phase I), 25 site-specific background samples were collected from surface soil, sediment, surface water, and groundwater at five sites. The analytical results for these samples were evaluated by IT Corporation to determine if the samples were representative of background conditions. The analytical results indicate that some of the designated background sample locations contained organic compounds or high concentrations of inorganic compounds.

IT Corporation only retained 9 of the 25 samples (4 surface soil, 3 surface water, and 2 groundwater samples) as background data for use in the RFI/RI (Phase I). IT Corporation noted that the data set was too small to represent site-specific background conditions; therefore, the samples were grouped by media to provide a data set that was representative of regional conditions.

2.3 OTHER INVESTIGATIONS

Several other investigations have been performed at NAS Key West although no background data are available as a result of these studies. These studies were performed to confirm or characterize contamination rather than determine background conditions. A summary of each study is presented in the remainder of this section.

As part of the Naval Assessment and Control of Installation Pollutants Program (NACIP), an Initial Assessment Study (IAS) was performed by Envirodyne Engineers, Inc., at NAS Key West in 1985 (Envirodyne Engineers 1985). Additional evaluation was recommended for six sites and three other sites were recommended for investigation based on information collected after completion of the IAS report.

The verification phase of the NACIP confirmation study was performed in 1986 by Geraghty and Miller (Geraghty & Miller 1987). The presence or absence of shallow groundwater and soil contamination at the various sites was verified during this study. The verification study report (March 1987) recommended sites that needed further site-specific investigations during the second phase (the characterization phase) of the confirmation study.

In April 1988, a visual site inspection (VSI) was conducted by EPA at NAS Key West as part of the RFA process (EPA 1988c). Seven SWMUs were identified and recommended for a RCRA facility assessment (RFA) under a HSWA permit. EPA then conducted an RFA and prepared a draft RFA report in 1988 (EPA 1988c).

A final remedial investigation (RI) report was prepared by IT Corporation (IT 1991). The RI was conducted to evaluate potential contaminant sources at eight NAS Key West sites. The objectives included assessing the risk to the environment and human health and determining if remedial actions were required.

From October 1993 to February 1994, a petroleum contamination assessment of the Jet Engine Test Cell, Building A969, (SWMU 9) was conducted by ABB. The contamination assessment report (ABB 1994) identified petroleum and 1,2-dichloroethene contamination in groundwater.

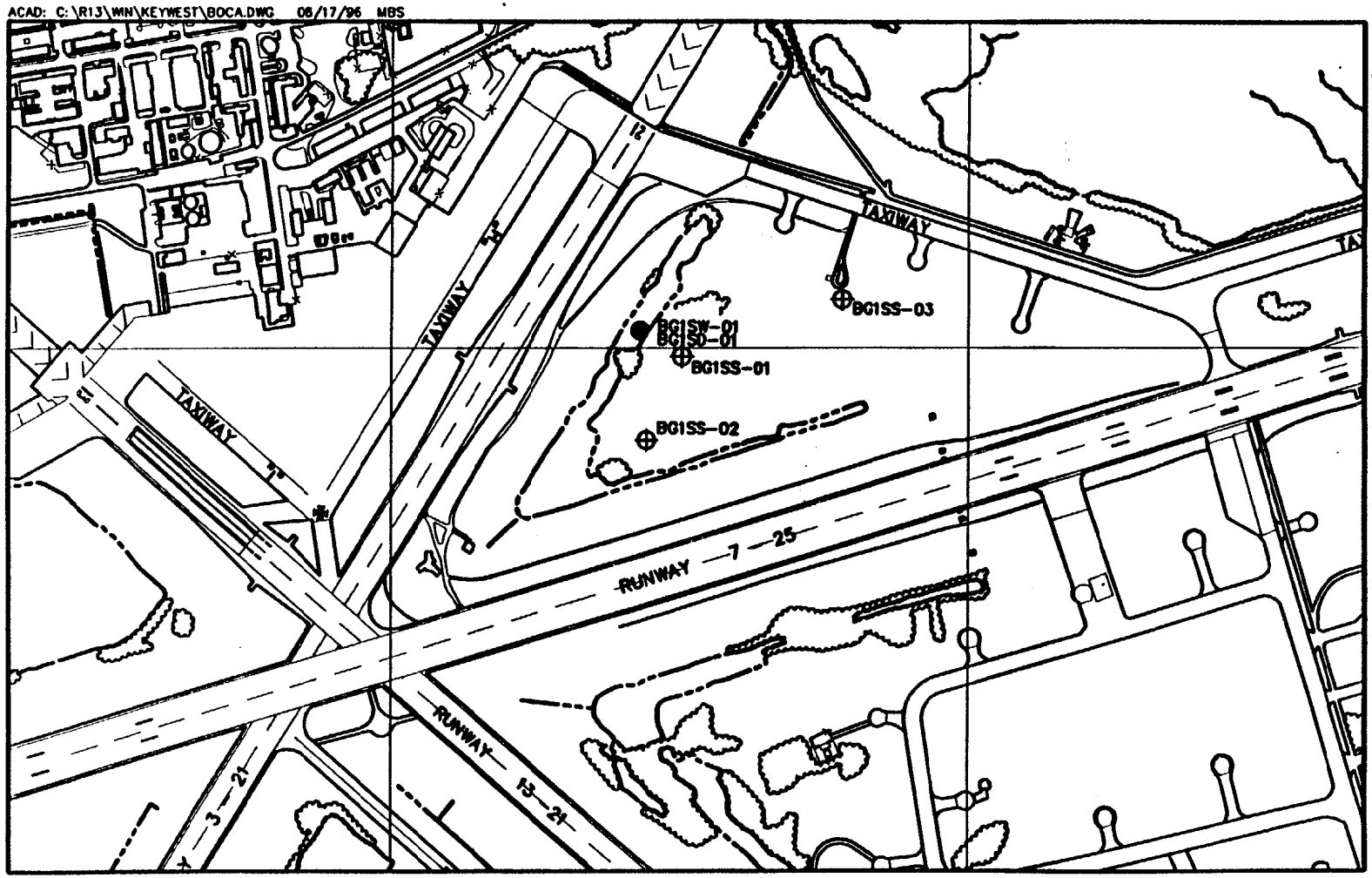
An additional assessment of groundwater at the Jet Engine Test Cell was conducted by BEI in 1995 to complete characterization of the extent of groundwater contamination and to perform aquifer tests to support evaluation of a pump-and-treat system (BEI 1995c).

3.0 SUPPLEMENTAL RFI/RI BACKGROUND SAMPLING

Based on the RFI/RI Phase I analytical results and the need for a more complete background data set for Boca Chica sites, additional background samples (surface soil, surface water, sediment and biota) as proposed in the ABB workplan (ABB 1995a) were collected by B&R Environmental during the supplemental RFI/RI. Site-wide and site-specific background samples were collected.

Three facility-wide background areas were selected to represent Boca Chica Key as a whole. Site-wide background locations on Boca Chica Key were selected based on a review of site aerial photographs, historical maps, and field visits. At each of the three site-wide background sites (BG 1, BG 2, and BG 3) soil, sediment and surface water samples were collected and analyzed. In addition, sediment and surface water samples were collected for toxicity tests and biological sampling was conducted. One of the background sites (BG 1) is far from any SWMU, but close to the runways of the NAS. This site was chosen to reflect any site-wide contamination that might be ubiquitous at Boca Chica Key due to historic military operations or civilian development. The other two background sites were selected on Boca Chica Key but are far from airfield operations and military or civilian development and represent pristine Boca Chica Key conditions to the maximum extent possible. Site-wide background sampling locations are shown in Figures 3-1, 3-2, and 3-3.

In addition, several site-specific soil and groundwater samples were collected for background characterization during the January 1996 supplemental RFI/RI field investigation. Procedures for sampling will be discussed in the RFI/RI. These locations are discussed in more detail in Sections 4.2.2 and 4.2.5.



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LEGEND
- SURFACE WATER & SEDIMENT SAMPLE LOCATION
- SURFACE SOIL SAMPLE LOCATION

0 600 1200
SCALE IN FEET

FIGURE 3-1. BOCA CHICA KEY
BACKGROUND 1 – SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: MBS	SCALE: –	DATE: 06/04/96	REV: 0
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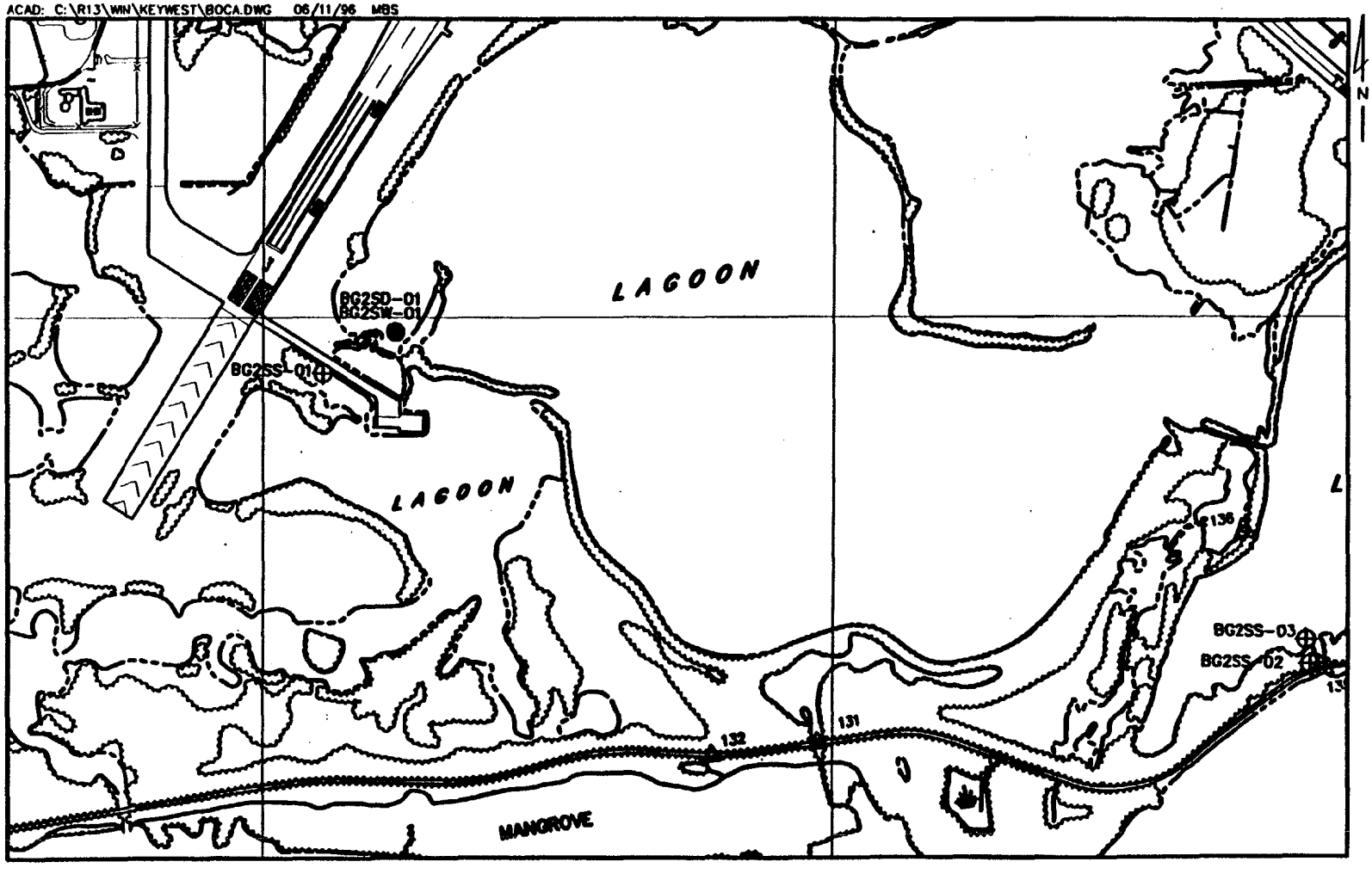

Brown & Root Environmental

LEGEND
- SURFACE WATER & SEDIMENT SAMPLE LOCATION
- SURFACE SOIL SAMPLE LOCATION

0 600 1200
SCALE IN FEET

FIGURE 3-2. BOCA CHICA KEY BACKGROUND 2 – SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

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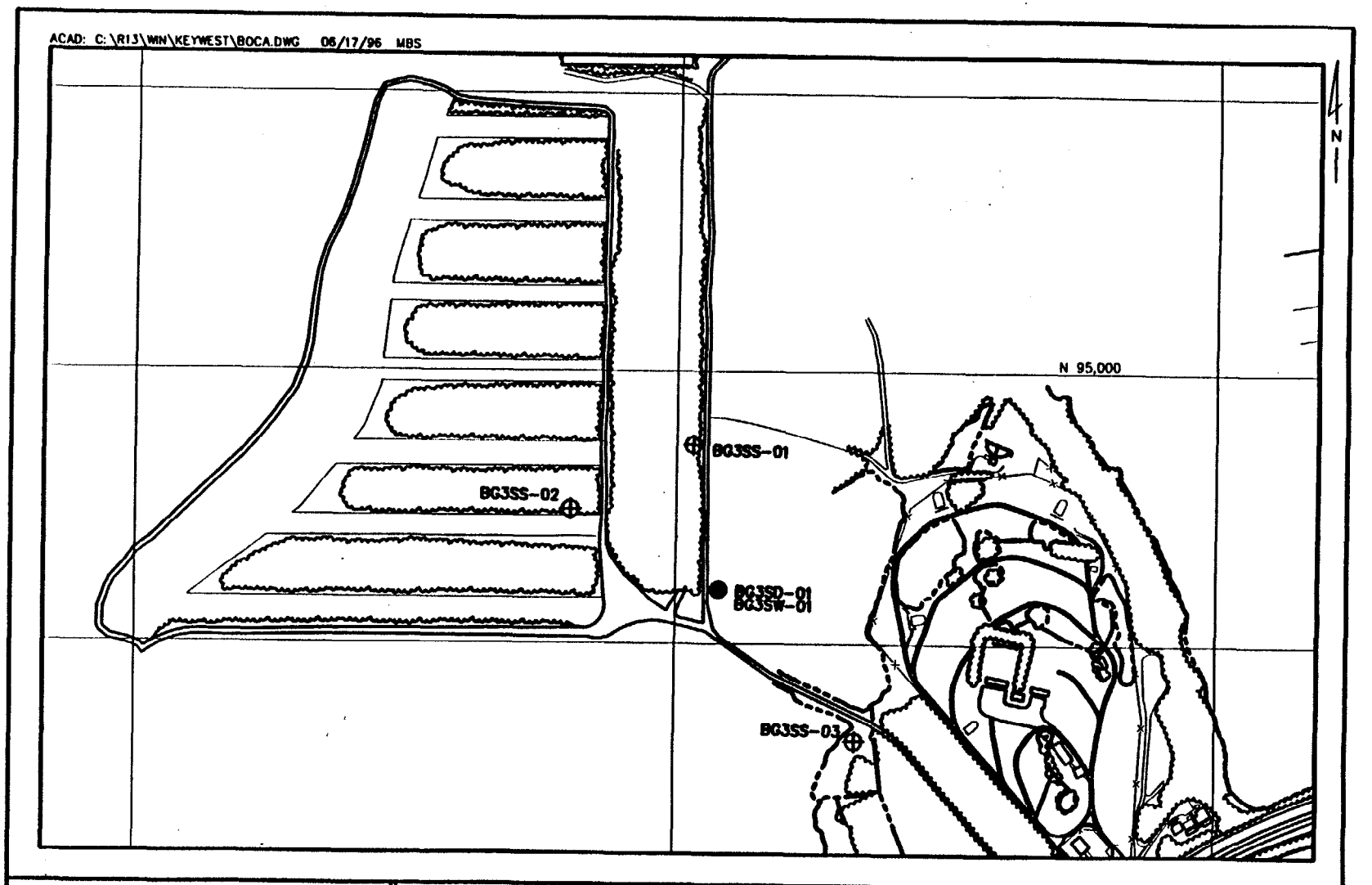
CHECKED BY: RML	CONTRACT NO: –	FILE NAME: KEY WEST/T1/BOCA.DWG	



Brown & Root Environmental

LEGEND
SURFACE WATER & SEDIMENT SAMPLE LOCATION
SURFACE SOIL SAMPLE LOCATION

0 600 1200
SCALE IN FEET

FIGURE 3-3. BOCA CHICA KEY
BACKGROUND 3 - SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: MBS	SCALE: -	DATE: 06/04/96	REV: 0
CHECKED BY: RML	CONTRACT NO.: -	FILE NAME: KEY WEST/T1/BOCA.DWG	

4.0 DEVELOPMENT OF THE RI BACKGROUND DATA SET

During investigations of NAS Key West, a substantial amount of soil, sediment, surface water, and groundwater data have been generated. Biota and toxicological background data have also been collected from some of the sites. A portion of these data representing site-specific and site-wide background locations have been extensively evaluated for use in the characterization of Boca Chica background conditions. This section discusses the development of the comprehensive data set used to characterize background conditions at Boca Chica Key. The discussion includes the selection and evaluation of background sample locations from previous investigations, the methodology used for screening each potential background sample, and sampling locations for the final data set. Table 4-1 summarizes the final background data set. Although many summary tables of detections are provided in Sections 6 through 10 of this report, all raw data used for this background report has not been included and will be provided as a separate data appendix in the final RFI/RI report.

4.1 SELECTION OF THE BACKGROUND DATA SET

The selection of the final background data set included an initial review of background sample data sources. Each previous investigation report was reviewed to identify samples that were collected from locations considered to represent background conditions by a previous contractor. All site-specific and site-wide background samples collected by B&R Environmental in accordance with the Supplemental RFI/RI SAP were added to the background data set.

Soil and sediment sample locations from the background data set were compared to BEI interim remedial action excavation boundaries. If the sample was collected prior to BEI interim remedial actions and fell within the boundaries of an excavation, it was eliminated from the background data set. Discarding this data was necessary to insure that data from samples collected within a site that was contaminated enough to require an interim remedial action was not included in the background data set. In addition, the locations of samples designated by previous contractors as background were re-evaluated to determine if the locations could have been affected by site operations. Data from samples collected in questionable locations (i.e., areas affected by site operations) were discarded as background samples and retained for use as site data. The retained samples are considered the background data sample set for Boca Chica Key (Table 4-1).

TABLE 4-1

**BACKGROUND DATA FOR BOCA CHICA KEY
NAS KEY WEST, FLORIDA
PAGE 1 OF 2**

Site	Groundwater	Soil	Media Surface Water	Sediment	Biota	Data Source
SWMU 1	NA	S1SB-7 (Grid location U25)	S1SS-7SW (Grid location AB18)	S1SS-7SD (Grid location AB18)	NA	BEI 1994
	S1MW-3	S1SS-4 (T)	NA	NA	NA	B&R Environmental 1996
SWMU 2	S2MW-1 (AS1071 for all parameters except for pest/ PCBs use AS2184)	NA	NA	NA	NA	IT 1994
	NA	S2SB-9 (Grid location AC13)	S2SS-4SW (Off-grid)	NA	NA	BEI 1994
	S2MW-1 S2MW-4	NA	NA	NA	NA	B&R Environmental 1996
SWMU 3	NA	S3BG-1 (AS1526, AS2168) S3BG-1 (AS2167)	S3SS-4 (AS1096)	NA	NA	IT 1994
SWMU 4	S4MW-1 (AS1137)	NA	S4BG-1 (AS1122)	S4BG-1 (AS1123)	NA	IT 1994
SWMU 7	S7MW-2 (AS1135)	NA	S7SS-4 (AS1117)	NA	NA	IT 1994
Boca Chica Background 1	NA	BG1SS-01 (T) BG1SS-02 BG1SS-03	BG1SW-01 (T)	BG1SD-01 (T)	BG1F-01 BG1F-02 BG1F-03 BG1F-04 BG1F-05 BG1F-06 BG1F-07 BG1F-08 BG1F-09 BG1F-10 BG1F-11 BG1F-13 BG1F-14 BG1F-15 BG1F-16 BG1F-17 BG1F-18 BG1F-19 BG1F-21 BG1F-22 BG1F-23	B&R Environmental 1996

TABLE 4-1

**BACKGROUND DATA FOR BOCA CHICA KEY
NAS KEY WEST, FLORIDA
PAGE 2 OF 2**

Site	Groundwater	Soil	Media Surface Water	Sediment	Biota	Data Source
Boca Chica Background 2	NA	BG2SS-01 (T) BG2SS-02 BG2SS-03	BG2SW-01 (T)	BG2SD-01 (T)	BG1F-24 BG1F-25 BG1F-26 BG1F-27 BG1F-28 BG2F-01 BG2F-02 BG2F-03 BG2F-04 BG2F-05 BG2F-06 BG2F-07 BG2F-08 BG2F-09 BG2F-10	B&R Environmental 1996
Boca Chica Background 3	NA	BG3SS-01 (T) BG3SS-02	BG3SW-01 (T)	BG3SD-01 (T)	BG3F-03 BG3F-04 BG3F-06 BG3F-07 BG3F-08 BG3F-09 BG3F-10 BG3F-11 BG3F-12 BG3F-13 BG3F-14 BG3F-15 BG3F-16 BG3F-17 BG3F-18 BG3F-19 BG3F-20 BG3F-21 BG3BV-01 BG3BV-02 BG3BV-03	B&R Environmental 1996
Total No. Locations Sampled	6	13	8	5	56 samples (53F/3BV)	

NA: No background samples collected
T: Toxicity tests conducted
F: Fish sample
BV: Bivalve (oyster) sample

Selection of background data also involved evaluating the chemical constituents detected in the sample as compared to other background samples. Inorganic or organic constituents that were detected in a sample at unusually high values when compared to the other background samples (using best professional judgment) were considered to be statistical outliers. Detected values for inorganic and organic constituents were ordered according to descending values for comparison within each media or species. Unusually high inorganic values, as determined through professional judgment, were considered to be statistical outliers and the specific inorganic outliers were removed from the background data set. Two samples (S3SS-4 and S7SS-4) contained numerous metal outliers and these samples were completely discarded from the background data set.

Pesticide and PAH values were also evaluated for statistical outliers. If these fractions were detected at low concentrations, they were considered anthropogenic yet ubiquitous and the sample was retained. If the fractions were detected at relatively high concentrations or several pesticides or several PAHs were detected, the sample was not considered to be representative of background and was removed from the background data set. The presence of chlorinated aliphatic or aromatic compounds was considered indicative of contamination and the sample was removed from the background data set in a first run of the statistics, as described in Section 5.2.3. One sample had evidence of petroleum contamination, indicated by the presence of toluene and ethylbenzene. Therefore, that sample was not retained as a background sample in the first statistical run, but was retained in the second statistical run, as described in Section 5.2.3.

Table 4-2 summarizes the background samples that were evaluated for use in the background report and lists the reasons for retaining or discarding the samples as representative background samples.

4.2 BACKGROUND SAMPLING LOCATIONS

This section discusses the locations for all background samples in the background data set. Soil, sediment, surface water and groundwater background data were obtained from three site-wide locations (BG 1, BG 2, and BG 3) and five site-specific locations (SWMU 1, SWMU 2, SWMU 3, SWMU 4 and SWMU 7). Biological background data were obtained from BG 1, BG 2, BG 3, and SWMU 1.

TABLE 4-2

SUMMARY OF EVALUATION OF POTENTIAL BACKGROUND SAMPLES
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 3

Site	Location	Sample ID	Media	Source	Comments
BG 1	BG1SS-01	NA	SO	BRE 1996	Retained.
	BG1SS-02	NA	SO	BRE 1996	Retained.
	BG1SS-03	NA	SO	BRE 1996	Retained.
	BG1SW-01	NA	SW	BRE 1996	Retained.
	BG1SD-01	NA	SD	BRE 1996	Retained.
BG 2	BG2SS-01	NA	SO	BRE 1996	Retained.
	BG2SS-02	NA	SO	BRE 1996	Retained.
	BG2SS-03	NA	SO	BRE 1996	Retained.
	BG2SW-01	NA	SW	BRE 1996	Retained.
	BG2SD-01	NA	SD	BRE 1996	Retained. Arsenic outlier discarded.
BG 3	BG3SS-01	NA	SO	BRE 1996	Retained. Sample not included in Run 1 due to 1,1,2,2-TCA, chloroform, and bis(2-chloroisopropyl)ether.
	BG3SS-02	NA	SO	BRE 1996	Retained.
	BG3SS-03	NA	SO	BRE 1996	Discarded due to many metal outliers.
	BG3SW-01	NA	SW	BRE 1996	Retained.
	BG3SD-01	NA	SD	BRE 1996	Retained.
SWMU 1	S1MW-3	NA	GW	BRE 1996	Retained.
	S1SB-6	KW02564	SO	BEI 1995	Discarded due to PAHs.
	S1SB-7 (Grid location U25)	KW02561	SO	BEI 1995	Retained. Sample not included in Run 1 due to aroclor-1260 and TCE.
	S1SS-4	NA	SO	BRE 1996	Retained. Sample not included in Run 1 due to toluene and ethylbenzene.
	S1SS-1	AS1248	SW	IT 1994	Discarded due to location. Based on field knowledge of the site, this sample is believed to have been collected from one of the 3 ditches east of the open disposal area (one of which contained 55-gallon drums).
	S1SS-7SW (Grid location AB-18)	KW02568	SW	BEI 1995	Retained.
	S1SS-1	AS1249	SD	IT 1994	Discarded due to location. Based on field knowledge of the site, this sample is believed to have been collected from one of the 3 ditches east of the open disposal area (one of which contained 55-gallon drums).
	S1SS-7SD (Grid locaton AB-18)	KW02569	SD	BEI 1995	Retained. Sample not included in Run 1 due to hexachlorophene.
SWMU 2	S2MW-1	NA	GW	BRE 1996	Retained.
	S2MW-4	NA	GW	BRE 1996	Retained.

TABLE 4-2

SUMMARY OF EVALUATION OF POTENTIAL BACKGROUND SAMPLES
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 3

Site	Location	Sample ID	Media	Source	Comments
SWMU 2 (cont't)	S2MW-1	AS1071	GW	IT 1994	Retained. Lead and antimony outliers discarded. Pesticide/PCBs data omitted because lab exceeded holding time.
	S2MW-1	AS2184	GW	IT 1994	Retained. Pesticide/PCBs only. Resample of AS1071 due to lab exceeding holding time for pesticides/PCBs.
	S2SB-2	AS1505	SO	IT 1994	Discarded due to location. Sample collected from area affected by previous site activities.
	S2SB-2	AS1503	SO	IT 1994	Discarded due to location. Sample collected from area affected by previous site activities.
	S2SB-9 (Grid location Ac-13)	NA	SO	BEI 1995	Retained.
	S2SS-1	AS1069	SW	IT 1994	Discarded due to location. This sample was collected from the SWMU 2 ditch.
	S2SS-1	AS2183	SW	IT 1994	Discarded due to location This sample was collected from the SWMU 2 ditch. Resample of AS1069 for pesticides/PCBs due to lab exceeding holding time.
	S2SS-1	AS1070	SD	IT 1994	Discarded due to location This sample was collected from the SWMU 2 ditch. (The sediment in this part of the ditch was excavated by BEI 1995).
	S2SS-4SD	KW02591	SD	BEI 1995	Discarded due to location. Sample collected at outfall/inlet of pipe running northwest from ditch.
SWMU 3	MW10-1	AS1091	GW	IT 1994	Discarded due to location in relation to burn areas and groundwater flow toward northeast, as presented in IT 1994 report.
	S3BG-1	AS1524	SO	IT 1994	Discarded. TCLP analysis data.
	S3BG-1	AS1526	SO	IT 1994	Retained.
	S3BG-1	AS2167	SO	IT 1994	Retained. Resample of AS1524 location analyzed for herbicides.
	S3BG-1	AS2168	SO	IT 1994	Retained. Resample of AS1526 location analyzed for herbicides.
	S3SS-4	AS1096	SW	IT 1994	Retained.
	S3SS-4	AS1097	SD	IT 1994	Discarded due to many outliers, especially metals.
	S3SS-4	AS1569	SD	IT 1994	Discarded due to outliers. Resample of AS1097 VOCs only.

TABLE 4-2

SUMMARY OF EVALUATION OF POTENTIAL BACKGROUND SAMPLES
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 3 OF 3

Site	Location	Sample ID	Media	Source	Comments
SWMU 4	S4MW-1	AS1137	GW	IT 1994	Retained.
	S4SB-19	AS1390	SO	IT 1994	Discarded due to location. Sample collected from area affected by previous site activities.
	S4SB-19	AS1577	SO	IT 1994	Discarded due to location. Sample collected from area affected by previous site activities.
	S4SB-19	AS1391	SO	IT 1994	Discarded due to location. Sample collected from area affected by previous site activities.
	S4SB-19	AS1578	SO	IT 1994	Discarded due to location. Sample collected from area affected by previous site activities.
	S4BG-1	AS1122	SW	IT 1994	Retained. Lead outlier discarded.
	S4BG-1	AS1123	SD	IT 1994	Retained.
SWMU 7	S7MW-2	AS1135	GW	IT 1994	Retained.
	S7SB-13A	AS1547	SO	IT 1994	Discarded due to PAHs and DCE in sample.
	S7SS-4	AS1117	SW	IT 1994	Retained. Antimony and barium outliers discarded.
	S7SS-4	AS1118	SD	IT 1994	Discarded due to many outliers (DCE, pesticides, metals).

4.2.1 Description of Site-Wide Background Locations

Site-wide background locations were sampled in accordance with the Supplemental RFI/RI Sampling and Analysis Plan (ABB 1995b). A description of each site-wide Boca Chica Key background location selected during the supplemental RFI/RI is provided below. No historical Boca Chica Key site-wide background data exists.

4.2.1.1 Background Site 1 (BG 1)

Site BG 1 is in the northeastern portion of Boca Chica Key between Perimeter Road and the intersection of the air station's three major runways (Figure 3-1). BG 1 consists of a water-filled borrow pit, apparently excavated to provide fill material for other areas. Scattered red mangrove (*Rhizophora mangle*) trees occur along the water's edge. Terrestrial habitat surrounding the borrow pit consists of various grasses interspersed with areas of bare ground.

The borrow pit is V-shaped, with one segment parallel to and approximately 300 feet from runways 3-21 and the other segment parallel to and approximately 300 feet from runway 7-25. The northern segment is approximately 100 feet wide and 10 feet deep, while the southern segment is approximately 40 feet wide and 3 to 6 feet deep. The borrow pit drains to a channel north of the site via a ditch at the north end of the pit. The elevation of the pit is high enough so that marine water does not flow from the channel into the borrow pit.

4.2.1.1 Background Site 2 (BG 2)

Site BG 2 is in the southern portion of Boca Chica Key and consists of a large lagoon east of runway 3-21 (Figure 3-2). The lagoon is connected by narrow channels to the Atlantic Ocean. Water depth in most portions of the lagoon is 3 feet or less. Red mangrove, black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*) trees occur along the edges of the lagoon. Mangrove swamps occur immediately beyond the edges of most of the lagoon.

4.2.1.2 Background Site 3 (BG 3)

Site BG 3 is in the northwestern portion of Boca Chica Key north of U.S. Highway 1, and consists primarily of a shallow, 8-acre lagoon (Figure 3-3). The lagoon is isolated from marine waters except during storm events. Mangroves occur along the lagoon shoreline. A rockland hammock dominated by the exotic

Australian pine (*Casuarina spp.*) is located to the west and north of the lagoon. Water depth throughout the lagoon is approximately 18 inches.

4.2.2 Soil Sampling Locations

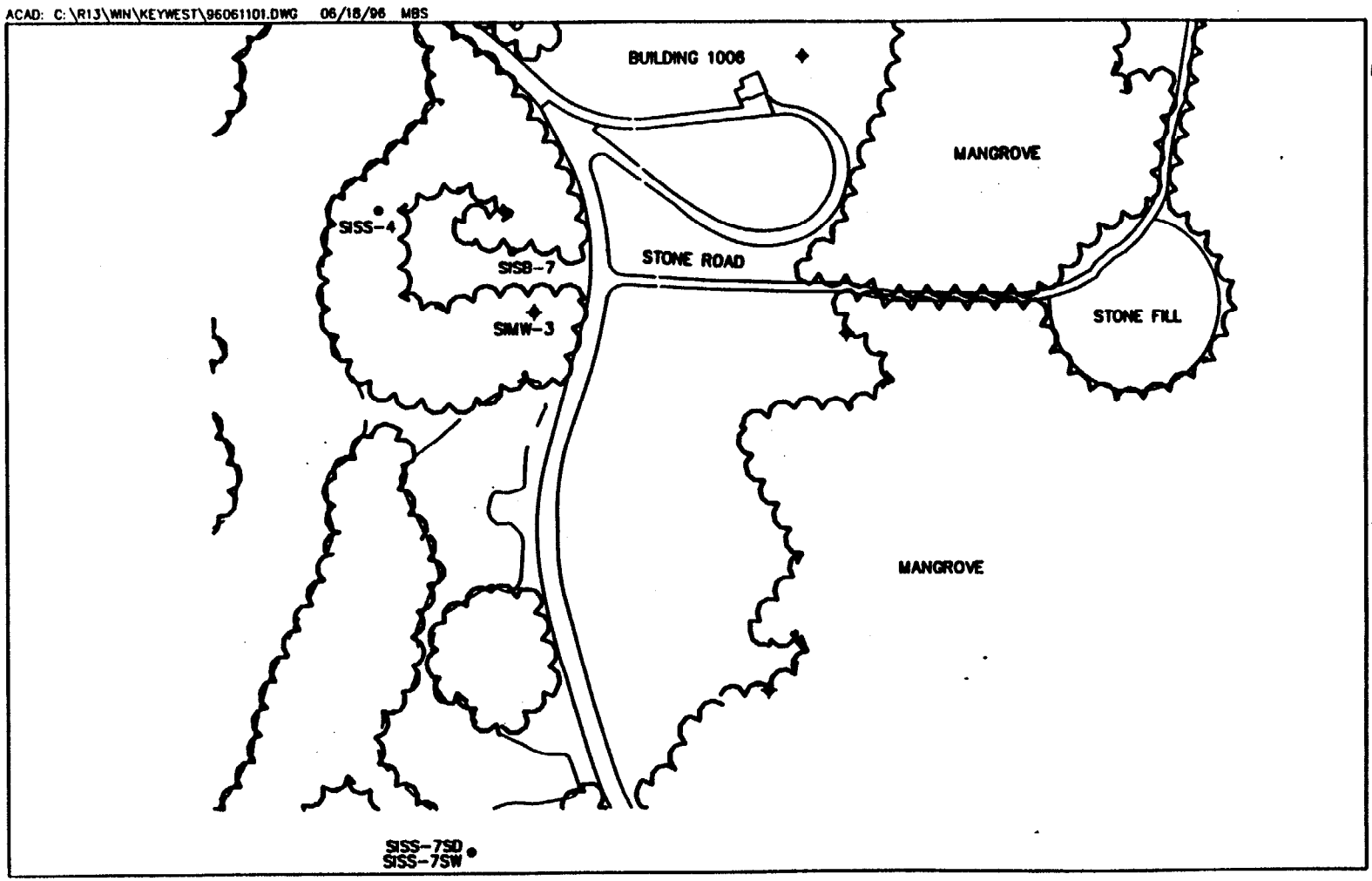
Thirteen soil sampling locations are included in the background data set. Five of these locations were site-specific sample locations: S1SB-7 was collected by BEI during delineation sampling and S1SS-4 was collected by B&R Environmental during the Supplemental RFI/RI in January 1996. Samples S1SB-7 and S1SS-4 are west of the SWMU 1 Open Disposal Area (Figure 4-1). S2SB-9 was also collected during the BEI delineation sampling and is northwest of the SWMU 2 DDT Mixing Area ditch (Figure 4-2). S3BG-1 is north of the SWMU 3 Fire Fighting Training Area burn areas (Figure 4-3). The 0- to 1-foot and 2- to 5-foot interval samples from S3BG-1 were collected by IT Corporation during Phase I of the RFI/RI.

Eight site-wide background soil samples (BG1SS-01, BG1SS-02, BG1SS-03, BG2SS-01, BG2SS-02, BG2SS-03, BG3SS-01, and BG3SS-02) were selected for use in the background characterization (Figures 3-1, 3-2, and 3-3). In accordance with the Supplemental RFI/RI SAP (ABB 1995b), site-wide background samples were collected at nine locations throughout Boca Chica Key from three soil types classified as rockland, compacted made land, and coastal beach, dunes, and water. In some cases, more than one soil type was collected within a site-wide background site.

4.2.3 Surface Water Sampling Locations

Eight surface water samples were selected to characterize background surface water conditions. Five samples comprise the site-specific background surface water data at Boca Chica Key. S1SS-7SW and S2SS-4SW were collected as part of the delineation sampling conducted by BEI at SWMU 1 and SWMU 2, respectively. S1SS-7SW was collected from south of the SWMU 1 Open Disposal Area adjacent to Old Boca Chica Road (Figure 4-1). S2SS-4SW was collected from approximately 310 feet northwest of the headwall of the ditch at SWMU 2 (Figure 4-2). Surface water samples S3SS-4, S4BG-1 and S7SS-4 were collected by IT Corporation during the Phase I of the RFI/RI. Sample S3SS-4 was obtained south of the SWMU 3 Fire Fighting Training Area (Figure 4-3) on the west edge of the mangroves approximately 450 feet from the bank (IT 1994). S4BG-1 was collected from northwest of the SWMU 4 AIMD Building A-980 (Figure 4-4) and S7SS-4 was collected from the ditch southwest of SWMU 7 AIMD Building 824 (Figure 4-5).

Samples were also obtained from three site-wide surface water background locations (BG1SW-01, BG2SW-01, and BG3SW-01). These sampling locations are presented in Figures 3-1, 3-2 and 3-3.



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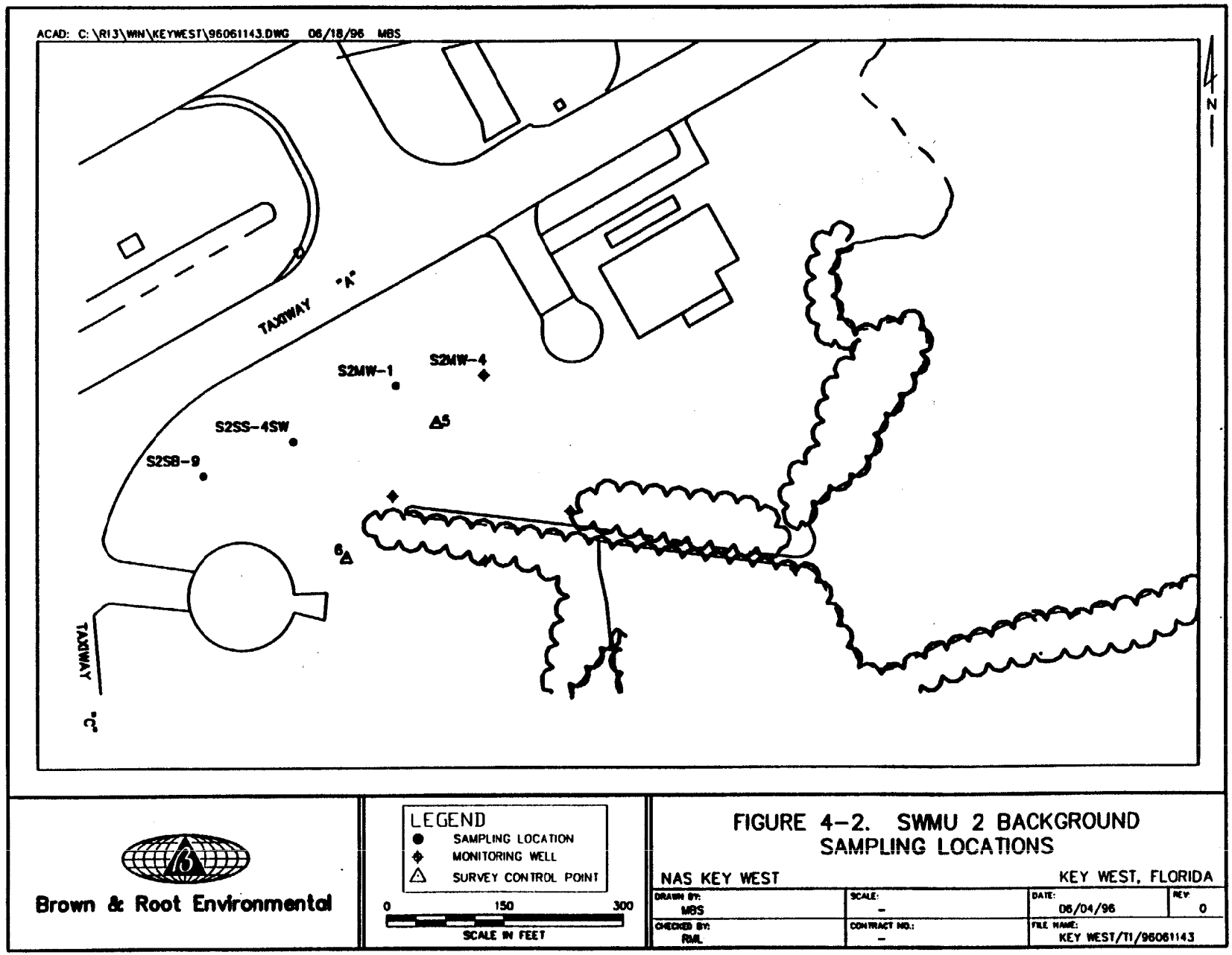
LEGEND
- SAMPLING LOCATION
- MONITORING WELL
- SURVEY CONTROL POINT

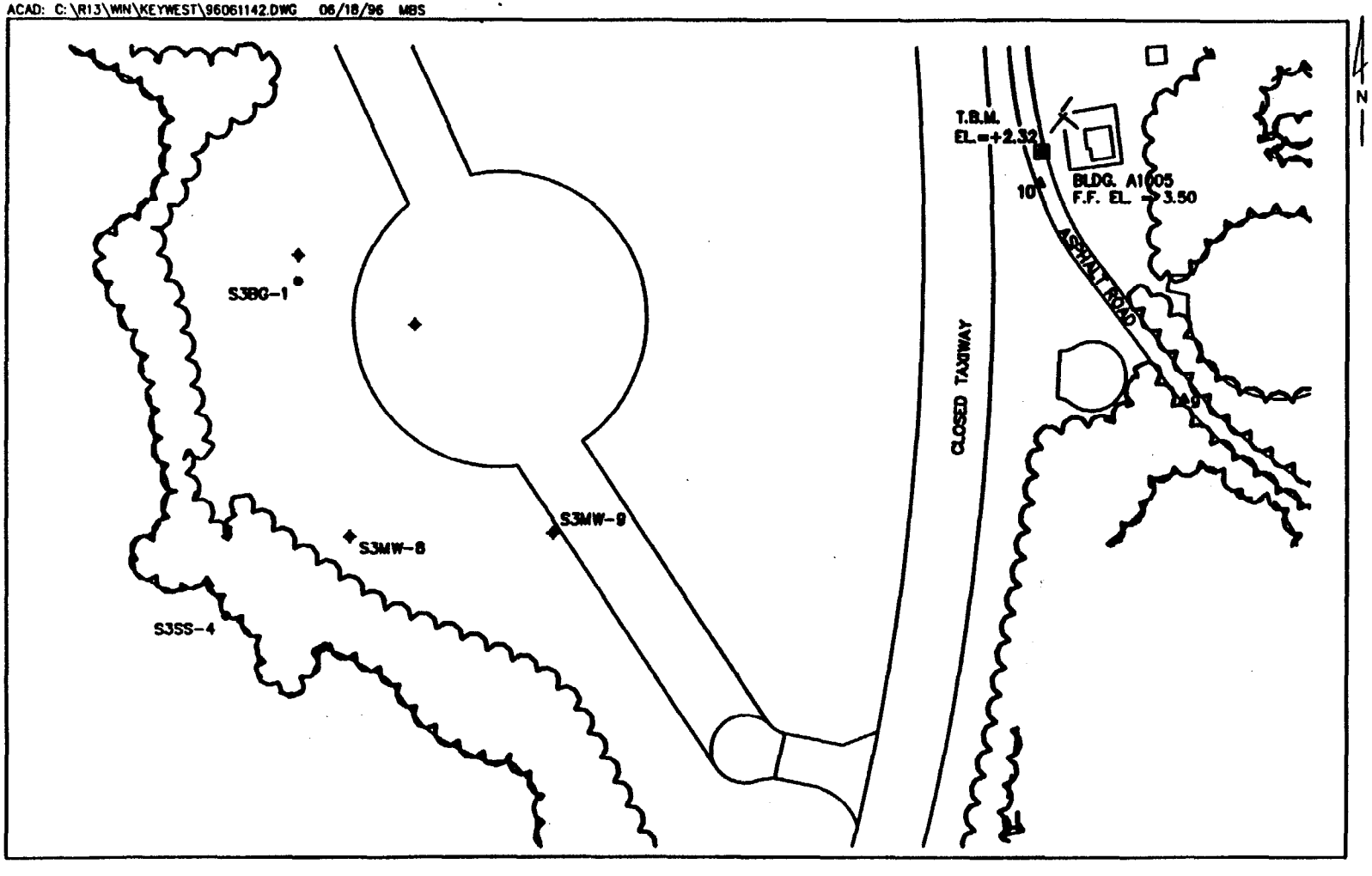
0 150 300
SCALE IN FEET

FIGURE 4-1. SWMU 1 BACKGROUND SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY:	SCALE:	DATE:	REV:
MBS	–	06/04/96	0
CHECKED BY: RML	CONTRACT NO.: –	FILE NAME: KEY WEST/T1/96061101	


ACAD: C:\RI3\WIN\KEYWEST\96061143.DWG 06/18/96 MBS
N
TAXIWAY "A"
S2MW-1
S2MW-4
S2SS-4SW
S2SB-9
5
6
TAXIWAY "C"
Brown & Root Environmental
LEGEND
SAMPLING LOCATION
MONITORING WELL
SURVEY CONTROL POINT
0 150 300
SCALE IN FEET
FIGURE 4-2. SWMU 2 BACKGROUND SAMPLING LOCATIONS
NAS KEY WEST
KEY WEST, FLORIDA
DRAWN BY: MBS
SCALE: -
DATE: 06/04/96
REV: 0
CHECKED BY: RML
CONTRACT NO.: -
FILE NAME: KEY WEST/T1/96061143



Brown & Root Environmental

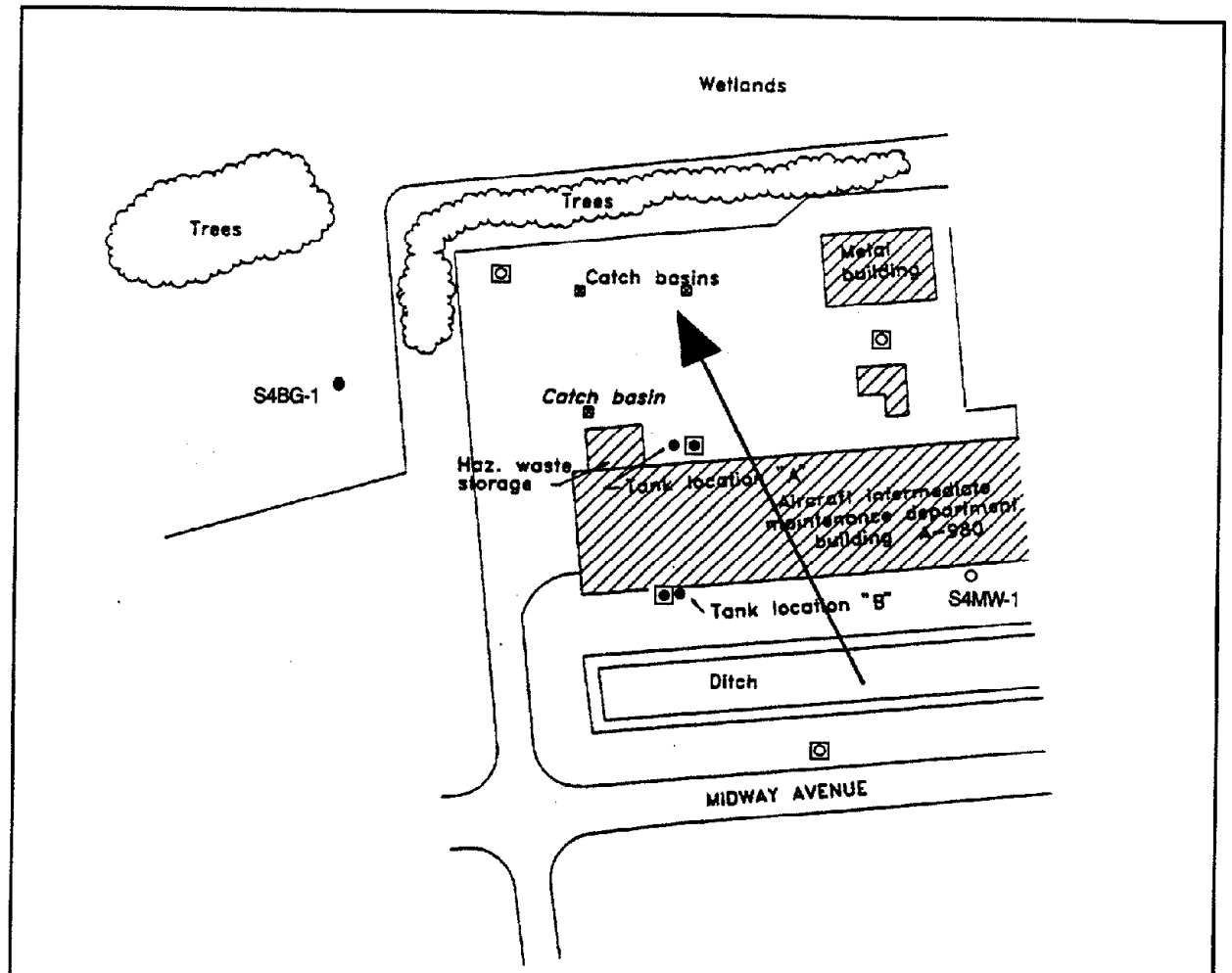
LEGEND
- SAMPLING LOCATION
- MONITORING WELL
- SURVEY CONTROL POINT

0 150 300
SCALE IN FEET

FIGURE 4-3. SWMU 3 BACKGROUND SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: MBS	SCALE: –	DATE: 06/04/96	REV: 0
CHECKED BY: RML	CONTRACT NO.: –	FILE NAME: KEY WEST/T1/96061142	



LEGEND

- NET DIRECTION OF GROUNDWATER FLOW
- FORMER IN-GROUND TANK LOCATION
- EXISTING MONITORING WELL LOCATION
- EXISTING MONITORING WELL AND GROUNDWATER SAMPLING LOCATION
- PROPOSED MONITORING WELL AND GROUNDWATER SAMPLING LOCATION

NOTES:

SWMU SOLID WASTE MANAGEMENT UNIT

RFI/RI RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) FACILITY INVESTIGATION/REMEDIAL INVESTIGATION

SOURCE: IT CORPORATION, 1994.

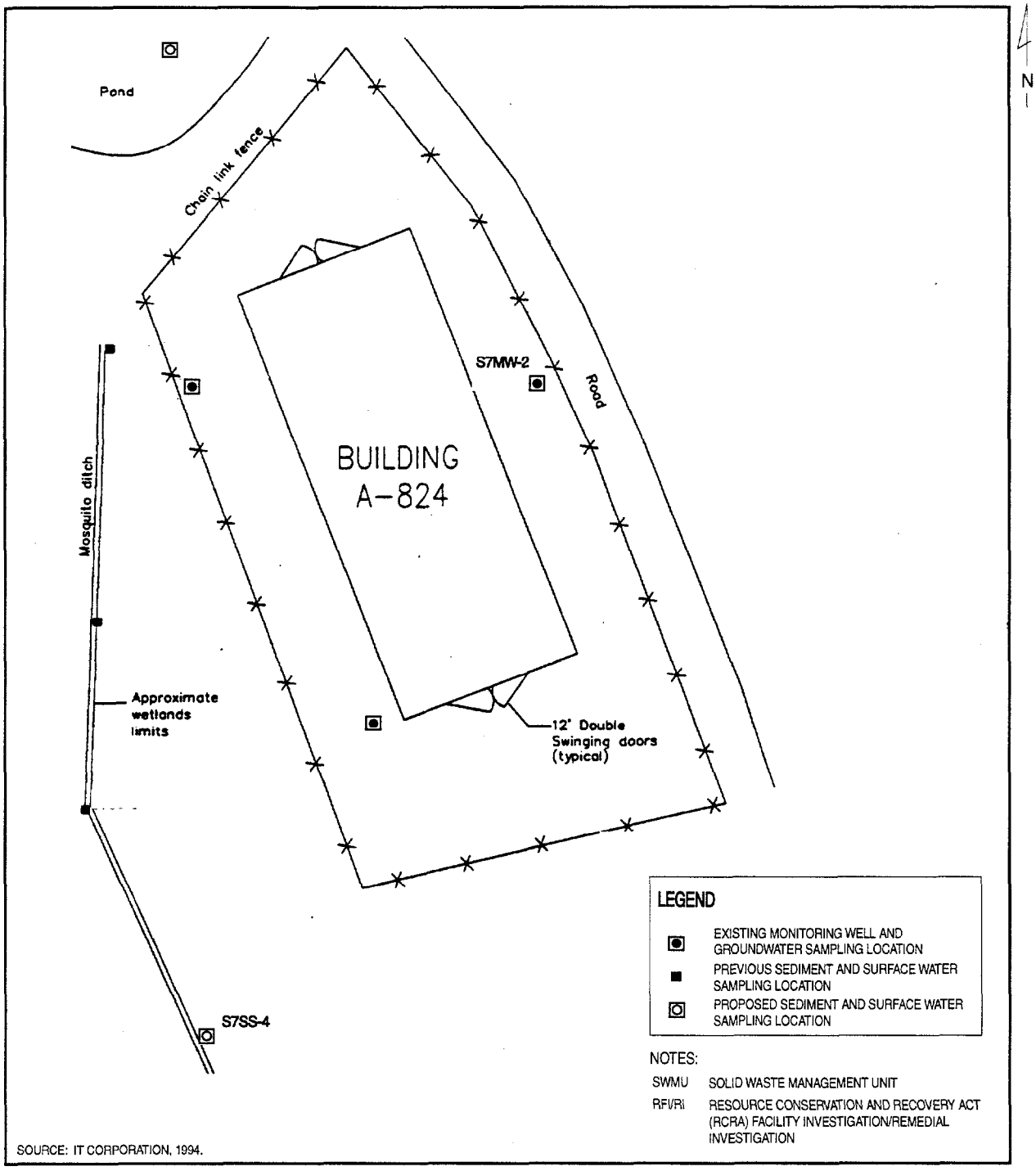
Brown & Root Environmental

0 150 300
SCALE IN FEET

FIGURE 4-4. SWMU 4 BACKGROUND SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: MDB	SCALE: AS NOTED	DATE: 06/04/96	REV: 0
CHECKED BY: RML	CONTRACT NO.: -	FILE NAME: 7045-25\Mod-0\F4-4BSL8.CDR	



Brown & Root Environmental

0 150 300
SCALE IN FEET

FIGURE 4-5. SWMU 7 BACKGROUND SAMPLING LOCATIONS

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY:	SCALE:	DATE:	REV:
MDB	AS NOTED	06/04/96	0
CHECKED BY: RML	CONTRACT NO.: -	FILE NAME: 7046-25\Mod-0\F4-5BSL8.CDR	

4.2.4 Sediment Sampling Locations

A total of five site-specific and site-wide samples were used to characterize background sediment. In 1994, BEI collected S1SS-7SD as part of the delineation sampling at SWMU 1. IT Corporation collected S4BG-1 during Phase 1 of the RFI/RI. Sample S1SS-7SD was collected from south of the SWMU 1 Open Disposal Area, while S4BG-1 was collected northwest of AIMD Building A-980. Samples were also collected from three site-wide background locations (BG1SD-01, BG2SD-01, and BG3SD-01) (Figures 3-1 through 3-3).

4.2.5 Groundwater Sampling Locations

Six site-specific groundwater samples from five monitoring wells are included as background groundwater samples. All background monitoring wells were installed to help characterize background groundwater quality. Monitoring well S1MW-3, sampled by B&R Environmental in January 1996, is west of the SWMU 1 Open Disposal Area across from Stone Road (Figure 4-1).

Monitoring wells S2MW-1 and S2MW-4 are northwest of the SWMU 2 DDT Mixing Area ditch (Figure 4-2). Results from S2MW-1 samples by IT Corporation in 1994 and B&R Environmental in 1996 are both included in the background data set. S2MW-4 was also sampled by B&R Environmental during supplemental RFI/RI field activities in January 1996. S4MW-1 and S7MW-2 background samples were collected by IT Corporation in 1994 (Figures 4-4 and 4-5). Monitoring well S4MW-1 is located south of the SWMU 4 AIMD Building A-980. Monitoring well S7MW-2 is located at the northwest edge of the SWMU 7 AIMD Building A-824.

4.2.6 Biota Sampling Locations

This section discusses biological sampling that was conducted to calculate background conditions at Boca Chica Key. Fish, oysters, and earthworms were collected and analyzed for the same suite of chemical constituents as for soil, sediment and water.

4.2.6.1 Fish

Fish were collected from several locations throughout BG 1 and BG 3 (Figures 3-1 and 3-3). BG 2 fish were collected from the southwestern portion of the large lagoon (Figure 3-2).

Fish collected in gill nets at BG 1 consisted of ladyfish (*Elops saurus*), striped mullet (*Mugil cephalus*), yellowfin mojarra (*Gerres cinereus*), and tarpon (*Megalops atlanticus*). Fish collected in minnow traps at BG 1 consisted of crested goby (*Lophogobius cyprinoides*), sailfin molly (*Poecilia latipinna*), and sheepshead minnow (*Cyprinodon variegatus*). The tarpon were released unharmed to avoid exceeding the bag limit established by FDEP for that species. All other fish were retained for subsequent tissue analyses.

Fish collected in gill nets at BG 2 consisted of pinfish (*Lagodon rhomboides*), gray snapper (*Lutjanus griseus*), bluestriped grunt (*Haemulon sciurus*), and sea robin (*Prionotus sp.*). Fish collected in minnow traps at BG 2 consisted of sailfin molly. All fish were retained for subsequent tissue analyses.

Fish collected in minnow traps at BG 3 consisted of gulf killifish (*Fundulus grandis*), sheepshead minnow (*Cyprinodon variegatus*), and sailfin molly. As a result of the shallow water and isolated character of the lagoon, only minnow-sized fish were available. All fish were retained for subsequent tissue analyses.

4.2.6.2 Oysters

Mangrove oysters (*Isognomon alatus*) were collected from one of several excavated channels approximately 650 feet west of the lagoon at BG 3. The oysters were collected by hand from submersed prop roots of red mangroves along the water's edge. The quantity of oysters collected provided sufficient mass for three samples. These were retained for subsequent tissue analyses. Mangrove oysters were not present at BG 1 or BG 2.

4.2.6.3 Earthworms

Earthworms are not commonly found in the rocky Key West soils and were not collected from background sites. However, laboratory earthworms were utilized for soil toxicity tests. The use of earthworms in soil toxicity tests is a standard procedure in assessing the toxicity of soil contaminants on terrestrial invertebrates. One soil sample was collected from each of four background locations (BG1SS-01, BG2SS-01, BG3SS-01, and S1SS-04) and shipped to an approved testing laboratory for 14-day screening-level toxicity tests using earthworms (*Eisenia foetida*), which were introduced into the samples by the laboratory. To investigate bioaccumulation of contaminants by soil-dwelling organisms, earthworms were reared in soil samples for an additional 14 days beyond the 14-day toxicity test. Following the 28-day study, earthworm samples were subjected to laboratory analysis of metals.

4.3 SAMPLE COLLECTION

Methods for sampling soil, surface water, sediment, and groundwater are specified in the supplemental RFI/RI SAP (ABB 1995b). Methods for sampling biota are specified in the Ecological Sampling Technical Memorandum, December 1995 (B&R Environmental 1995). Any further discussion of sample collection will be included in the supplemental RFI/RI report.

4.4 ANALYTICAL PROCEDURES

Analytical procedures are specified in the supplemental RFI/RI SAP (ABB 1995b) and the Ecological Sampling Technical Memorandum, December 1995 (B&R Environmental 1995). Laboratory analytical procedures will be discussed in more detail in the supplemental RFI/RI report.

4.5 TOXICITY TESTS

Toxicity tests were conducted with surface water, sediment, and soil samples collected during January 1996. Surface waters were evaluated using silverside minnow (*Menidia beryllina*), mussel (*Mytilus edulis*), and sea urchin (*Strongylocentrotus franciscana*). Sediments were evaluated using mysid shrimp (*Mysidopsis bahia*) and an amphipod (*Hyalella azteca*). Soils were evaluated using earthworms (*Eisenia foetida*). Analytical methods will be discussed in more detail in the RFI/RI report.

5.0 DATA SET MODIFICATIONS AND STATISTICAL ANALYSIS PROCEDURES

The development, modification and statistical evaluation of the background data set occurred in three general steps. The first step involved development of the initial background data set. This step included: selecting potentially usable sampling locations (surface water, groundwater, sediment, and soil) based on physical location; compiling all available data from the historical data base which includes the IT Corporation 1994 RI Report (IT 1994), Bechtel's "Delineation Sampling" (BEI 1995b) and "Technical Memorandum: Groundwater Evaluation, Jet Engine Test Cell" reports (BEI 1995c), along with the addition of B&R Environmental samples collected in January 1996. Chemical and physical information was used to retain the most appropriate sampling locations as described in Section 4.1. The outcome of Step 1 was a data file containing all analytical data for the sampling sites chosen as background locations. [B&R Environmental was presented with an incomplete database from IT Corporation (i.e., the validation status of the data was unclear; multiple runs of the same sample were often included in the database)]. Ten percent of the data from B&R Environmental samples collected in 1996 underwent full data validation and 90 percent received "limited review," which included evaluating holding time, calibration, and blank contamination. The objective of B&R Environmental's limited review was to eliminate false positives and false negatives. The data validation and review process provided a determination of the quality of data associated with the January 1996 sampling activities. Data not meeting quality standards established by EPA and the Navy were discarded. Data obtained from previous investigations (i.e., BEI 1995 and IT 1994) was assumed to be usable even though the quality of the data is indeterminate.

The second step involved further evaluation of the data set and removal of data that could cause bias in the statistical results. This included analyzing for and removing data outliers and averaging results from duplicate samples. The outcome of Step 2 was a modified data set that contained only data that were usable and statistically appropriate for background characterization.

The third step involved statistical evaluation of the final background data set and the performance of statistical procedures appropriate for background characterization. These procedures included tests for data distribution and descriptive statistics. The rationale for the statistical design and the overall evaluation approach is described in Section 5.2.

The remainder of Section 5.0 describes the modification of the initial data set (Section 5.1), and how the modified data set was statistically analyzed (Section 5.2). EPA guidance regarding statistical procedures for data analysis has been followed to the fullest extent possible.

5.1 MODIFICATIONS OF THE BACKGROUND DATA SET

The initially compiled background data set was modified in two different ways:

- Inorganic outlier data were identified and deleted.
- Data from field duplicate samples were averaged.

Each of these modifications was essential to create a background data set that contained only usable representative data.

5.1.1 Treatment of Outlier Data

Each group of data (e.g., chromium, soil data set) was sorted according to value, high detects to low detects. Unusually high detect values were identified and these selected values were then checked against the original data package to ensure that the data had been properly entered into the data base. If the data were entered correctly, the high values were considered outliers and removed from the data base. These potential outliers were selected using subjective professional judgment. In general, if a potential outlier was more than twice the next highest value, then it was discarded. Those data that fall outside the expected distribution are likely the result of sampling error, analytical error, or unusual conditions that existed at the location when the sample was collected. Thus, such data are probably not representative of background conditions.

5.1.2 Field Duplicates

Groundwater sampling locations S1MW-3 and S2MW-1 had duplicate samples collected during the January 1996 sampling event. In order to avoid statistical bias, results from duplicate samples were averaged and counted as one sample. Nondetect values were assigned a value of one-half the detection limit for computing the averages. If the values being averaged were both nondetects, then the average value was considered to be a nondetect value. If one of the values was a nondetect and the other value a detect, then the resulting average was considered to be a detect value. The result of the data averaging was a statistical data set where only one result exists for any given sampling location and date.

5.2 STATISTICAL ANALYSIS

Statistical analysis of the background data was performed to provide meaningful evaluations of Boca Chica Key background conditions. This analysis included testing the distribution of the data population,

calculating descriptive statistics, and evaluating the effect of anomalous organic compounds detected in a minority of the sample results.

5.2.1 Testing of Data Distribution

The Shapiro-Wilk statistical test was performed to determine if the data were normally or lognormally distributed. The procedure for this test is described in Statistical Methods for Environmental Pollution Monitoring (Gilbert 1987) and summarized in Attachment A. This test for normality calculates a W statistic, which is then compared against a critical value. If the calculated statistic exceeded the critical value, then the data group was assigned one of two distributions, either normal or lognormal.

In many cases, the results showed that a data set was neither normally nor lognormally distributed. According to EPA Region IV guidance, a lognormal distribution was assumed for these data sets. An example of the Shapiro-Wilk calculation and the critical values for accepting normality or lognormality are included in Attachment A.

5.2.2 Descriptive Statistics

A set of descriptive statistics was calculated for each parameter in each appropriate data group. Descriptive statistics included minimum values, maximum values, arithmetic mean, standard deviation, one-sided 95 percent Upper Confidence Limit (UCL), and one-sided 95 percent Upper Tolerance Limit (UTL). The formulas used to calculate the UCL and UTL are included in Attachment A. If the UCL exceeded the maximum detected value for a data group, then the maximum value was considered representative of the data set.

The column labeled "Average of All Values" was calculated using all data points for a given chemical. For results that were reported as below detection limit, one-half of the detection limit for that sample was used in the calculation. This type of calculation is commonly performed to obtain an average value from all sample results, not just the results where the chemical was detected. Occasionally, however, this type of calculation may cause the average value to be above the maximum detected value or below the minimum detected value. This will normally occur when a chemical is detected at a low frequency and the average value is determined more by the detection limit values than the relatively low number of detected values.

5.2.3 Evaluation of Organic Compounds

Two different background data bases were compiled. The first data base did not include samples with detections in the following organic compounds that were considered inappropriate for background samples: chlorinated aliphatic and aromatic compounds at any level or high concentrations of pesticides, PCBs, or PAHs, and BTEX compounds. A statistical run was performed on this data set. The organics were placed back into the database and a second statistical run was performed for soil and sediment because these were the only two media that differed between the two data bases. The inclusion of the inappropriate organics did not make a significant difference in the descriptive statistical results from the two runs. Therefore, the second run containing all of the organics was considered representative of background conditions and the statistical results of this second run are presented and discussed in Sections 6.0 through 9.0. The statistics results from the first run are included in Attachment B for informational purposes only.

6.0 SOIL CHARACTERIZATION

The descriptive statistics shown in Table 6-1 are based on the analytical results from 13 soil samples that were collected from background sampling locations at Boca Chica Key. Several inorganic and organic parameters were detected in the samples. The organics that were detected include common laboratory or rinsate contaminants (e.g., acetone), PAHs (e.g., chrysene), chlorinated and unchlorinated VOCs (e.g., benzene and trichloroethene), pesticides (e.g., 4,4'-DDD), and PCBs (e.g., aroclor-1260). The low-level pesticide and PAH contamination may be a consequence of the wide-spread use of pesticides and fuels in our industrialized society. The maximum concentrations of VOCs do not exceed 5 µg/kg except for methylene chloride. In addition, a visual inspection of the data set indicates that the metal concentrations reported in soil samples containing these organic constituents do not differ significantly from metals concentrations noted in samples that do not contain VOCs. With the exception of arsenic, none of the metals or organics were reported at maximum concentrations exceeding current EPA Region III RBCs. The maximum reported arsenic concentration is within the range of arsenic concentrations reported for soils in the eastern Unites States (Shacklette and Boerngen 1984).

The distribution of the data set (i.e., normal or lognormal), the 95 percent UCL on the mean (which is often used as the representative concentration for risk assessments), the 95 percent UTL and other descriptive statistics were determined for each analyte detected in the background soil samples, using the methodologies described in Attachment A. However, the utility of some of the information presented (particularly the distribution designation, the UCL and the UTL) is restricted by the number of positive detections reported for some of the analytes. Less than six positive inorganic detections were reported for antimony, beryllium, cadmium, mercury, selenium, and tin. Statistically, this means that the distribution for these analytes is undefined. Thus, the maximum detected concentrations for these analytes will be used as the representative concentration and the UTL in the supplemental RFI/RI report for NAS Key West. In addition the UTL for lead in soil was higher than the OSWER clean-up standard of 400 mg/kg. Thus, the maximum detected concentration for lead will also be used as the representative concentration and as the UTL in the supplemental RFI/RI report for NAS Key West. All other descriptive statistics presented in Table 6-1 will be used in the supplemental RFI/RI report.

Toxicity tests were performed using earthworms that were placed in soil collected from BG 1, BG 2, BG 3, and S1SS-04. The results from the toxicity testing indicate that soils from BG 1 and BG 3 were toxic to the earthworms, while soil from BG 2 and S1SS-04 appeared to be non-toxic to the earthworms.

TABLE 6-1

BACKGROUND SUMMARY STATISTICS FOR SOIL
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Chemical	Frequency of Selection	Minimum	Maximum	Average of All Values	Location of the Maximum	Distribution	95% UCL	95% UTL	RBC Industrial[1]	RBC Residential[1]	Basis	Soil to Air[1]	Soil to Ground-Water[1]
Metals													
Aluminum	11/11	120	4,250	2,130	BG1SS-03	Normal	3,020	6,750	1,000,000	78,000	N	-	-
Antimony	2/12	0.26	0.48	0.428	S1SB-7	Assume Lognormal	0.590	1.63	820	31	N	-	-
Arsenic	6/12	0.63	2.7	1.40	BG1SS-03	Lognormal	2.13	6.00	3.8	0.43	C	380	15
Barium	12/12	4.4	17.7	11.0	BG1SS-03	Lognormal	14.5	32.4	140,000	5,500	N	350,000	32
Beryllium	2/12	0.13	0.15	0.054	S1SB-7	Assume Lognormal	0.078	0.214	1.3	0.15	C	690	180
Cadmium	4/12	0.11	0.45	0.173	S1SB-7	Lognormal	0.443	1.71	1,000	39	N	920	6
Calcium	11/11	265,000	449,000	362,000	BG2SS-02	Normal	396,000	538,000	-	-		-	-
Chromium	12/12	1.9	15.5	6.22	S1SB-7	Lognormal	10.7	34.4	10,000	390	N	140 (VI)	19 (VI)
Cobalt	7/12	0.22	0.51	0.341	S1SB-7	Lognormal	0.747	2.80	120,000	4,700	N	-	-
Copper	11/12	1.3	15.6	5.28	BG1SS-03	Lognormal	13.0	49.5	82,000	3,100	N	-	-
Iron	11/11	98.1	2,260	1,290	BG3SS-01	Normal	1,740	3,580	610,000	23,000	N	-	-
Lead	11/12	0.65	48.3	16.8	BG3SS-01	Lognormal	528	1,020	-	400 (OSWER)	-	-	-
Magnesium	11/11	1,340	24,600	7,800	BG2SS-01	Lognormal	16,400	59,300	-	-	-	-	-
Manganese	11/11	2.6	33.7	19.4	BG1SS-01	Normal	25.4	50.2	10,000	390	N	-	-
Mercury	2/12	0.048	0.08	0.033	BG3SS-01	Lognormal	0.046	0.113	610	23	N	7	3
Nickel	8/12	0.63	4.1	1.63	S1SS-4	Lognormal	4.19	16.1	41,000	1,600	N	6,900	21
Potassium	11/11	48.6	944	356.	BG1SS-02	Lognormal	682	2,280	-	-	-	-	-
Selenium	4/12	0.46	1.8	0.724	BG3SS-01	Assume Lognormal	0.973	2.374	10,000	390	N	-	3
Sodium	11/11	834	18,700	4,620	BG1SS-02	Lognormal	10,400	39,300	-	-	-	-	-
Tin	2/5	0.78	2.1	1.94	S1SB-7	Normal	2.60	4.90	1,000,000	47,000	N	-	-
Vanadium	12/12	0.8	8.8	3.71	S1SS-4	Lognormal	6.91	23.3	14,000	550	N	-	-
Zinc	12/12	0.63	89.1	19.0	BG3SS-01	Lognormal	118	408	610,000	23,000	N	-	42,000
Miscellaneous													
Sulfide	1/1	49	49	49	S3BG-1	NA	NA	NA	-	-	-	-	-
Semivolatiles													
Anthracene	1/11	0.390	0.390	0.471	BG1SS-03	Assume Lognormal	0.770	2.680	610,000	23,000	N	6.8	4,300
Benzo(b)-fluoranthene	1/11	0.390	0.390	0.471	BG1SS-03	Assume Lognormal	0.770	2.680	7.8	0.88	C	23	4
Bis(2-chloro-isopropyl)ether	1/10	0.021	0.021	0.0321	BG3SS-01	Assume Lognormal	0.058	0.217	82	9.1	C	-	-
Bis(2-ethylhexyl)-phthalate	1/11	0.330	0.330	0.471	S3BG-1	Assume Lognormal	0.754	2.600	410	46	C	210	11

TABLE 6-1

BACKGROUND SUMMARY STATISTICS FOR SOIL
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Chemical	Frequency of Selection	Minimum	Maximum	Average of All Values	Location of the Maximum	Distribution	95% UCL	95% UTL	RBC Industrial[1]	RBC Residential[1]	Basis	Soil to Air[1]	Soil to Ground-Water[1]
Chrysene	1/11	0.280	0.280	0.461	BG1SS-03	Assume Lognormal	0.739	2.570	780	88	C	3.6	1
Di-N-butyl-phthalate	1/11	0.082	0.082	0.427	S1SB-7	Assume Lognormal	0.734	2.680	200,000	7,800	N	100	120
Fluoranthene	1/11	0.660	0.660	0.496	BG1SS-03	Assume Lognormal	0.865	0.0310	82,000	3,100	N	68	980
Hexachlorophene	1/2	0.051	0.051	0.526	S1SB-7	NA	NA	NA	610	23	N	-	-
Pyrene	1/11	0.470	0.470	0.478	BG1SS-03	Assume Lognormal	0.796	2.780	61,000	2,300	N	56	1,400
1,1,2,2-Tetrachloro-ethane	1/12	0.004	0.004	0.00196	BG3SS-01	Assume Lognormal	0.00270	0.00664	29	3.2	C		0.001
Volatiles													
2-Hexanone	1/12	0.002	0.002	0.00392	BG3SS-01	Lognormal	0.00490	0.010	-	-	-	-	-
Acetone	1/12	0.001	0.001	0.00367	S1SS-4	Lognormal	0.00619	0.0196	200,000	7,800	N	62,000	8
Chloroform	1/12	0.001	0.001	0.00171	BG3SS-01	Assume Lognormal	0.00225	0.00512	940	100	C	0.2	0.3
Chloromethane	1/12	0.004	0.004	0.00275	BG1SS-01	Assume Lognormal	0.00483	0.0161	440	49	C	0.06	0.006
Ethylbenzene	1/12	0.0031	0.0031	0.00165	S1SS-4	Assume Lognormal	0.00268	0.00794	200,000	7,800	N	260	5
Methylene chloride	6/12	0.0011	0.014	0.00280	S3BG-1	Lognormal	0.00919	0.0364	760	85	C	7	0.010
Toluene	1/12	0.001	0.001	0.00171	S1SS-4	Assume Lognormal	0.00225	0.00512	410,000	16,000	N	520	5
Trichloroethene	1/12	0.001	0.001	0.00158	S1SB-7	Assume Lognormal	0.00200	0.00419	520	58	C	3	0.020
Pesticides/PCBs													
4,4'-DDD	1/8	0.0067	0.0067	0.00571	S2SB-9	Lognormal	0.0540	0.179	24	2.7	C	37	0.7
4,4'-DDE	3/8	0.0039	0.0533	0.01238	BG1SS-02	Lognormal	228	0.586	17	1.9	C	10	0.5
4,4'-DDT	4/8	0.0026	0.0093	0.00762	BG2SS-02	Lognormal	323	0.127	17	1.9	C	80	1
Aroclor-1260	1/8	0.069	0.069	0.03244	S1SB-7	Lognormal	1,010	2.100	0.74	0.083	C	-	-
Methyl parathion	1/6	0.0022	0.0022	0.009266	BG2SS-02	Lognormal	5,174	0.0704	510	20	N	28	0.041

1 EPA, 1996b. Region III Risk-Based Concentration Table, January - June 1996.

Concentrations are mg/kg (ppm).

NA - Not applicable due to low sample count (<4 samples).
N - non-carcinogen
C - carcinogen

The remainder of this section presents additional details on the results of the statistical analysis for the Boca Chica Key background soil samples. The discussion of results is categorized by VOCs, SVOCs, pesticides and PCBs, inorganics, and toxicity testing.

6.1 VOLATILE ORGANIC COMPOUNDS

Nine VOCs were detected in the soil background samples. Eight of these compounds had only one detection. Methylene chloride (a common laboratory contaminant) had six detections and a C_{max} of 14 µg/kg. Three of the eight VOCs detected only once were at sample location BG3SS-1. Two BTEX compounds, toluene and ethylbenzene, had a C_{max} of 1 µg/kg and 0.31 µg/kg, respectively. Overall, the following five chlorinated VOCs were detected at levels near the detection limit: 1,1,2,2-tetrachloroethane, chloroform, chloromethane, trichloroethene, and methylene chloride.

6.2 SEMI-VOLATILE ORGANIC COMPOUNDS

Five PAHs with one positive detection each were detected at concentrations near the detection limit. One ether, bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were also detected at low concentrations and frequencies. Hexachlorophene was detected at a C_{max} of 51 µg/kg in one of the two samples collected by BEI.

6.3 PESTICIDES/POLYCHLORINATED BIPHENYLS

Four pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT and methyl parathion) were detected in almost half of the samples. The maximum detected concentration for each of the four pesticides was well below soil ARAR levels. Aroclor-1260 was detected in sample S1SB-7 at 69 µg/kg. This was the only detection of a PCB in all of the background soil samples.

6.4 INORGANICS

Aluminum, cobalt, copper, manganese, nickel, vanadium and zinc were detected at low concentrations. Chromium was detected in each sample with a C_{max} of 15.5 mg/kg and a UTL of 34.4 mg/kg, which is well below the residential RBC for this chemical. Lead had a high frequency of detection, but the maximum detected value was significantly less than the OSWER value of 400 mg/kg. Arsenic was detected in half of the samples with C_{max} of 2.7 mg/kg and a mean of 1.4 mg/kg, both of which are above the residential RBC of 0.43 mg/kg. Barium was detected in all samples at C_{max} of 17.7 mg/kg.

Macronutrients (e.g., calcium, magnesium, sodium, and potassium) were frequently detected in the background soil samples.

6.5 TOXICITY TESTS

After 14 days, earthworm survival in laboratory control samples was 85 percent. All earthworms died in BG 1 soil, while survival in BG 2 soil was 68 percent, survival in BG 3 soil was 16 percent, and survival in S1SS-04 soil was 57 percent. Although survival in BG 2 soil was less than in laboratory controls, the difference was not significant (Table 6-2). Note that Table 6-2 also contains the results of surface water and sediment toxicity tests. Therefore, this table will be referenced in Section 7 and 8.

Earthworms exposed to BG 1 soil exhibited significant stress when exposed to the test soil. Earthworms in this sample actively attempted to avoid the soil by climbing up the sides of the test chamber. After 30 minutes, worms from the other background sites had burrowed below the soil surface and were not visible, while BG 1 worms had not started burrowing during this period. General observations indicated that most BG 1 worms were either largely inactive or dead within 24 hours of test initiation.

In order to determine whether the observed mortality in BG 1 was actually due to soil toxicity, other factors must be explored. For example, survival may have been affected by having more earthworms than normal placed into the test chambers. This increased loading of earthworms may have resulted in an increase in metabolic waste products, which adversely affected survival. The increased loading was employed to provide an adequate amount of tissue to be used in subsequent tissue analyses. However, the reduced survival in BG 1 and BG 3 samples was extreme, and survival in laboratory controls was only slightly less than what is usually considered to be acceptable in control samples (90 percent). If the high mortality in background samples was a result of increased loading, high mortality would also be expected in the laboratory control samples.

Various soil characteristics, such as soil texture, moisture content, and pH, can affect earthworm survival. Although soil grain sizes were not measured, the B&RE biologist who collected the samples and the testing laboratory indicated that the soil textures appeared to be similar among samples. Soil moisture was adjusted to a level of approximately 30 percent, as per testing guidelines. Soil pH was within guideline values and did not require adjustment. All background samples appeared to be low in organic matter. However, according to the testing laboratory, this should not have affected earthworm survival for at least 7 days. Survival after 7 days was as follows: 90 percent in lab controls, 0 percent in BG 1, 85 percent in BG 2, 49 percent in BG 3, and 77 percent in S1SS-04. Thus, after only 7 days, survival was already greatly reduced at BG 1 and BG 3, but was relatively high in the other two background samples.

TABLE 6-2

ENVIROSYSTEMS TOXICITY TEST RESULTS SUMMARY
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Estuarine <25 ppt	Background 1 (sample result/ control result)
Location	**BG1SD-01**
Amphipod (*Hyallela azteca*) 10-day chronic survival (%) and growth (mg) sediment toxicity test	*61.3%/86.3% *0.029 mg/0.060 mg
Location	**BG1SW-01**
Silverside minnow (*Menidia beryllina*) 96-hour static acute aquatic toxicity survival (%) test	60%/70%

Marine > 25 ppt	Background 2 (sample result/ control result)	Background 3 (sample result/ control result)
Location	**BG2SD-01**	**BG3SD-01**
Mysid (*Mysidopsis Bahia*) 10-day static sediment toxicity test survival (%) and growth (mg)	91.3%/96.3% 0.156 mg/0.175 mg	90.0%/86.7% 0.301 mg/0.252 mg
Location	**BG2SW-01**	**BG3SW-01**
Silverside minnows (*Menidia beryllina*) 96-hour static acute aquatic toxicity survival (%) test	*25%/90%	*20%/90%
Mussel (*Mytilus edulis*) 48-hour egg larval development (% normal) aquatic toxicity test	*11.8%/91.5%	94.6%/91.5%
Sea urchin (*Strongylocentrotus fransiscana*) sperm motility and fertilization (% eggs fertilized) aquatic toxicity test	92.1%/94.3%	86.6%/94.3%

Terrestrial	Background 1 (sample result/ control result)	Background 2 (sample result/ control result)	Background 3 (sample result/ control result)	S1SS-04 (sample result/ control result)
Location	**BG1SS-01**	**BG2SS-01**	**BG3SS-01**	**S1SS-04**
Earthworm (*Eisenia foetida*) 14-day acute static soil toxicity survival (%) test	*0%/85%	68%/85%	*16%/85%	*57%/85%

* Significantly different from laboratory control.

At the end of 14 days, survival in the lab controls dropped only slightly (from 90 percent to 86 percent), while survival dropped from 85 percent to 68 percent in BG 2, from 49 percent to 16 percent in BG 3, and from 77 percent to 57 percent in S1SS-04. The absence of organic matter (especially when combined with increased loading) probably contributed to mortality in BG 2 and S1SS-04 samples.

In summary, signs of toxicity in BG 1 samples, and high mortality soon after test initiation in BG 1 and BG 3 samples, indicate that the soil at BG 1 and BG 3 was toxic to the earthworms. Survival in BG 2 and S1SS-04 samples was probably affected by increased loading and low organic matter.

7.0 SURFACE WATER CHARACTERIZATION

Water quality parameters were measured during December 1995 and January 1996 at each of the three background sites. Results from these measurements are shown in Table 7-1. Surface water at BG 1 is classified as brackish, while surface water at BG 2 and BG 3 is classified as euhaline. Surface water at all three locations supported healthy populations of fish.

Chemical and toxicity analyses were performed on eight background surface water samples as shown on Table 4-1. Descriptive statistics based on the chemical analytical results from the surface water samples are shown in Table 7-2. Several inorganic and three organic compounds were detected in the samples. All of the organic compounds detected are common laboratory or rinsate blank contaminants that were detected at C_{max} values below 20 µg/L. Except for thallium, none of the metals were detected at C_{max} values above maximum contaminant levels (MCLs). Thallium was detected with a C_{max} of 20 µg/L, while the MCL for thallium is 2 µg/L.

The distribution of the data set (i.e., normal or lognormal), the 95 percent UCL, on the mean (which is often used as the representative concentration for risk assessments), the 95 percent UTL and other descriptive statistics were determined for each analyte detected in the background surface water samples, using the methodologies described in Attachment A. However, the utility of some of the information presented (particularly the distribution designation, the UCL and the UTL) is restricted by the small data set (only seven samples were evaluated) and by the number of positive detections reported for some of the analytes. Barium is the only analyte detected in all samples and it is the only analyte with more than five positive detections. The descriptive statistics for barium will be used in the supplemental RFI/RI report. The distribution for all other analytes is undefined. Consequently, the maximum detected concentration will be used as the representative background concentration and the UTL for all analytes except barium in the supplemental RFI/RI report.

Species used in aquatic toxicity tests were dependent upon the salinity of the surface water at each site as measured in the field using a Horiba U-10 water analyzer. At BG 1, where the surface water salinity was approximately 5 parts per thousand (ppt), surface water toxicity was evaluated using the silverside minnow (*Menidia beryllina*). At BG 2 and BG 3, where the surface water salinity was approximately 30-34 ppt and 29-35 ppt respectively, surface water toxicity was evaluated using the silverside minnow as

TABLE 7-1

**WATER QUALITY DATA SUMMARY
NAS KEY WEST
BOCA CHICA KEY, FLORIDA**

Location	Date	Temperature (°C)	Salinity (%)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
Background 1	12/14/95	21.9	0.63	NR	11.1	NR	NR
	12/14/95	22.2	0.62	NR	11.0	NR	NR
	1/26/96	22.3	0.43	6.87	7.99	4.63	27
Background 2	12/14/95	22.4	3.43	NR	52.1	NR	NR
	1/20/96	21.3	3.13	7.96	47.9	7.67	NR
	1/21/96	20.9	2.96	7.10	45.6	5.20	10
	1/26/96	25.6	3.12	7.63	47.2	6.32	NR
Background 3	12/14/95	24.3	3.51	NR	53.1	NR	NR
	1/26/96	22.4	2.92	7.47	44.5	6.23	102

NR - not recorded

TABLE 7-2

BACKGROUND SUMMARY STATISTICS FOR SURFACE WATER
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Location of the Maximum	Distribution	MCL(1)	Federal AWQC(2)(3)	Federal AWQC(3)(4)
Metals									
Aluminum	2/5	25	148	37.9	S1SS-7SW	Lognormal	50 to 200	-	-
Antimony	2/5	3.5	7.3	2.9	BG3SW-01	Lognormal	6	14.0	4,300
Arsenic	3/7	2.6	5.2	2.94	S4BG-1	Normal	50	0.018	0.14
Barium	6/6	5.8	16.3	9.05	S4BG-1	Lognormal	2,000	-	-
Beryllium	2/7	0.17	0.26	0.27	S2SS-4SW	Assume Lognormal	4	0.00770	0.13
Calcium	5/5	105,000	326,000	200,000	BG3SW-01	Lognormal	-	-	-
Chromium	1/7	16.4	16.4	3.44	S4BG-1	Assume Lognormal	100	33,000	3,400 (4)
Copper	1/7	2	2	2.05	S1SS-7SW	Assume Lognormal	1,300	1,300	-
Iron	2/5	61.6	170	47.2	S1SS-7SW	Assume Lognormal	300	-	-
Magnesium	5/5	193,000	1,360,000	684,000	BG2SW-01	Lognormal	-	-	-
Manganese	2/5	3.2	12.3	3.4	S1SS-7SW	Lognormal	50	-	-
Mercury	1/7	0.48	0.48	0.123	BG1SW-01	Assume Lognormal	2	0.14	0.15
Potassium	5/5	70,600	418,000	227,000	BG2SW-01	Lognormal	-	-	-
Sodium	5/5	1,720,000	11,800,000	5,980,000	BG2SW-01	Lognormal	-	-	-
Thallium	2/7	7.4	12	4.88	BG2SW-01	Lognormal	2	1.7	6.3
Vanadium	2/7	2	2.8	2.26	S1SS-7SW	Normal	-	-	-
Zinc	4/7	1.4	21.5	6.51	S4BG-1	Lognormal	5,000	-	-
Miscellaneous									
Sulfide	2/2	4,000	6,000	5,000	S7SS-4	NA	-	-	-

TABLE 7-2

BACKGROUND SUMMARY STATISTICS FOR SURFACE WATER
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Location of the Maximum	Distribution	MCL(1)	Federal AWQC(2)(3)	Federal AWQC(3)(4)
Semivolatiles									
Di-N-butyl phthalate	1/7	2	2	4.64	S1SS-7SW	Assume Lognormal	-	2,700	1,2000
Volatiles									
Acetone	2/7	4	12	4.14	S1SS-7SW	Lognormal	-	-	-
Methylene chloride	2/7	1	2	1.57	S7SS-4	Assume Lognormal	5	4.7	1,600

1 EPA 1996a - Drinking Water Regulations and Health Advisories.
2 EPA 1986d - Quality Criteria for Water.
3 AWQC for consumption of water and organisms.
4 AWQC for consumption of organisms.
Concentrations are in µg/L (ppb).
NA - Not applicable due to low sample count (<4 samples).

well as the mussel (*Mytilus edulis*), and sea urchin (*Strongylocentrotus franciscana*). Results of the surface water toxicity tests are shown in Table 6-2, and are discussed in Section 7.6.

The following sections discuss in greater detail the results from surface water quality testing, chemical analysis and toxicity testing results for background surface water at Boca Chica Key. The discussion of results is categorized by water quality, VOCs, SVOCs, pesticides and PCBs, inorganics, and toxicity testing.

7.1 WATER QUALITY

The pond (borrow pit) at BG 1 is classified as mixohaline or mixo-mesohaline ("brackish"), with salinities ranging from 4.3 ppt to 6.3 ppt. For comparison, the salinity of sea water is normally around 35 ppt, while the salinity of fresh water is normally less than 1.0 ppt. Conductivity measurements at this location ranged from 7.99 to 11.1 millisiemens per centimeter (mS/cm) and, as expected, were directly related to salinity with the highest conductivity (11.1 mS/cm) associated with the highest salinity measurement. Turbidity was relatively low at this location (27 NTUs), indicating that the water is low in suspended matter (silt, fine particulate organic matter, microscopic organisms) and high in light transmissivity. Dissolved oxygen measured 4.63 mg/L at this background location on January 26, 1996, which is sufficient to support most fish and aquatic life. NAS Key West waters are classified by FDEP as "Class III Marine," and have the following minimum dissolved oxygen standards: a daily average of 5.0 mg/L dissolved oxygen and a daily minimum of 4.0 mg/L. These Florida surface water quality standards are intended to protect recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Based on January 1996 fish collections, this pond supports a healthy, fairly diverse population of fish (e.g., striped mullet, yellowfin mojarra, ladyfish, and tarpon) typical of south Florida tidal creeks and mangrove swamps.

The lagoon at BG 2 is connected to the Atlantic Ocean via culverts that run under Boca Chica Road. Salinities in this lagoon were typical of euhaline estuaries and coastal waters in south Florida, ranging from 29.6 ppt to 34.3 ppt. Conductivities were highly correlated with salinities, ranging from 45.6 to 52.1 mS/cm. Turbidity was very low at this location (10 NTUs), indicating that water clarity was high. Dissolved oxygen levels were high in January 1996, ranging from 5.20 to 7.67 mg/L, which is sufficient to support a balanced biological community of aquatic organisms. Fish species collected at this location were more typical of inshore marine waters than tidal creeks or mangrove swamps, and included pinfish, bluestriped grunt, and gray snapper.

The lagoon at BG 3 does not appear to have a direct outlet to the Gulf of Mexico but almost certainly receives water from the gulf as a result of wind-generated (storm) tides. This lagoon, like BG 2, may be classified as euhaline, with salinities ranging from 29.2 ppt to 35.1 ppt. Salinities at the highend of this

range are equivalent to sea water, while salinities at the low end of this range suggest a barely perceptible freshwater influence. Turbidity, although somewhat higher (102 NTUs) at this location than the other background locations, was still indicative of relatively low levels of suspended matter. The only dissolved oxygen measurement taken at this location was high (6.23 mg/L, on January 26, 1996), which is sufficient to support a balanced indigenous aquatic community. Fish collected at this location were all small, hardy schooling species such as killifish and sheepshead minnow, presumably because the lagoon is shallow (generally less than 2 feet in depth) and unshaded and would be subject to high water temperatures in most months of the year.

Like conductivity, the pH of estuarine and marine waters is strongly influenced by salinity. As salinity increases, the solubility of carbon dioxide in estuarine waters decreases, resulting in higher pH values. The pH of sea water is normally slightly basic, between 8.1 and 8.3. This salinity to pH relationship was evident in the water quality measurements from the three background sites, with the pH at the brackish BG 1 pond measuring 6.87 and the pH at the BG 2 and BG 3 lagoons (both considerably more saline) measuring from 7.1 to 7.96.

7.2 VOLATILE ORGANIC COMPOUNDS

Acetone and methylene chloride were detected in less than one-third of the background surface water samples. Both of these VOCs are considered to be a result of laboratory contamination. No other VOCs were detected in the background surface water samples.

7.3 SEMI-VOLATILE ORGANIC COMPOUNDS

Di-n-butyl phthalate was detected in one of seven samples at 2 µg/L. This detection is considered to be a result of laboratory contamination. No other SVOCs were detected in the background surface water samples.

7.4 PESTICIDES/POLYCHLORINATED BIPHENYLS

No pesticides or PCBs were detected in the background surface water samples.

7.5 INORGANICS

Seventeen metals were detected in background surface water samples. The essential macronutrients (calcium, magnesium, potassium and sodium) were frequently detected at high concentrations. Antimony

was detected at a C_{max} of 7.3 µg/L and thallium was detected at a C_{max} of 12 µg/L, both of which are above their respective MCLs. Barium was detected frequently, but at low levels. The remaining inorganic analytes had few positive detections. The maximum concentration for several metals were from sample S4BG-1. The maximum concentrations for five other inorganic analytes were from sample S1SS-7SW.

7.6 TOXICITY TESTS

Mussel fertilization and development was greatly reduced at BG 2, and normal at BG 3 (Table 6-2). Sea urchin fertilization was normal at both BG 2 and BG 3. According to the testing laboratory, the salinity of BG 2 and BG 3 water samples used in the toxicity tests was 38 ppt and 37 ppt, respectively (Appendix F, Table 8). The acceptable salinity range for the mussel is 5-35 ppt, while the sea urchin can be tested in salinities of 20-35 ppt. Thus, the salinity of the samples was slightly beyond the range for which these species are recommended. In spite of this, sea urchin fertilization was normal at both BG 2 and BG 3, as was mussel fertilization and development at BG 3. It is unlikely that the greatly reduced mussel fertilization and development at BG 2 (11.8 percent, compared to 91.5 percent in laboratory controls) was due to high salinity, in view of the normal results in the BG 3 sample.

Survival of silverside minnows was low in all three background samples. The silverside minnow is tolerant of a wide range of salinities (5-32 ppt). However, as discussed above, laboratory-measured salinity values of BG 2 and BG 3 samples were 38 ppt and 37 ppt, respectively. Thus, the relatively high salinity may have been responsible for the extremely low survival in the BG 2 and BG 3 samples. Survival of silverside minnows in the BG 1 sample and in the accompanying laboratory control was 60 percent and 70 percent, respectively. Salinity in these samples was 5 ppt. These low survival rates may have been due to the method in which the test organisms (cultured in water with a salinity of 25 ppt) were acclimated to test solutions. The acclimation period was less than that specified in protocols. Thus, the salinity of the test solutions may have been at least partially responsible for the low survival of silverside minnows in all background samples.

8.0 SEDIMENT CHARACTERIZATION

The descriptive statistics shown in Table 8-1 are based on the analytical results from five sediment samples (Table 4-1). Several inorganic and five organic compounds were detected in the samples. With the exception of hexachlorophene, all of the organic compounds are common laboratory or rinsate blank contaminants. With the exception of arsenic, none of the inorganic or organic compounds were reported at maximum concentrations that exceed current EPA Region III RBCs. However, arsenic was reported with a C_{max} of 1.6 mg/kg, which is in the range of arsenic concentrations reported for soils in the eastern United States. (Shacklette and Boerngen 1984).

The distribution of the data set (i.e., normal or lognormal), the 95 percent UCL, on the mean (which is often used as the representative concentration for risk assessments), the 95 percent UTL and other descriptive statistics were determined for each analyte detected in the background sediment samples, using the methodologies described in Attachment A. However, the utility of some of the information presented (particularly the distribution designation, the UCL and the UTL) is restricted by the small data set (only five samples were evaluated) and by the number of positive detections reported for some of the analytes. The data evaluation portion of the supplemental RFI/RI report will be based on the assumption that the distribution of all analytes detected in the background sediments is undefined. Consequently, the maximum detected concentration will be used as the representative background concentration and the UTL for all analytes in the supplemental RFI/RI report.

The following sections discuss in greater detail the results from the chemical analytical and toxicity testing for background sediment at Boca Chica Key. The discussion of results is categorized by VOCs, SVOCs, pesticides and PCBs, inorganics, and toxicity testing.

Species used in the sediment toxicity tests were dependent on the salinity of the overlying water samples. At BG 1, sediment toxicity was evaluated using the amphipod (*Hyalella azteca*). At BG 2 and BG 3, sediment toxicity was evaluated using the shrimp (*Mysidopsis bahia*). Results of the toxicity tests are shown in Table 6-2, and are discussed in Section 8.5.

TABLE 8-1

BACKGROUND SUMMARY STATISTICS FOR SEDIMENT
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Selection	Minimum	Maximum	Average of All Values	Location of the Maximum	Distribution	RBC[1] Industrial	RBC[1] Residential	Basis	Soil to Air[1]	Soil to Ground-Water[1]
Metals											
Aluminum	4/4	497	3,350	2,041.75	BG1SD-01	Normal	1,000,000	78,000	N	-	-
Arsenic	2/4	1.5	1.6	1.7125	S4BG-1	Lognormal	3.8	0.43	C	380	15
Barium	5/5	5	15.2	9.88	BG2SD-01	Normal	140,000	5,500	N	350,000	32
Beryllium	1/5	0.12	0.12	0.113	S1SS-7SD	Normal	1.3	0.15	C	690	180
Cadmium	2/5	0.12	0.9	0.423	BG1SD-01	Lognormal	1,000	39	N	920	6
Calcium	4/4	223,000	393,000	325,250	BG3SD-01	Normal	-	-	-	-	-
Chromium (VI)	5/5	2.1	11.7	6.94	BG1SD-01	Normal	10,000	390	N	140	19
Cobalt	2/5	0.12	0.56	0.883	BG1SD-01	Lognormal	120,000	4,700	N	-	-
Copper	5/5	0.76	34.6	9.012	BG1SD-01	Lognormal	82,000	3,100	N	-	-
Iron	4/4	363	2,600	1,305.25	BG1SD-01	Lognormal	610,000	23,000	N	-	-
Lead	4/5	5.5	56.5	24.654	BG1SD-01	Normal	-	400 (OSWER)	-	-	-
Magnesium	4/4	4,680	20,000	12,425	BG2SD-01	Lognormal	-	-	-	-	-
Manganese	4/4	14.9	38.5	21.95	BG1SD-01	Lognormal	10,000	390	N	-	-
Nickel	4/5	0.7	5.5	2.486	BG1SD-01	Lognormal	41,000	1,600	N	6,900	21
Potassium	4/4	517	4,180	1,469	BG2SD-01	Assume Lognormal	-	-	-	-	-
Selenium	1/5	0.24	0.24	1.041	S1SS-7SD	Lognormal	10,000	390	N	-	3
Sodium	4/4	5,500	86,900	28,787.5	BG2SD-01	Lognormal	-	-	-	-	-
Tin	1/2	0.99	0.99	2.845	S1SS-7SD	Undefined	1,000,000	47,000	N	-	-
Vanadium	5/5	2.8	8.9	4.84	BG1SD-01	Lognormal	14,000	550	N	-	-
Zinc	5/5	3.5	58.2	30.4	BG1SD-01	Lognormal	610,000	23,000	N	-	42,000
Miscellaneous											
Sulfide	1/1	340	340	340	S4BG-1	NA	-	-	-	-	-
Semivolatiles											
Bis(2-Ethylhexyl)phthalate	1/5	4.5	4.5	2.299	S4BG-1	Normal	410	46	C	210	11
Hexachlorophene	1/2	0.820	0.820	6.660	S1SS-7SD	NA	610	23	N	-	-
Volatiles											
2-Butanone	1/5	0.004	0.004	0.0088	S4BG-1	Lognormal	1,000,000	47,000	N	-	-
Acetone	3/5	0.004	0.120	0.0343	S4BG-1	Lognormal	200,000	7,800	N	62,000	8
Methylene chloride	2/5	0.005	0.020	0.0076	S4BG-1	Lognormal	760	85	C	0.700	0.010

1 EPA 1996b. Risk-based concentration table, January-June. (Soil values assumed for sediment).

Concentrations are mg/kg (ppm).
NA - Not applicable due to low sample count (<4 samples).
N - non-carcinogin
C - carcinogin

8.1 VOLATILE ORGANIC COMPOUNDS

2-butanone, acetone and methylene chloride were detected in about one-third of the sediment samples. Acetone and methylene chloride are considered common laboratory contaminants. 2-butanone was only detected in sample S4BG-1 at 4 µg/kg, which was the same sample with the highest detections for acetone and methylene chloride. Thus, all detected VOCs are considered to be a result of laboratory or rinsate contamination.

8.2 SEMI-VOLATILE ORGANIC COMPOUNDS

Bis(2-ethylhexyl)phthalate was detected at 4,500 µg/kg in sample S4BG-1. This detection is considered to be a result of laboratory or rinsate contamination. Hexachlorophene was detected in sample S1SS-7SD at 820 µg/kg, which is well below the EPA Region III residential RBC for soil. No other SVOCs were detected in the background sediment samples.

8.3 PESTICIDES/POLYCHLORINATED BIPHENYLS

No pesticides or PCBs were detected in the background sediment samples at Boca Chica Key.

8.4 INORGANICS

Twenty inorganic compounds were detected in the background sediment samples. Most metals had a high frequency of detection in the five sediment samples. Arsenic exceeded the residential soil RBC of 0.43 mg/kg with a C_{max} of 1.6 mg/kg at S4BG-1. A majority of the maximum inorganic concentrations were from sample BG1SD-01.

8.5 TOXICITY TESTS

Survival and growth of amphipods in sediment were significantly reduced at BG 1, while survival and growth of mysid shrimp in sediment were normal at BG 2 and BG 3. The reason for the reduced survival and growth of organisms in BG 1 samples is unknown. Water quality conditions were within those specified by protocols for this species. The salinity of the overlying water was 5 ppt; *Hyalella azteca* can be tested in conditions of up to 15 ppt.

9.0 GROUNDWATER CHARACTERIZATION

The descriptive statistics shown in Table 9-1 are based on the six groundwater samples collected from background monitoring wells (Table 4-1). Several inorganic and four organic compounds were detected in the samples. Acetone, 2-butanone and methylene chloride are considered laboratory or rinsate blank contamination. Naphthalene was reported in S7MW-2 at 2 µg/L, which is well below the EPA RBC for tap water (1,500 µg/L). The maximum thallium concentration is 5 µg/L, which is above the MCL of 2 µg/L. No other compounds from the background groundwater samples were detected above MCLs.

The distribution of the data set (i.e., normal or lognormal), the 95 percent UCL, on the mean (which is often used as the representative concentration for risk assessments), the 95 percent UTL and other descriptive statistics were determined for each analyte detected in the background groundwater samples, using the methodologies described in Attachment A. However, the utility of some of the information presented (particularly the distribution designation, the UCL and the UTL) is restricted by the small data set (only six samples were evaluated) and by the number of positive detections reported for some of the analytes. Barium was the only compound detected in all six groundwater samples. The data evaluation portion of the supplemental RFI/RI report will be based on the assumption that the distribution of all analytes detected in the background groundwater samples, with the exception of barium, is undefined. Consequently, the maximum detected concentration will be used as the representative background concentration and the UTL for all analytes except barium in the supplemental RFI/RI report. The descriptive statistics for barium shown in Table 9-1 will be used in the supplemental RFI/RI report.

The following sections discuss in greater detail the results from the chemical analytical testing for background groundwater at Boca Chica Key. The discussion of results is categorized by VOCs, SVOCs, pesticides and PCBs, and inorganics.

9.1 VOLATILE ORGANIC COMPOUNDS

Acetone, 2-butanone and methylene chloride were detected at low concentrations in nearly two-thirds of the samples. These three compounds, however, are common laboratory or rinsate blank contaminants.

TABLE 9-1

BACKGROUND SUMMARY STATISTICS FOR GROUNDWATER
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Distribution	95% UCL	95% UTL	Tap Water RBC[1]	MCL[2]	SDWA[3]	MCL Goal[2]
Metals											
Arsenic	3/6	4.1	11.9	4.33	Lognormal	18.3	16.3	0.045	50	-	-
Barium	6/6	6.6	19.45	13.9	Normal	18.2	24.1	2,600	2,000	2,000	2,000
Calcium	3/3	114,250	243,500	181,000	Normal	290,000	NA	-	-	-	-
Chromium	2/6	0.71	13	4.09	Lognormal	350	33.9	180	100	100	100
Cyanide	2/3	2.4	5.525	2.76	Assume Lognormal	NA(1)	NA	730	200	-	200
Iron	2/3	76.9	97.4	62.6	Normal	136	NA	11000	300	-	-
Lead	1/5	2.5	2.5	1.19	Assume Lognormal	2.45	8.34	-	15	-	-
Magnesium	3/3	123,750	820,250	433,000	Lognormal	2,060,000,000	NA	-	-	-	-
Manganese	2/3	3.9	10.3	4.87	Normal	13.4	NA	180	50	-	-
Mercury	1/6	0.13	0.13	0.08	Normal	0.116	0.17	11	2	2	2
Potassium	3/3	38,850	181,750	119,000	Normal	231,000	NA	-	-	-	-
Sodium	3/3	982,250	6,615,000	3,670,000	Normal	8,430,000	NA	-	-	-	-
Thallium	1/6	4.925	4.925	2.52	Lognormal	6.90	7.75	-	2	0.4	0.5
Zinc	3/6	3.425	15.3	4.94	Lognormal	124	32.0	11,000	5,000	2,000	-
Miscellaneous											
Sulfide	3/3	10,000	52,000	28,000	Lognormal	16,700	NA	-	-	-	-
Semivolatiles											
Naphthalene	1/4	2	2	4.09	Normal	5.77	11.4	1,500	-	20	-
Volatiles											
2-Butanone	2/3	7	32	14.7	Lognormal	149,000	NA	1,900	-	-	-
Acetone	1/3	5	5	5	Assume Lognormal	5	NA	3,700	-	-	-
Methylene chloride	2/3	1	1	1.5	Assume Lognormal	20.4	NA	4.1	5	2,000	0

1 EPA 1996b. Region III Risk-Based Concentration Table, January-June 1996.
2 EPA 1996a. Dringking Water Regulations and Health Advisories.
3 Safe Drinking Water Act (SDWA).
Concentrations in µg/L (ppb).
NA - Not applicable due to low sample count (<4 samples).

9.2 SEMI-VOLATILE ORGANIC COMPOUNDS

Naphthalene was reported in S7MW-2 at 2 µg/L, which is well below the EPA RBC for tap water (1,500 g/L).

9.3 PESTICIDES/POLYCHLORINATED BIPHENYLS

No pesticides or PCBs were detected in the background groundwater samples.

9.4 INORGANICS

Thirteen metals and cyanide were detected in background groundwater samples. The essential macronutrients (calcium, magnesium, potassium and sodium) had positive detections in 3 of 3 samples. the remaining inorganics, except for thallium, were also frequently detected at low concentrations. Thallium was detected at 4.9 µg/L, which is above the MCL of 2 µg/L. Lead was detected at 2.5 µg/L, which is below the action level of 15 µg/L. Finally, the C_{max} for arsenic of 11.9 µg/L is less than the MCL of 50 µg/L. A low concentration of mercury (0.13 µg/L) was detected in one well. While the presence of mercury is possible from naturally occurring levels in soils, it is uncertain whether this is dissolved or particulate contamination.

10.0 TISSUE CHARACTERIZATION

Tissue concentrations of metals in the present study were reported by the analytical laboratory in milligrams per kilogram (mg/kg), while all other chemicals were reported in micrograms per kilogram (µg/kg). These designations have been retained in the text of this report, and are synonymous with parts per million (ppm) and parts per billion (ppb), respectively.

10.1 FISH

Fish species collected at each site are provided in Section 4.2.6.1, and summarized in Table 10-1. Minnow-sized fish collected in minnow traps and beach seines consisted of sheepshead minnow, gulf killifish, sailfin molly, and crested goby. Larger fish collected in gill nets consisted of striped mullet, ladyfish, yellowfin mojarra, gray snapper, pinfish, bluestriped grunt, and sea robin.

Individual lengths and weights of the gill-netted fish were measured. Individual lengths and weights of minnow-sized fish were not determined. Instead, lengths of the smallest and largest fish in each minnow sample were measured, and minnows were pooled by species to create samples of 30-35 grams each. Lengths and weights are provided in the RI/RFI report.

Chemical analyses were performed on whole-body samples. Concentrations of all chemicals detected in fish samples are summarized for all sites combined (Table 10-2), for each site (Tables 10-3 through 10-5), and for each species by site (Tables 10-6 through 10-19).

The following is a discussion of chemicals detected in fish samples from the background sites. Where available, data regarding each detected chemical's "normal" background fish tissue concentration and the threshold at which it is considered toxic to fish and to piscivorous (fish eating) wildlife is provided. Unfortunately, there are no uniformly acceptable standards for tolerable tissue concentrations of contaminants which will protect fish and piscivorous wildlife. Instead, various action and alert levels have been proposed by government agencies and individual experts.

TABLE 10-1

NUMBER OF FISH AND OYSTER SAMPLES COLLECTED FOR CHEMICAL ANALYSES FROM BACKGROUND SITES DURING JANUARY 1996
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Species	BG 1	BG 2	BG 3
Striped mullet	2		
Ladyfish	5		
Yellowfin mojarra	3		
Pinfish		4	
Gray snapper		3	
Bluestriped grunt		1	
Sea robin		1	
Sheepshead minnow	1		5
Gulf killifish			12
Sailfin molly	10	1	1
Crested goby	4		
Mangrove oyster			3
Total # samples analyzed	**25**	**10**	**21**

TABLE 10-2

SUMMARY STATISTICS FOR FISH AT BACKGROUND SITES 1, 2, AND 3
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Det.		Minimum	Maximum	Average of Detections	Standard Deviation	Average of All Values	Standard Deviation	Sample ID of Maximum
	# of Detections	# of Samples							
Metals									
Arsenic	30	53	0.29	8.30	2.80	2.35	1.64	2.21	BG3F-11
Barium	25	53	0.55	3.90	1.87	1.11	1.01	1.12	BG1F-14
Chromium	2	53	1.00	3.10	2.05	1.48	0.54	0.36	BG1F-27
Copper	39	53	0.50	22.80	4.17	4.47	3.13	4.20	BG3F-10
Lead	27	53	0.14	11.90	2.26	3.73	1.18	2.86	BG3F-09
Mercury	27	53	0.02	0.12	0.04	0.02	0.03	0.02	BG2F-01
Nickel	2	53	2.80	12.40	7.60	6.79	0.99	1.62	BG1F-13
Selenium	41	53	0.24	1.20	0.41	0.18	0.35	0.20	BG1F-10
Zinc	51	53	5.00	248.00	33.51	38.62	32.35	38.33	BG1F-10
Semivolatiles									
Bis(2-ethylhexyl)phthalate	5	53	1.60	13.00	7.04	5.309	1.102	2.458	BG3F-04
Phenol	4	53	1.40	10.00	3.60	4.267	0.859	1.394	BG3F-12
Pyridine	4	53	3.00	4.60	3.65	0.695	0.817	0.977	BG1F-14
Pesticides/PCBs									
4,4'-DDD	38	53	0.0011	0.0166	0.00588	0.00463	0.00430	0.00458	BG3F-16
4,4'-DDE	51	53	0.0022	0.2820	0.04604	0.04991	0.04432	0.04972	BG1F-02
4,4'-DDT	2	53	0.0020	0.0025	0.00225	0.00035	0.00058	0.00034	BG3F-06
Aroclor-1260	26	53	0.0270	0.2940	0.08946	0.06295	0.04926	0.05910	BG1F-02
Beta-BHC	11	53	0.0021	0.0063	0.04200	0.00138	0.00129	0.00162	BG1F-01
Dieldrin	3	53	0.0013	0.0049	0.00270	0.01093	0.00064	0.00064	BG1F-15
Endosulfan II	1	53	0.0019	0.0019	0.00190		0.00055	0.00020	BG3F-03
Endosulfan Sulfate	1	53	0.0016	0.0016	0.00160		0.00054	0.00016	BG1F-24

Concentrations are mg/kg (ppm).

TABLE 10-3

SUMMARY STATISTICS FOR FISH AT BACKGROUND SITE 1
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Det. # of Detections	Frequency of Det. # of Samples	Minimum	Maximum	Average of Detections	Standard Deviation	Average of All Values	Standard Deviation	Sample ID of Maximum
Metals									
Arsenic	4	25	0.29	0.53	0.39	0.10	0.14	0.11	BG1F-07
Barium	15	25	0.67	3.90	2.25	1.07	1.45	1.29	BG1F-14
Chromium	1	25	3.10	3.10	3.10		0.59	0.52	BG1F-27
Copper	15	25	0.70	16.3	5.00	4.15	3.10	3.96	BG1F-27
Lead	9	25	0.14	0.33	0.22	0.06	0.13	0.08	BG1F-17
Mercury	5	25	0.03	0.06	0.05	0.01	0.02	0.01	BG1F-21
Nickel	1	25	12.40	12.40	12.40		1.20	2.33	BG1F-13
Selenium	20	25	0.24	1.20	0.41	0.23	0.35	0.24	BG1F-10
Zinc	25	25	5.00	248.00	40.73	53.35	40.73	53.35	BG1F-10
Semivolatiles									
Pyridine	3	25	3.000	4.600	3.633	0.850	1.146	1.125	BG1F-14
Pesticides/PCBs									
4,4'-DDD	14	25	0.0016	0.0046	0.00229	0.00080	0.00151	0.00107	BG1F-02
4,4'-DDE	25	25	0.0058	0.2820	0.05106	0.06356	0.05106	0.06356	BG1F-02
Aroclor-1260	18	25	0.0290	0.2940	0.09367	0.06854	0.07050	0.06904	BG1F-02
Beta-BHC	6	25	0.0042	0.0063	0.00523	0.00086	0.00165	0.00209	BG1F-01
Dieldrin	1	25	0.0049	0.0049	0.00490		0.00069	0.00088	BG1F-15
Endosulfan Sulfate	1	25	0.0016	0.0016	0.00160		0.00056	0.00023	BG1F-24

Concentrations are mg/kg (ppm).

TABLE 10-4

SUMMARY STATISTICS FOR FISH AT BACKGROUND SITE 2
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Det. # of Detections	Frequency of Det. # of Samples	Minimum	Maximum	Average of Detections	Standard Deviation	Average of All Values	Standard Deviation	Sample ID of Maximum
Metals									
Arsenic	10	10	0.57	3.20	1.87	0.82	1.87	0.82	BG2F-01
Barium	4	10	0.55	3.80	1.54	1.53	0.76	1.11	BG2F-10
Copper	6	10	0.50	5.90	1.85	2.12	1.21	1.78	BG2F-10
Lead	1	10	0.24	0.24	0.24		0.09	0.05	BG2F-10
Mercury	10	10	0.02	0.12	0.04	0.03	0.04	0.03	BG2F-01
Nickel	1	10	2.80	2.80	2.80		0.94	0.65	BG2F-01
Selenium	3	10	0.25	0.32	0.28	0.04	0.17	0.08	BG2F-02
Zinc	8	10	9.80	15.20	12.69	2.22	10.71	4.60	BG2F-08
Semivolatiles									
Bis(2-ethylhexyl)phthalate	3	10	2.300	12.000	6.867	4.875	2.155	3.982	BG2F-06
Pesticides/PCBs									
4,4'-DDD	6	10	0.0011	0.0042	0.00213	0.00116	0.00148	0.00121	BG2F-10
4,4'-DDE	8	10	0.0022	0.0121	0.00639	0.00347	0.00521	0.00394	BG2F-09
4,4'-DDT	1	10	0.0020	0.0020	0.00200		0.00065	0.00047	BG2F-10
Beta-BHC	5	10	0.0021	0.0035	0.00296	0.00055	0.00176	0.00132	BG2F-03
Dieldrin	1	10	0.0019	0.0019	0.00190		0.00064	0.00044	BG2F-10

Concentrations are mg/kg (ppm).

TABLE 10-5

SUMMARY STATISTICS FOR FISH AT BACKGROUND SITE 3
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Det.		Minimum	Maximum	Average of Detections	Standard Deviation	Average of All Values	Standard Deviation	Sample ID of Maximum
	# of Detections	# of Samples							
Metals									
Arsenic	16	18	0.56	8.30	3.99	2.58	3.60	2.67	BG3F-11
Barium	6	18	0.91	1.90	1.15	0.37	0.55	0.49	BG3F-16
Chromium	1	18	1.00	1.00	1.00		0.51	0.12	BG3F-10
Copper	18	18	0.95	22.80	4.26	5.16	4.26	5.16	BG3F-10
Lead	17	18	0.27	11.90	3.45	4.30	3.26	4.25	BG3F-09
Mercury	12	18	0.02	0.05	0.03	0.01	0.02	0.01	BG3F-13
Selenium	18	18	0.26	0.64	0.44	0.10	0.44	0.10	BG3F-03
Zinc	18	18	23.30	60.70	32.73	9.31	32.73	9.31	BG3F-14
Semivolatiles									
Bis(2-ethylhexyl)phthalate	2	18	1.600	13.000	7.300	8.061	1.165	2.981	BG3F-04
Phenol	4	18	1.400	10.000	3.600	4.267	1.240	2.250	BG3F-12
Pyridine	1	18	3.700	3.700	3.700		0.700	0.856	BG3F-12
Pesticides/PCBs									
4,4'-DDD	18	18	0.0034	0.0166	0.00972	0.00381	0.00972	0.00381	BG3F-16
4,4'-DDE	18	18	0.0212	0.1060	0.05668	0.02684	0.05668	0.02684	BG3F-08
4,4'-DDT	1	18	0.0025	0.0025	0.0025		0.00064	0.00047	BG3F-06
Aroclor-1260	8	18	0.0027	0.1650	0.08000	0.05097	0.04128	0.04837	BG3F-12
Dieldrin	1	18	0.0013	0.0013	0.00130		0.00057	0.00019	BG3F-06
Endosulfan II	1	18	0.0019	0.0019	0.00190		0.00060	0.00033	BG3F-03

Concentrations are mg/kg (ppm).

TABLE 10-6

BACKGROUND SITE 1 SUMMARY STATISTICS FOR CRESTED GOBY
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Barium	4/4	0.67	0.89	0.74	0.74	BG1F-16
Chromium	1/4	3.10	3.10	3.10	1.13	BG1F-27
Copper	2/4	0.70	16.30	8.50	4.37	BG1F-27
Lead	1/4	0.16	0.16	0.16	0.09	BG1F-16
Mercury	2/4	0.03	0.04	0.04	0.03	BG1F-28
Selenium	4/4	0.26	0.37	0.32	0.32	BG1F-28
Zinc	4/4	29.40	45.00	38.35	38.35	BG1F-16
Pesticides/PCBs						
4,4'-DDE	4/4	0.0058	0.0070	0.00643	0.00643	BG1F-28
Beta-BHC	1/4	0.0044	0.0044	0.00440	0.00156	BG1F-18

Concentrations are mg/kg (ppm).

TABLE 10-7

BACKGROUND SITE 1 SUMMARY STATISTICS FOR LADYFISH
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	4/5	0.29	0.53	0.39	0.33	BG1F-07
Mercury	2/5	0.05	0.06	0.06	0.03	BG1F-04
Zinc	5/5	5.00	11.20	7.92	7.92	BG1F-05
Pesticides/PCBs						
4,4'-DDD	1/5	0.0016	0.0016	0.00160	0.00072	BG1F-03
4,4'-DDE	5/5	0.0194	0.0901	0.04754	0.04754	BG1F-06
Aroclor-1260	5/5	0.0590	0.0182	0.11540	0.11540	BG1F-06

Concentrations are mg/kg (ppm).

TABLE 10-8

BACKGROUND SITE 1 SUMMARY STATISTICS FOR YELLOWFIN MOJARRA
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Selenium	3/3	0.40	1.20	0.83	0.83	BG1F-10
Zinc	3/3	17.60	248.00	144.53	144.53	BG1F-10
Pesticides/PCBs						
4,4'-DDD	2/3	0.0016	0.0046	0.00310	0.00223	BG1F-02
4,4'-DDE	3/3	0.0736	0.2820	0.15853	0.15853	BG1F-02
Aroclor-1260	3/3	0.1300	0.2940	0.18967	0.18967	BG1F-02
Beta-BHC	3/3	0.0042	0.0063	0.00513	0.00513	BG1F-01

Concentrations are mg/kg (ppm).

TABLE 10-9

BACKGROUND SITE 1 SUMMARY STATISTICS FOR SAILFIN MOLLY
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Barium	10/10	1.90	3.90	2.88	2.88	BG1F-14
Copper	10/10	2.10	10.20	4.26	4.26	BG1F-22
Lead	7/10	0.14	0.25	0.21	0.17	BG1F-13
Mercury	1/10	0.06	0.06	0.06	0.02	BG1F-21
Nickel	1/10	12.40	12.40	12.40	1.90	BG1F-13
Selenium	10/10	0.24	0.42	0.34	0.34	BG1F-14, 22,26
Zinc	10/10	24.50	45.40	33.29	33.29	BG1F-26
Semivolatiles						
Pyridine	2/10	3.000	4.600	3.800	1.857	BG1F-14
Pesticides/PCBs						
4,4'-DDD	8/10	0.0018	0.0027	0.00216	0.00183	BG1F-15
4,4'-DDE	10/10	0.0152	0.0301	0.02244	0.02244	BG1F-14
Aroclor-1260	7/10	0.0290	0.0540	0.04200	0.03240	BG1F-14
Beta-BHC	2/10	0.0056	0.0060	0.00580	0.00157	BG1F-21
Dieldrin	1/10	0.0049	0.0049	0.00490	0.00095	BG1F-15
Endosulfan sulfate	1/10	0.0016	0.0016	0.00160	0.00062	BG1F-24

Concentrations are mg/kg (ppm).

TABLE 10-10

BACKGROUND SITE 1 SUMMARY STATISTICS FOR STRIPED MULLET
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Copper	2/2	1.60	3.50	2.55	2.55	BG1F-09
Selenium	2/2	0.28	0.38	0.33	0.33	BG1F-09
Zinc	2/2	8.50	9.00	8.75	8.75	BG1F-09
Pesticides/PCBs						
4,4'-DDD	2/2	0.002	0.003	0.00260	0.00260	BG1F-08
4,4'-DDE	2/2	0.119	0.165	0.14200	0.14200	BG1F-08
Aroclor-1260	2/2	0.075	0.116	0.09550	0.09550	BG1F-08

Concentrations are mg/kg (ppm).

TABLE 10-11

BACKGROUND SITE 1 SUMMARY STATISTICS FOR SHEEPSHEAD MINNOW
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Barium	1/1	2.00	2.00	2.00	2.00	BG1F-17
Copper	1/1	10.30	10.30	10.30	10.30	BG1F-17
Lead	1/1	0.33	0.33	0.33	0.33	BG1F-17
Selenium	1/1	0.40	0.40	0.40	0.40	BG1F-17
Zinc	1/1	41.30	41.30	41.30	41.30	BG1F-17
Semivolatiles						
Pyridine	1/1	3.300	3.300	3.300	3.300	BG1F-17
Pesticides/PCBs						
4,4'-DDD	1/1	0.0017	0.0017	0.00170	0.00170	BG1F-17
4,4'-DDE	1/1	0.0292	0.0292	0.02920	0.02920	BG1F-17
Aroclor-1260	1/1	0.0550	0.0550	0.05500	0.05500	BG1F-17

Concentrations are mg/kg (ppm).

TABLE 10-12

BACKGROUND SITE 2 SUMMARY STATISTICS FOR BLUESTRIPED GRUNT
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	1/1	2.00	2.00	2.00	2.00	BG2F-05
Mercury	1/1	0.03	0.03	0.03	0.03	BG2F-05
Zinc	1/1	9.90	9.90	9.90	9.90	BG2F-05
Semivolatiles						
Bis(2-ethylhexyl)phthalate	1/1	2.300	2.300	2.300	2.300	BG2F-05
Pesticides/PCBs						
4,4'-DDD	1/1	0.0023	0.00237	0.00230	0.00230	BG2F-05
4,4'-DDE	1/1	0.0072	0.0072	0.00720	0.00720	BG2F-05
Beta-BHC	1/1	0.0033	0.0033	0.00330	0.00330	BG2F-05

Concentrations are mg/kg (ppm).

TABLE 10-13

BACKGROUND SITE 2 SUMMARY STATISTICS FOR PINFISH
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	4/4	0.95	2.30	1.81	1.81	BG2F-06
Barium	3/4	0.55	1.20	0.79	0.65	BG2F-09
Copper	2/4	0.50	0.93	0.72	0.48	BG2F-06
Mercury	4/4	0.02	0.04	0.03	0.03	BG2F-08
Selenium	1/4	0.25	0.25	0.25	0.15	BG2F-08
Zinc	4/4	9.80	15.20	13.43	13.43	BG2F-08
Semivolatiles						
Bis(2-ethylhexyl)phthalate	1/4	12.000	12.000	12.000	3.112	BG2F-06
Pesticides/PCBs						
4,4'-DDD	3/4	0.0012	0.0025	0.00173	0.00143	BG2F-09
4,4'-DDE	4/4	0.0022	0.0121	0.00650	0.00650	BG2F-09
Beta-BHC	1/4	0.0021	0.0021	0.00210	0.00090	BG2F-09

Concentrations are mg/kg (ppm).

TABLE 10-14

BACKGROUND SITE 2 SUMMARY STATISTICS FOR SEA ROBIN
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	1/1	0.57	0.57	0.57	0.57	BG2F-04
Mercury	1/1	0.04	0.04	0.04	0.04	BG2F-04
Zinc	1/1	13.60	13.60	13.60	13.60	BG2F-04
Pesticides/PCBs						
4,4'-DDE	1/1	0.0024	0.0024	0.00240	0.00240	BG2F-04

Concentrations are mg/kg (ppm).

TABLE 10-15

BACKGROUND SITE 2 SUMMARY STATISTICS FOR GRAY SNAPPER
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	3/3	2.30	3.20	2.67	2.67	BG2F-01
Copper	3/3	0.58	2.50	1.26	1.26	BG2F-01
Mercury	3/3	0.04	0.12	0.07	0.07	BG2F-01
Nickel	1/3	2.80	2.80	2.80	1.43	BG2F-01
Selenium	2/3	0.27	0.32	0.30	0.24	BG2F-02
Zinc	1/3	10.70	10.70	10.70	5.43	BG2F-01
Pesticides/PCBs						
4,4'-DDD	1/3	0.0011	0.0011	0.00110	0.00070	BG2F-03
4,4'-DDE	1/3	0.0052	0.0052	0.00520	0.00207	BG2F-03
Beta-BHC	3/3	0.0028	0.0035	0.00313	0.00313	BG2F-03

Concentrations are mg/kg (ppm).

TABLE 10-16

BACKGROUND SITE 2 SUMMARY STATISTICS FOR SAILFIN MOLLY
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	1/1	0.89	0.89	0.89	0.89	BG2F-10
Barium	1/1	3.80	3.80	3.80	3.80	BG2F-10
Copper	1/1	5.90	5.90	5.90	5.90	BG2F-10
Lead	1/1	0.24	0.24	0.24	0.24	BG2F-10
Mercury	1/1	0.02	0.02	0.02	0.02	BG2F-10
Zinc	1/1	13.60	13.60	13.60	13.60	BG2F-10
Semivolatiles						
Bis(2-ethylhexyl)phthalate	1/1	6.300	6.300	6.300	6.300	BG2F-10
Pesticides/PCBs						
4,4'-DDD	1/1	0.0042	0.0042	0.0042	0.0042	BG2F-10
4,4'-DDE	1/1	0.0103	0.0103	0.0103	0.0103	BG2F-10
4,4'-DDT	1/1	0.0020	0.0020	0.0020	0.0020	BG2F-10
Dieldrin	1/1	0.0019	0.0019	0.0019	0.0019	BG2F-10

Concentrations are mg/kg (ppm).

TABLE 10-17

BACKGROUND SITE 3 SUMMARY STATISTICS FOR GULF KILLIFISH
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	12/12	1.70	8.30	5.08	5.08	BG3F-11
Chromium	1/12	1.00	1.00	1.00	0.53	BG3F-10
Copper	12/12	0.95	22.80	4.41	4.41	BG3F-10
Lead	11/12	0.27	0.80	0.53	0.50	BG3F-04
Mercury	12/12	0.02	0.05	0.03	0.03	BG3F-13
Selenium	12/12	0.26	0.64	0.43	0.43	BG3F-03
Zinc	12/12	23.40	60.70	31.85	31.85	BG3F-14
Semivolatiles						
Bis(2-ethylhexyl)phthalate	2/12	1.600	13.000	7.300	1.476	BG3F-04
Phenol	4/12	1.400	10.000	3.600	1.481	BG3F-12
Pyridine	1/12	3.700	3.700	3.700	0.671	BG3F-12
Pesticides/PCBs						
4,4'-DDD	12/12	0.0042	0.0140	0.00938	0.00938	BG3F-03
4,4'-DDE	12/12	0.0276	0.1060	0.06879	0.06879	BG3F-08
Aroclor-1260	6/12	0.0390	0.1650	0.09217	0.05125	BG3F-12
Endosulfan II	1/12	0.0019	0.0019	0.00190	0.00063	BG3F-03

Concentrations are mg/kg (ppm).

TABLE 10-18

BACKGROUND SITE 3 SUMMARY STATISTICS FOR SAILFIN MOLLY
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	1/1	1.10	1.10	1.10	1.10	BG3F-16
Barium	1/1	1.90	1.90	1.90	1.90	BG3F-16
Copper	1/1	1.40	1.40	1.40	1.40	BG3F-16
Lead	1/1	5.30	5.30	5.30	5.30	BG3F-16
Selenium	1/1	0.33	0.33	0.33	0.33	BG3F-16
Zinc	1/1	26.20	26.20	26.20	26.20	BG3F-16
Pesticides/PCBs						
4,4'-DDD	1/1	0.0166	0.0166	0.0166	0.0166	BG3F-16
4,4'-DDE	1/1	0.0683	0.0683	0.0683	0.0683	BG3F-16
Aroclor-1260	1/1	0.0600	0.0600	0.0600	0.0600	BG3F-16

Concentrations are mg/kg (ppm).

TABLE 10-19

BACKGROUND SITE 3 SUMMARY STATISTICS FOR SHEEPSHEAD MINNOW
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	3/5	0.56	0.72	0.62	0.57	BG3F-09
Barium	5/5	0.91	1.10	1.00	1.00	BG3F-06
Barium	5/5	0.91	1.10	1.00	1.00	BG3F-15
Copper	5/5	2.80	8.00	4.46	4.46	BG3F-06
Lead	5/5	7.40	11.90	9.50	9.50	BG3F-09
Selenium	5/5	0.40	0.61	0.47	0.47	BG3F-06
Zinc	5/5	23.30	45.50	36.16	36.16	BG3F-18
Pesticides/PCBs						
4,4'-DDD	5/5	0.0034	0.0131	0.00918	0.00918	BG3F-09
4,4'-DDE	5/5	0.0212	0.0341	0.02530	0.02530	BG3F-09
4,4'-DDT	1/5	0.0025	0.0025	0.00250	0.00091	BG3F-06
Aroclor-1260	1/5	0.0270	0.0270	0.02700	0.01360	BG3F-09
Dieldrin	1/5	0.0013	0.0013	0.00130	0.00067	BG3F-06

Concentrations are mg/kg (ppm).

10.1.1 Volatile Organic Compounds

There were no volatile organic compounds detected in any fish samples from any background site.

10.1.2 Semi-volatile Organic Compounds

Bis(2-ethylhexyl)phthalate

Phthalates, or phthalate esters such as Bis(2-ethylhexyl)phthalate, represent a large family of chemicals widely used as plasticizers. The toxicity of phthalates varies widely (EPA 1980a).

Bis(2-ethylhexyl)phthalate was detected in only 5 of 53 fish samples at background sites; in two samples from BG 3 and in three samples from BG 2.

Phenol

Phenol is used as an intermediate in a wide variety of chemical processes including production of epoxy and phenolic resins, pharmaceutical, pesticides, dyes, and numerous industrially-important acids. Information on chronic toxicity of phenol to aquatic organisms is sparse, but tests indicate that phenol is not likely to bioconcentrate or biomagnify (EPA 1980b).

Phenol was detected in 4 of 18 gulf killifish samples from BG 3, and was not detected in any fish sample at any other background site. The maximum concentration (10,000 µg/kg) occurred in sample ID BG3F-12; this sample also contained a higher concentration of aroclor-1260 than any other BG 3 sample, and was the only sample at BG 3 in which pyridine was detected.

Pyridine

Pyridine is used in a variety of chemical processes including the manufacture of waterproofing and rubber chemicals, and in the synthesis of vitamins and drugs (Verschueren, 1983).

Pyridine was detected in three samples from BG 1 and in one sample from BG 3. As mentioned above, the single BG 3 sample in which this compound was detected also contained high concentrations of phenol and aroclor-1260.

10.1.3 Pesticides/PCBs

Aroclor-1260

Aroclor-1260 is one of 209 polychlorinated biphenyl (PCB) congeners. Although production and use was banned in the United States in 1979, PCBs are extremely persistent in the environment and are known to bioaccumulate and biomagnify within the foodchain. PCBs in fish collected nationwide contained the following mean values: 892 ppb (1970-1976), 880 ppb (1976-1977), 850 ppb (1978-1979), and 530 ppb (1980-1981) (ATSDR 1995). Steimle et al (1990) reported PCB values of 40-90 ppb in fish from the relatively uncontaminated areas of the northwestern Atlantic Ocean.

Newell et al (1987) considered 130 µg/kg total PCBs as a non-carcinogenic based wildlife criterion, and 110 µg/kg total PCBs as a 1 in 100 cancer risk level for piscivorous wildlife. Eisler (1986a) recommended 400 µg/kg in fish (PCBs) as a protection criterion. The Great Lakes International Joint Commission (1988) recommended 100 µg/kg total PCBs as a whole-body maximum fish residue to protect birds and mammals that consume fish.

Aroclor-1260, the only PCB detected from background sites, was detected in 18 of 25 BG 1 samples, 8 of 18 BG 3 samples, and was not detected in BG 2 samples. At BG 1, concentrations of aroclor-1260 were highest in the larger (piscivorous) fish, and lowest in the minnow-sized fish (most of which feed on algae and small invertebrates), as expected for contaminants that biomagnify within the food chain. Concentrations in 7 of 10 of the larger fish (mullet, ladyfish, and yellow-fin mojarra) exceeded 100 µg/kg. All fish collected from BG 3 were minnow sized, and aroclor-1260 concentrations in three gulf killifish samples exceeded 100 µg/kg. In conclusion, concentrations of aroclor-1260 do not appear to be elevated above values considered to be typical of the region.

Aldrin and Dieldrin

Aldrin and dieldrin have been among the most widely used and distributed organochlorine insecticides in the United States. Once released to the environment, aldrin readily transforms into dieldrin (EPA, 1980c). As a result of the relatively long half-life of dieldrin, it continues to be detected nationwide, even though most uses of aldrin and dieldrin have been banned since 1974, and production was terminated in 1987 (EPA, 1994b). Using conservative assumptions for various uncertainty factors, Newell et al (1987) selected 120 µg/kg as a non-carcinogenic based wildlife criterion for aldrin and dieldrin, and 22 µg/kg as a 1 in 100 cancer risk level for piscivorous wildlife.

Aldrin was not detected in any background fish sample. Dieldrin was detected in only one fish at each background site at the following concentrations: 4.9 µg/kg (BG 1), 1.9 µg/kg (BG 2), and 1.3 µg/kg (BG 3). Thus, dieldrin was detected in only 3 of 53 fish samples, and detected values were well below levels considered to be ecologically significant.

Benzene hexachloride

Benzene hexachloride (BHC), also known as hexachlorocyclohexane, is an organochlorine insecticide consisting of eight stereo isomers. Newell et al (1987) selected 100 µg/kg total BHC as a non-carcinogenic based wildlife criterion, and 510 µg/kg total BHC as a 1 in 100 cancer risk level for piscivorous wildlife.

Beta BHC was the only BHC isomer detected in any fish samples from background sites, and was detected in 6 samples from BG 1 and 5 samples from BG 2. Detected values ranged from 4.2 to 6.3 µg/kg at BG 1 and 2.1 to 3.5 µg/kg at BG 2. Thus, all values were well below levels considered to be toxic to piscivorous wildlife.

DDT, DDD and DDE

The organochlorine insecticide DDT has not been marketed in the United States since 1972, but is ubiquitous in the environment due to its widespread use in previous decades and its relatively long half-life. DDT's close structural analogs, DDE and DDD, are metabolites of DDT (Hayes, 1982). DDT and its metabolites are concentrated from water by aquatic organisms at all trophic levels, and are biomagnified by organisms at higher trophic levels (EPA, 1980d). Newell et al (1987) concluded that 200 µg/kg represents a safe fish flesh criterion for the protection of sensitive wildlife species.

DDT was detected in one fish sample from BG 2 (2.0 µg/kg) and in one sample from BG 3 (2.5 µg/kg). DDE and DDD were detected in most fish from all three background sites, with the lowest values occurring in BG 2 samples. DDD concentrations were relatively low in all fish, but tended to be highest in BG 3 samples, while DDE tended to be highest in BG 1 samples. Only one sample of DDT, DDD, or DDD exceeded Newell et al's (1987) protective threshold of 200 µg/kg; DDE was detected at 282 µg/kg in a yellow-fin mojarra from BG 1. This same mojarra (sample ID BG1F-02) also exhibited the highest values from BG 1 for DDD and aroclor-1260. In summary, concentrations of DDT, DDD, and DDE were relatively low at all three background sites, and only one of 53 fish samples exceeded the threshold considered to be toxic to piscivorous wildlife.

Endosulfan

Endosulfan is an organochlorine insecticide comprised of stereoisomers designated I and II, both of which have similar toxicities. Endosulfan and its metabolites have been found widely in food samples, and are absorbed through the GI tract and distributed throughout the body (EPA, 1993). No information has been located regarding normal background values or toxicity thresholds for endosulfan in fish.

Endosulfan II was detected at 1.9 µg/kg in a gulf killifish sample from BG 3, and was not detected in any other samples at any site. This single sample (BG3F-03) also contained the highest values at BG 3 for selenium. Endosulfan sulfate was detected at 1.6 µg/kg in a sailfin molly sample from BG 1, and was not detected in any other samples at any background location.

10.1.4 Inorganics (Metals)

Arsenic

Mean concentrations of arsenic in freshwater fish in a national survey by the USFWS National Contaminant Biomonitoring Program (NCBP) were 0.16 mg/kg during 1978-1979 and 0.14 mg/kg during 1980-1981 (Lowe et al 1985). However, marine organisms in general accumulate more arsenic from the water column than fresh water organisms (Maher, 1983), and arsenic concentrations of 2 to 5 mg/kg are common in marine finfish (Eisler, 1988). Eisler (1988) also noted that some marine finfish appear to be unaffected at muscle total arsenic concentrations of 40 mg/kg.

Arsenic was detected in only four samples from BG 1, but was detected in all BG 2 samples and in 16 of 18 BG 3 samples. All detected values were relatively low, except in six gulf killifish samples from BG 3, in which arsenic exceeded the 5 mg/kg level reported as common in marine fish. The maximum value was 8.3 mg/kg.

Barium

Barium was detected in 15 of 25 samples from BG 1 and in less than one half of samples from BG 2 and BG 3. Mean detected values were 2.25 mg/kg (BG 1), 1.54 mg/kg (BG 2), and 1.15 mg/kg (BG 3). At present, no information has been located regarding normal background values or toxicity thresholds for barium in fish.

Chromium

Based on a review of data from several studies conducted by USFWS in the southwestern USA, Irwin (1988) considered 0.8 mg/kg in fish and wildlife tissue to represent an elevated level of chromium. Eisler (1986b) has recommended a protection criterion of 0.2 mg/kg in animal tissues.

Chromium was detected in only one sample from BG 1 (3.1 mg/kg) and one sample from BG 3 (1.0 mg/kg).

Copper

Copper is an essential element in vertebrates. Normal tissue concentrations of copper (as well as its toxicity threshold) vary widely depending on numerous factors such as water hardness, alkalinity, salinity, pH, organic level, temperature, and fish size (Sorensen, 1991).

Copper was detected in most samples from BG 1 and BG 2, and in all BG 3 samples. Mean detected values were 5.0 mg/kg (BG 1), 1.85 mg/kg (BG 2), and 4.26 mg/kg (BG 3).

Lead

Mean concentrations of lead in freshwater fish in a national survey by the USFWS NCBP were 0.19 ppm during 1978-1979 and 0.17 ppm during 1980-1981 (Lowe et al 1985).

Lead was detected in 9 of 25 BG 1 samples, in one BG 2 sample (0.24 mg/kg), and in all BG 3 samples. Mean detected values were 0.22 mg/kg at BG 1, and 3.45 mg/kg at BG 3. The mean for BG 3 samples was high relative to the other two sites due to values in five sheepshead minnow samples, which ranged from 7.4 to 11.9 mg/kg. The concentration of lead in the single sheepshead minnow sample from BG 1 was 0.33 mg/kg. With the exception of the sheepshead minnow samples from BG 3, lead values do not appear to be higher than expected.

Mercury

Mean concentrations of mercury in freshwater fish in the NCBP national survey were 0.11 ppm during 1978-1979 and 0.11 ppm during 1980-1981 (Lowe et al 1985). Eisler (1987) recommended the following protection criteria for wildlife: 0.1 mg/kg in fish eaten by birds, and 1.1 mg/kg in fish eaten by small

mammals. Field studies indicate that muscle tissue concentrations of 6 to 20 mg/kg are toxic to adult fish, and estimated whole body no-observed-effect concentrations in salmonids are 3 mg/kg (Wiener and Spry, 1996).

Mercury was detected in 5 of 25 samples from BG 1, all 10 samples from BG 2, and 12 of 18 samples from BG 3. Detected values were generally about 0.04 mg/kg, and only one sample was higher than 0.06 mg/kg. The highest value (0.12 mg/kg) was in a gray snapper from BG 2. This same fish (sample ID BG2F-01) also exhibited the highest values from BG 2 for arsenic, and nickel. At BG 3, mercury was detected in all 12 gulf killifish samples, but was not detected in any sheepshead minnow or sailfin molly samples. Overall, mercury concentrations from the background sites are within the range of normal values.

Nickel

Specific toxicity thresholds or background levels of nickel have not been identified in a literature search. However, nickel is commonly found in most surface water bodies and, like many other heavy metals, the bioavailability and toxicity of this metal to aquatic species is a function of water quality characteristics, including alkalinity, hardness, pH, salinity and humic acid concentrations (EPA 1986a). Results of tests indicate that this metal does not bioconcentrate to any appreciable extent nor does it biomagnify in foodchains (EPA 1986a).

Nickel was detected at 12.4 mg/kg in one sailfin molly sample from BG 1, and at 2.8 mg/kg in one gray snapper at BG 2. As mentioned above, the single fish from BG 2 that contained detectable nickel also contained the highest BG 2 values of mercury and arsenic.

Selenium

Selenium is an element that is required in trace amounts by some organisms. While considered to be an essential element for plants and animals, selenium is toxic at higher concentrations (Masscheleyn and Patrick 1993). Mean concentrations of selenium in freshwater fish in the NCBP national survey were 0.46 ppm during 1978-1979 and 0.47 ppm during 1980-1981 (Lowe et al 1985). Sorensen (1991), in a summary of selenium data, reported that selenium normally is present at 0.47 ppm in fish in the United States, and levels of 1 ppm are common. Lemly recommended 3 mg/kg (dry weight) as the toxic threshold for selenium in food-chain organisms (including small fish) consumed by piscivorous fish and

birds. Assuming a 75 percent moisture content (Lemly 1996), this value equates to 0.75 mg/kg in forage fish.

Selenium was detected in 20 of 25 samples from BG 1, 3 of 10 samples from BG 2, and in all samples from BG 3. Mean detected values were 0.41 mg/kg (BG 1), 0.28 mg/kg (BG 2), and 0.44 mg/kg (BG 3). These values are within the normal range of concentration expected for fish tissue.

Zinc

Zinc is an essential micronutrient for all living organisms, but is toxic to fish at elevated levels. Accumulation of zinc is dependent on fish size, water hardness, temperature, pH, the presence of other elements, and additional factors (Sorensen 1991). Mean concentrations of zinc in freshwater fish in the NCBP national survey were 25.63 ppm during 1978-1979 and 23.82 ppm during 1980-1981 (Lowe et al 1985).

Zinc was detected in all samples from BG 1 and BG 3, and in 8 of 10 BG 2 samples. Mean values were: 40.7 mg/kg at BG 1, 10.7 mg/kg at BG 2, and 32.7 mg/kg at BG 3. These values do not appear to be abnormally high.

10.1.5 Summary and Conclusions - Fish Tissue

Three semi-volatile compounds were detected in fish tissue. Each of these compounds was detected in only 4 to 5 out of 53 samples, but a few detected values were quite high. All of the samples in which semi-volatile compounds were detected consisted of minnows. Since all minnow samples were actually composites of several individual fish, the occurrence of high values in only a few samples is surprising. Whether these "outliers" represent true concentrations or are an artifact of the analytical process is unknown.

Only one PCB compound (aroclor-1260) was detected in fish tissue. Pesticides detected in fish tissue were limited to dieldrin, BHC, endosulfan, and DDT and its metabolites. These organochlorine insecticides were once widely used and are known to remain in the environment for extremely long periods. The degree to which the tissue concentrations of these pesticides and aroclor-1260 are a results of base-related activities or other sources (e.g., atmospheric transport) is unknown. Concentrations of metals and PCBs were generally within the range of values considered to be normal, with only a few exceptions. For example, arsenic was slightly elevated in 6 gulf killifish samples from BG 3, and lead concentrations were high in 5 sheepshead minnow samples from BG 3. Interestingly, a few samples were

responsible for several of the maximum values observed during the study. For a few contaminants, no information has been located regarding normal background values or toxicity thresholds.

In general, tissue concentrations at BG 2 were slightly lower than at the other two background sites. However, as seen in Table 10-1, there were few species common among sites. Thus, the lower tissue concentrations could be due to species differences rather than contamination differences. Overall, the tissue concentrations at all sites show no evidence of contamination problems, and the data indicate that the fish collected from these sites provide a data set that is indicative of background conditions at NAS Key West.

10.2 OYSTERS

Six metals and one semi-volatile compound were detected in mangrove oysters collected from BG 3 (Table 10-20). Oysters were not available at BG 1 nor BG 2. Furthermore, as mentioned in Section 4.2.6.2, the oysters at BG 3 were not collected from the same lagoon in which the fish were collected; but instead, from one of several excavated channels approximately 200 meters west of the lagoon.

Values of analytes detected in oysters were generally similar to those in fish tissue from the three background, with exceptions discussed below. Silver was detected in all three oyster samples, but was not detected in any fish sample; values ranged from 3.8 to 5.5 mg/kg. Zinc values in oysters greatly exceeded those in fish tissue. This is not surprising, since oysters are "notoriously strong accumulators of the metal" (Rainbow, 1996), and are often recommended as a source of human dietary zinc.

Pyridine concentrations in oysters ranged from 4.2 to 20.0 mg/kg. Pyridine was detected in 4 of 53 background fish samples, with a maximum value of 4.6 mg/kg. The pyridine values in the oysters appear to be quite high. However, mangrove oysters are not consumed by humans.

Although the data set is small (3 samples), the oyster tissue concentrations overall show no evidence of contamination problems, with the possible exception of high values of pyridine.

TABLE 10-20

BACKGROUND SITE 3 SUMMARY STATISTICS FOR MANGROVE OYSTER
NAS KEY WEST
BOCA CHICA KEY, FLORDIA

Chemical	Frequency of Detection	Minimum	Maximum	Average of Positive Detections	Average of All Values	Sample ID of Maximum
Metals						
Arsenic	3/3	2.40	3.70	3.17	3.17	BG3BV-03
Copper	3/3	1.70	3.80	2.40	2.40	BG3BV-01
Mercury	3/3	0.05	0.08	0.06	0.06	BG3BV-01
Selenium	3/3	1.20	1.40	1.30	1.30	BG3BV-01
Silver	3/3	3.80	5.5	4.53	4.53	BG3BV-01
Zinc	3/3	582.00	1.570	0.933	0.933	BG3BV-01
Semivolatiles						
Pyridine	3/3	4.200	20.000	11.733	11.733	BG3BV-02

Concentrations are mg/kg (ppm).

10.3 EARTHWORMS

Concentrations of metals in earthworms from sites S1SS-04, BG 1 and BG 3, and in laboratory control samples, are shown in Table 10-21. Earthworm tissue from BG 3 was not available for analyses, since mortalities in that sample were too decomposed for use in chemical analyses. Background samples were analyzed for metals only, since rapid decomposition of mortalities precluded the collection of tissue in a quantity sufficient for analyses of other contaminants.

The values shown in Table 10-21 for laboratory controls were supplied by EnviroSystems, Inc. (the toxicity testing laboratory that conducted the earthworm toxicity tests), and represent values for earthworms maintained in the laboratory's backup culture system. Thus, when comparing values from background sites to those of laboratory controls, two points should be noted: (1) values represent those of two different analytical laboratories, and (2) values for laboratory controls were not obtained from the worms used as laboratory controls in the toxicity tests.

As shown in Table 10-21, eight metals were detected in at least one background sample. Values in BG 1 earthworms were generally the highest, and greater than those in BG 2 earthworms, which were the lowest of the three background sites. For some metals, comparisons between background samples and control samples is hindered by the lower detection limits in the control samples relative to the background samples, but as seen in Table 10-21, there is no consistent pattern regarding comparisons to control. In summary, concentrations of metals in earthworms were highest in BG 1 samples, but the values do not greatly exceed those in the control samples.

TABLE 10-21

METAL CONCENTRATIONS (MG/KG WET WEIGHT) IN EARTHWORM TISSUE FROM BACKGROUND SITES AND IN LABORATORY CONTROLS NAS KEY WEST BOCA CHICA KEY, FLORIDA

Metal	BG 1	BG 2	S1SS-04	Laboratory Controls
Antimony	<4.9	<5.0	<4.8	0.2883
Arsenic	0.79	0.79	0.97	0.9875
Barium	7.6	1.7	5.0	0.3696
Beryllium	<0.39	<0.40	<3.8	0.0082
Cadmium	<0.49	<0.50	<0.48	0.3021
Chromium	4.0	<1.0	2.5	0.0971
Cobalt	<0.98	<1.0	<0.95	0.0115
Copper	4.2	2.6	2.3	1.701
Lead	4.2	0.45	3.9	0.4413
Mercury	<0.02	<0.02	<0.02	not analyzed
Nickel	<1.5	<1.5	<1.4	0.147
Selenium	<1.2	0.28	0.30	0.7167
Silver	<0.49	<0.50	<0.48	not analyzed
Thallium	<0.20	<0.20	<0.19	not analyzed
Tin	<4.9	<5.0	<4.8	not analyzed
Vanadium	2.6	<1.0	1.8	<0.0008
Zinc	21.3	13.5	15.7	19.780

11.0 CONCLUSIONS

Background sampling and analysis is conducted to ensure that site-related contamination can be distinguished from naturally occurring or other nonsite-related anthropogenic compounds. The presence of chemicals in background samples can be attributed to either naturally occurring ambient concentrations of chemicals in the environment (e.g., aluminum, manganese), or concentrations of chemicals that are in the environment as a result of nonsite-related human activities (e.g., industry, agriculture, automobile emissions).

Background samples are collected at or near locations of potential contamination in areas that could not have received chemical releases from site activities, but have the same basic physical and geochemical characteristics as the medium of concern at the site. Knowledge of upgradient, upwind and upstream conditions is critical in the identification of background locations.

This report describes background characterization performed at NAS Key West on Boca Chica Key. During January 1996, soil, sediment, surface water and groundwater samples were obtained for chemical analysis. In addition, fish and oysters were collected for tissue analyses. Finally, toxicity tests were performed on soil, water, and sediments collected from Boca Chica Key. Results from the background samples were combined with data obtained from previous investigations at Boca Chica Key. The primary sources for additional background data were the "Delineation Sampling Report for SWMU 1, SWMU 2, SWMU 3, SWMU 7, AOC-A, AOC-B, IR-1, and IR-2 at the Naval Air Station Key West, Florida" (BEI 1995b) and the "RCRA Facility Investigation/Remedial Investigation, Final Report Naval Air Station, Key West, Florida" (IT 1994). The analytical results for background samples, applicable State and Federal regulatory standards and guidance criteria, and human health and ecological risk assessment techniques will provide the primary basis to evaluate analytical results for NAS Key West sites in the supplemental RFI/RI report.

Chemical analyses have been conducted on soil, sediment, surface water and groundwater background samples that were obtained from three site-wide locations (BG 1, BG 2, and BG 3) and five site-specific locations (SWMU 1, SWMU 2, SWMU 3, SWMU 4 and SWMU 7). Biological background data were obtained from samples at BG 1, BG 2, and BG 3.

After all the data were obtained from historical records and current sampling activities, it was consolidated into a final background data set. The selection of data for inclusion into the final background data set

involved an initial review of background sample data sources. Each previous investigation report was reviewed for samples that were collected from locations considered to represent background conditions by a previous contractor. All site-specific and site-wide background samples collected by B&R Environmental in accordance with the supplemental RFI/RI SAP were added to the background data set.

Each soil and sediment sample location from the background data set was compared to BEI interim remedial action excavation boundaries. If the sample was collected prior to BEI interim remedial actions and fell within the boundaries of an excavation, it was discarded from use. In addition, the location of samples designated by previous contractors as background was reevaluated. Data from samples collected in questionable locations (i.e., areas affected by site operations) were rejected as background samples and retained for use as site data. The remaining samples are considered the background data set for Boca Chica Key.

Selection of background data also involved evaluating the chemical constituents detected in the sample as compared to other background samples. Detected values for inorganic and organic constituents were ordered according to descending values for comparison within each media or species. Unusually high inorganic values, as determined through professional judgment, were considered to be statistical outliers and the specific inorganic outliers were removed from the background data set. Two samples (S3SS-4 and S7SS-4) contained numerous metal outliers and data from these two samples were completely discarded from the background data set.

Pesticide and PAH values were also evaluated for statistical outliers. If these fractions were detected at low concentrations, they were considered anthropogenic yet ubiquitous and the sample was retained. If the fractions were detected at relatively high concentrations or several pesticides or PAHs were detected, the sample was considered to be non-representative of background and was removed from the background data set. The presence of chlorinated aliphatic or aromatic compounds was considered indicative of contamination and the sample was removed from the background data set in a first run of the statistics and then replaced for a second statistical run for comparison purposes. One sample had evidence of petroleum contamination, indicated by the presence of toluene and ethylbenzene. Therefore, that sample was not retained as a background sample in the first statistical run, but was retained in the second statistical run. Descriptive statistics were found to be similar for both runs so the results of the second run were used in the statistical analysis of background data for Boca Chica Key.

The distribution of the data set (i.e., normal or lognormal), the 95 percent upper confidence limit (UCL) of the mean (which is often used as the representative concentration for risk assessments), the 95 percent upper tolerance limit (UTL) and other descriptive statistics were determined for each analyte detected in

the background soil samples. However, the utility of some of the information presented (particularly the distribution designation, the UCL and the UTL) is restricted by the number of positive detections reported for some of the analytes. In soil, less than six positive inorganic detections were reported for antimony, beryllium, cadmium, mercury, selenium, and tin. Statistically, this means that the distribution for these analytes is undefined. Thus, the maximum detected concentrations for these analytes will be used as the representative concentration and as the UTL in the supplemental RFI/RI report for NAS Key West. In addition the UTL for lead in soil was higher than the OSWER clean-up standard of 400 mg/kg. Thus, the maximum detected concentration for lead will also be used as the representative concentration and as the UTL in the supplemental RFI/RI report for NAS Key West. Descriptive statistics for all other analytes detected in soil will be used in the supplemental RFI/RI report.

For most analytes in surface water, sediment, and groundwater, the data are not sufficient for descriptive statistics. Barium was the only analyte detected frequently enough to allow for the use of descriptive statistics in surface water and groundwater. Descriptive statistics for barium in surface water and groundwater will be used in the supplemental RFI/RI report. All other analytes in surface water, sediment, and groundwater (including barium in sediment) are considered to have an undefined distribution. Thus, the maximum detected concentrations for these analytes will be used as the representative concentration and the UTL in the supplemental RFI/RI report for NAS Key West.

Arsenic was detected in soil and sediment above generic residential RBC (EPA 1994a) but within the range of arsenic concentrations reported for soils in the eastern United States (Shacklette and Boerngen 1984). Thallium was detected slightly above the maximum contaminant level in both surface water and groundwater. All other analytes were detected below their corresponding RBC.

Fish were collected for chemical analyses from BG 1, BG 2, and BG 3. Three semi-volatile compounds were detected in fish tissue. Each of these compounds were detected in only 4 to 5 out of 53 samples, but a few detected values were high. Whether these "outliers" represent true concentrations or are an artifact of the analytical process is unknown. Concentrations of pesticides and PCBs in background fish show no evidence of being abnormally high. Concentrations of metals were generally within the range of values considered to be normal, with only a few exceptions. In general, tissue concentrations at BG 2 were slightly lower than at the other two background sites. Overall, the tissue concentrations at all sites show no evidence of contamination problems, and the data indicate that the fish collected from these sites provide a data set that is indicative of background conditions at NAS Key West.

Mangrove oysters were collected from BG 3. Concentrations of analytes detected in oysters were generally similar to those in fish tissue from the three background sites. Although the data set is small

(3 samples), the oyster tissue concentrations overall show no evidence of contamination problems, with the possible exception of high values of pyridine.

Metal concentrations in BG 1 earthworms were generally greater than those in BG 2 earthworms. There was no clear pattern regarding metal concentrations in background samples when compared to control samples. Concentrations of metals in earthworms were highest in BG 1 samples, but the values did not greatly exceed those in the control samples.

Toxicity tests were conducted using water and sediment collected from BG 1, BG 2, and BG 3. Earthworm toxicity tests were conducted on soil samples collected at BG 1, BG 2, BG 3, and S1SS-04. Results of the toxicity tests suggest that all three site-wide background sites appear to have been impacted to some extent by previous activities on Boca Chica Key. At BG 1, growth and survival of amphipods in sediment, survival of silverside minnows in surface water, and survival of earthworms in soil were all reduced. At BG 2 and BG 3, sea urchin fertilization and mysid shrimp growth and survival were normal, but survival of silverside minnows from both sites was greatly reduced. However, the survival of silverside minnows at all three background sites may have been adversely impacted by salinity problems. Mussel fertilization and development was greatly reduced at BG 2, and normal at BG 3. Earthworm survival was greatly reduced in BG 1 and BG 3 soil and was normal in BG 2 soil. Because of lower than expected survival of at least one test species at all three background sites, the results of SWMU-related toxicity tests will be assessed relative to laboratory controls rather than to background samples in the supplemental RFI/RI report.

The background data set for Boca Chica Key appears to be sufficient to accurately characterize background conditions. Although some of the results are inconclusive (i.e., toxicity tests for soil and silverside minnows), there is currently sufficient background information available for supporting the NAS Key West RFI/RI at Boca Chica Key.

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ATTACHMENT A

STATISTICAL PROCEDURES AND EQUATIONS

ATTACHMENT A

STATISTICAL PROCEDURES AND EQUATIONS

A.1 Introduction

Attachment A presents the statistical procedures used to describe and evaluate the background data collected for the Key West RFI. The statistical methods included in Attachment A are employed in order to determine the following:

1. Summary statistics (e.g., minimum value, maximum value, arithemetic mean, standard deviation) which describe background concentrations at Key West.

2. The 95 percent upper confidence limit on the mean (UCL) and the 95 percent upper tolerance limit (UTL).

The statistical methods presented in Attachment A were based on:

1. Gilbert, Richard O., Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company. New York, New York. 1987.

2. Snedecor and Cochran. Statistical Methods. The Iowa State University Press. 1980.

3. U.S. EPA 530/SW-89-026. "Guidance Document on the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities." 1989.

4. U.S. EPA 530/R-93-003. "Statistical Training Course for Ground-Water Monitoring Data Analysis." July, 1992.

Attachment A presents the equations used to calculate descriptive statistics for background data sets.

A.2 Calculation of Descriptive Statistics

Prior to statistical analysis of a background data set, the data set must be analyzed to determine whether the data were drawn from an underlying normal, log-normal or undetermined distribution. A number of statistical evaluations may be used to determine which, if either, of the distributions are exhibited by a

given data set. The Shapiro and Wilk "W-test" (for sample sets ≤50) will be used to determine whether the data are normally or log-normally distributed.

A.2.1 The Shapiro and Wilk "W-test"

The Shapiro and Wilk W-test (Gilbert, 1987) is an effective method for determining whether a data set has been drawn from an underlying normal distribution. In addition, by conducting the Shapiro and Wilk W-test on the log-transformed data, the test may be used to determine whether the data has been drawn from an underlying log-normal distribution. The null hypothesis (H_0) that is tested is:

H_0 The population has a normal (or log-normal when the data is log-transformed) distribution.

The alternate hypothesis (H_A) is:

H_A The population does not have a normal (or log-normal when the data is log-transformed) distribution.

If H_0 is rejected, then H_A is accepted. If H_0 is not rejected, the data set is consistent with the H_0 distribution.

A "W" statistic (W_{calc}) is computed for a data set (or a log transformed data set) and compared to a test statistic (W_{test}). If $W_{calc} > W_{test}$, then the null hypothesis is not rejected (i.e. the data are assumed to be normally distributed [or log-normally distributed if log transformed data are tested]). If $W_{calc} < W_{test}$, then the null hypothesis is rejected and the alternative hypothesis is accepted (i.e., the data are not assumed to be normally distributed [or not log-normally distributed if log transformed data are tested]).

The following equations present a step-by-step procedure for conducting the W-test. The equation for conducting the W-Test is:

$$W = \frac{1}{d}\left[\sum_{i=1}^{k} a_i \left(x_{[n-i+1]} - x_{[i]}\right)\right]^2$$

- Step 1. Order the n data points from smallest to largest to obtain the sample order statistics:

$$x_1 \leq x_2 \leq x_3 \leq \ldots \leq x_n$$

- Step 2. Compute the denominator (d) of the W-test statistic using the n data:

$$d = \sum_{i=1}^{n} (x_i)^2 - \frac{1}{n}\left[\sum_{i=1}^{n} x_i\right]^2$$

- Step 3. Compute k, where:

$$k = \frac{n}{2} \quad \textit{if n is even}$$

- Step 4. Determine the coefficients a_1, $a_2, a_3, \ldots, a_k$ for the sample size n using Table A-1

$$k = \frac{n-1}{2} \quad \textit{if n is odd}$$

- Step 5. Compute W_{calc}:

$$W_{calc} = \frac{1}{d}\left[\sum_{i=1}^{k} a_i \left(x_{[n-i+1]} - x_{[i]}\right)\right]^2$$

- Step 6. Determine W_{test} at the α significance level from Table A-2.

- Step 7. Reject H_O at the α significance level if W_{calc} is less than W_{test}.

To test the null hypothesis that the data set has been drawn from an underlying log-normal distribution, transform the data to $y_1, y_2, y_3, \ldots, y_n$ where $y_i = \ln x_i$. Repeat steps 1 through 7 as described in the preceding paragraphs.

A.2.2 Upper One-sided 95% Condidence Limit for the Arithmetic Mean

The 100(1-α) Upper Confidence Limit ($UCL_{100(1-\alpha)}$) of the population mean (μ) is often used as a descriptive statistic for background environmental data. When $\alpha = 0.05$, the 95 percent upper confidence limit (one-tailed test) may be calculated as follows:

$$UCL_{0.95} = \bar{x} + t_{0.95,n-1} \frac{S_x}{\sqrt{n}}$$

where:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i = \textit{arithmetic mean}$$

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}} = \textit{the sample standard deviation}$$

$$t_{0.95,n-1} = \textit{Value from t-distribution (Table A-3)}$$

It should be noted that the 95 percent confidence interval for a second sample of size n drawn from the same population will most likely not be the same as that for the first sample. In theory if an interval estimate is calculated for the means of a very large set of samples of size n, the true population mean will be within 95 percent of this limit.

A.2.3 Upper One-sided 95% Confidence Limit for the Geometric Mean (Log-normal distribution)

The following formula may be used to calculate the upper 95% confidence interval ($UCL_{95\%}$) for the geometric mean (x_g):

$$UCL_{0.95} = \exp\left[\bar{y} + 0.5\,(S_y)^2 + \frac{S_y\,H_{0.95,n}}{\sqrt{n}}\right]$$

where: $\bar{y}$ = arithmetic mean of the log-transformed data, y = ln(x)

S_y = standard deviation of y

$H_{0.95,n}$ = factor from Table A-4 for sample size n

A.2.4 Upper 95% Tolerance Limit (Normal Distribution)

As used in this report, the upper 95% tolerance limit ($UTL_{0.95}$) is actually the upper 95 percent confidence limit for the 95th quantile. The UTL is defined as that concentration below which, with 95% certainty, all values in a population will fall. The $UTL_{0.95}$ is calculated as follows:

$$UTL_{0.95} = \bar{x} + s_x\,K_{0.95,0.95}$$

Where: $UTL_{0.95}$ = Upper 95% tolerance limit

$\bar{x}$ = Arithmetic mean

s = Sample standard deviation

$K_{0.95,\,0.95}$ = One-sided tolerance factor for estimating the 95% confidence limit for the 95th quantile (Table A-5)

A.2.5 Upper 95% Tolerance Limit (Lognormal Distribution)

The upper 95 percent tolerance limit for data with an underlying lognormal distribution is given by:

$$UTL_{0.95} = \exp\,[\bar{y} + s_y\,K_{0.95,0.95}]$$

Where:	y	=	$\ln(x)$
	s_y	=	sample standard deviation of y
	$K_{0.95,0.95}$	=	one-sided tolerance factor for estimating the 95% confidence limit for the 95th quartile (Table A-5)

STATISTICAL TABLES

Table A-1 Coefficients a_i for the Shapiro-Wilk W Test for Normality

i \ n	2	3	4	5	6	7	8	9	10
1	0.7071	0.7071	0.6872	0.6646	0.6431	0.6233	0.6052	0.5888	0.5739
2	-	0.0000	0.1677	0.2413	0.2806	0.3031	0.3164	0.3244	0.3291
3	-	-	-	0.0000	0.0875	0.1401	0.1743	0.1976	0.2141
4	-	-	-	-	-	0.0000	0.0561	0.0947	0.1224
5	-	-	-	-	-	-	-	0.0000	0.0399

i \ n	11	12	13	14	15	16	17	18	19	20
1	0.5601	0.5475	0.5359	0.5251	0.5150	0.5056	0.4968	0.4886	0.4808	0.4734
2	0.3315	0.3325	0.3325	0.3318	0.3306	0.3290	0.3273	0.3253	0.3232	0.3211
3	0.2260	0.2347	0.2412	0.2460	0.2495	0.2521	0.2540	0.2553	0.2561	0.2565
4	0.1429	0.1586	0.1707	0.1802	0.1878	0.1939	0.1988	0.2027	0.2059	0.2085
5	0.0695	0.0922	0.1099	0.1240	0.1353	0.1447	0.1524	0.1587	0.1641	0.1686
6	0.0000	0.0303	0.0539	0.0727	0.0880	0.1005	0.1109	0.1197	0.1271	0.1334
7	-	-	0.0000	0.0240	0.0433	0.0593	0.0725	0.0837	0.0932	0.1013
8	-	-	-	-	0.0000	0.0196	0.0359	0.0496	0.0612	0.0711
9	-	-	-	-	-	-	0.0000	0.0163	0.0303	0.0427
10	-	-	-	-	-	-	-	-	0.0000	0.0140

i \ n	21	22	23	24	25	26	27	28	29	30
1	0.4643	0.4590	0.4542	0.4493	0.4450	0.4407	0.4366	0.4328	0.4291	0.4254
2	0.3185	0.3156	0.3126	0.3098	0.3069	0.3043	0.3018	0.2992	0.2968	0.2944
3	0.2578	0.2571	0.2563	0.2554	0.2543	0.2533	0.2522	0.2510	0.2499	0.2487
4	0.2119	0.2131	0.2139	0.2145	0.2148	0.2151	0.2152	0.2151	0.2150	0.2148
5	0.1736	0.1764	0.1787	0.1807	0.1822	0.1836	0.1848	0.1857	0.1864	0.1870
6	0.1399	0.1443	0.1480	0.1512	0.1539	0.1563	0.1584	0.1601	0.1616	0.1630
7	0.1092	0.1150	0.1201	0.1245	0.1283	0.1316	0.1346	0.1372	0.1395	0.1415
8	0.0804	0.0878	0.0941	0.0997	0.1046	0.1089	0.1128	0.1162	0.1192	0.1219
9	0.0530	0.0618	0.0696	0.0764	0.0823	0.0876	0.0923	0.0965	0.1002	0.1036
10	0.0263	0.0368	0.0459	0.0539	0.0610	0.0672	0.0728	0.0778	0.0822	0.0862
11	0.0000	0.0122	0.0228	0.0321	0.0403	0.0476	0.0540	0.0598	0.0650	0.0697
12	-	-	0.0000	0.0107	0.0200	0.0284	0.0358	0.0424	0.0483	0.0537
13	-	-	-	-	0.0000	0.0094	0.0178	0.0253	0.0320	0.0381
14	-	-	-	-	-	-	0.0000	0.0084	0.0159	0.0227
15	-	-	-	-	-	-	-	-	0.0000	0.0076

Source: From Shapiro and Wilk, 1965. Used by permission.
This table is used in Section 12.3.1.

Table A-1 (continued)

f \ n	31	32	33	34	35	36	37	38	39	40
1	0.4220	0.4188	0.4156	0.4127	0.4096	0.4068	0.4040	0.4015	0.3989	0.3964
2	0.2921	0.2898	0.2876	0.2854	0.2834	0.2813	0.2794	0.2774	0.2755	0.2737
3	0.2475	0.2462	0.2451	0.2439	0.2427	0.2415	0.2403	0.2391	0.2380	0.2368
4	0.2145	0.2141	0.2137	0.2132	0.2127	0.2121	0.2116	0.2110	0.2104	0.2098
5	0.1874	0.1878	0.1880	0.1882	0.1883	0.1883	0.1883	0.1881	0.1880	0.1878
6	0.1641	0.1651	0.1660	0.1667	0.1673	0.1678	0.1683	0.1686	0.1689	0.1691
7	0.1433	0.1449	0.1463	0.1475	0.1487	0.1496	0.1505	0.1513	0.1520	0.1526
8	0.1243	0.1265	0.1284	0.1301	0.1317	0.1331	0.1344	0.1356	0.1366	0.1376
9	0.1066	0.1093	0.1116	0.1140	0.1160	0.1179	0.1196	0.1211	0.1225	0.1237
10	0.0899	0.0931	0.0961	0.0988	0.1013	0.1036	0.1056	0.1075	0.1092	0.1108
11	0.0739	0.0777	0.0812	0.0844	0.0873	0.0900	0.0924	0.0947	0.0967	0.0986
12	0.0585	0.0629	0.0669	0.0706	0.0739	0.0770	0.0798	0.0824	0.0848	0.0870
13	0.0435	0.0485	0.0530	0.0572	0.0610	0.0645	0.0677	0.0706	0.0733	0.0759
14	0.0289	0.0344	0.0395	0.0441	0.0484	0.0523	0.0559	0.0592	0.0622	0.0651
15	0.0144	0.0206	0.0262	0.0314	0.0361	0.0404	0.0444	0.0481	0.0515	0.0546
16	0.0000	0.0068	0.0131	0.0187	0.0239	0.0287	0.0331	0.0372	0.0409	0.0444
17	-	-	0.0000	0.0062	0.0119	0.0172	0.0220	0.0264	0.0305	0.0343
18	-	-	-	-	0.0000	0.0057	0.0110	0.0158	0.0203	0.0244
19	-	-	-	-	-	-	0.0000	0.0053	0.0101	0.0146
20	-	-	-	-	-	-	-	-	0.0000	0.0049

f \ n	41	42	43	44	45	46	47	48	49	50
1	0.3940	0.3917	0.3894	0.3872	0.3850	0.3830	0.3808	0.3789	0.3770	0.3751
2	0.2719	0.2701	0.2684	0.2667	0.2651	0.2635	0.2620	0.2604	0.2589	0.2574
3	0.2357	0.2345	0.2334	0.2323	0.2313	0.2302	0.2291	0.2281	0.2271	0.2260
4	0.2091	0.2085	0.2078	0.2072	0.2065	0.2058	0.2052	0.2045	0.2038	0.2032
5	0.1876	0.1874	0.1871	0.1868	0.1865	0.1862	0.1859	0.1855	0.1851	0.1847
6	0.1693	0.1694	0.1695	0.1695	0.1695	0.1695	0.1695	0.1693	0.1692	0.1691
7	0.1531	0.1535	0.1539	0.1542	0.1545	0.1548	0.1550	0.1551	0.1553	0.1554
8	0.1384	0.1392	0.1398	0.1405	0.1410	0.1415	0.1420	0.1423	0.1427	0.1430
9	0.1249	0.1259	0.1269	0.1278	0.1286	0.1293	0.1300	0.1306	0.1312	0.1317
10	0.1123	0.1136	0.1149	0.1160	0.1170	0.1180	0.1189	0.1197	0.1205	0.1212
11	0.1004	0.1020	0.1035	0.1049	0.1062	0.1073	0.1085	0.1095	0.1105	0.1113
12	0.0891	0.0909	0.0927	0.0943	0.0959	0.0972	0.0986	0.0998	0.1010	0.1020
13	0.0782	0.0804	0.0824	0.0842	0.0860	0.0876	0.0892	0.0906	0.0919	0.0932
14	0.0677	0.0701	0.0724	0.0745	0.0765	0.0783	0.0801	0.0817	0.0832	0.0846
15	0.0575	0.0602	0.0628	0.0651	0.0673	0.0694	0.0713	0.0731	0.0748	0.0764
16	0.0476	0.0506	0.0534	0.0560	0.0584	0.0607	0.0628	0.0648	0.0667	0.0685
17	0.0379	0.0411	0.0442	0.0471	0.0497	0.0522	0.0546	0.0568	0.0588	0.0608
18	0.0283	0.0318	0.0352	0.0383	0.0412	0.0439	0.0465	0.0489	0.0511	0.0532
19	0.0188	0.0227	0.0263	0.0296	0.0328	0.0357	0.0385	0.0411	0.0436	0.0459
20	0.0094	0.0136	0.0175	0.0211	0.0245	0.0277	0.0307	0.0335	0.0361	0.0386
21	0.0000	0.0045	0.0087	0.0126	0.0163	0.0197	0.0229	0.0259	0.0288	0.0314
22	-	-	0.0000	0.0042	0.0081	0.0118	0.0153	0.0185	0.0215	0.0244
23	-	-	-	-	0.0000	0.0039	0.0076	0.0111	0.0143	0.0174
24	-	-	-	-	-	-	0.0000	0.0037	0.0071	0.0104
25	-	-	-	-	-	-	-	-	0.0000	0.0035

Table A-2 Quantiles of the Shapiro-Wilk W Test for Normality (Values of W Such That $100p\%$ of the Distribution of W Is Less Than W_p)

n	$W_{0.01}$	$W_{0.02}$	$W_{0.05}$	$W_{0.10}$	$W_{0.50}$
3	0.753	0.756	0.767	0.789	0.959
4	0.687	0.707	0.748	0.792	0.935
5	0.686	0.715	0.762	0.806	0.927
6	0.713	0.743	0.788	0.826	0.927
7	0.730	0.760	0.803	0.838	0.928
8	0.749	0.778	0.818	0.851	0.932
9	0.764	0.791	0.829	0.859	0.935
10	0.781	0.806	0.842	0.869	0.938
11	0.792	0.817	0.850	0.876	0.940
12	0.805	0.828	0.859	0.883	0.943
13	0.814	0.837	0.866	0.889	0.945
14	0.825	0.846	0.874	0.895	0.947
15	0.835	0.855	0.881	0.901	0.950
16	0.844	0.863	0.887	0.906	0.952
17	0.851	0.869	0.892	0.910	0.954
18	0.858	0.874	0.897	0.914	0.956
19	0.863	0.879	0.901	0.917	0.957
20	0.868	0.884	0.905	0.920	0.959
21	0.873	0.888	0.908	0.923	0.960
22	0.878	0.892	0.911	0.926	0.961
23	0.881	0.895	0.914	0.928	0.962
24	0.884	0.898	0.916	0.930	0.963
25	0.886	0.901	0.918	0.931	0.964
26	0.891	0.904	0.920	0.933	0.965
27	0.894	0.906	0.923	0.935	0.965
28	0.896	0.908	0.924	0.936	0.966
29	0.898	0.910	0.926	0.937	0.966
30	0.900	0.912	0.927	0.939	0.967
31	0.902	0.914	0.929	0.940	0.967
32	0.904	0.915	0.930	0.941	0.968
33	0.906	0.917	0.931	0.942	0.968
34	0.908	0.919	0.933	0.943	0.969
35	0.910	0.920	0.934	0.944	0.969
36	0.912	0.922	0.935	0.945	0.970
37	0.914	0.924	0.936	0.946	0.970
38	0.916	0.925	0.938	0.947	0.971
39	0.917	0.927	0.939	0.948	0.971
40	0.919	0.928	0.940	0.949	0.972
41	0.920	0.929	0.941	0.950	0.972
42	0.922	0.930	0.942	0.951	0.972
43	0.923	0.932	0.943	0.951	0.973
44	0.924	0.933	0.944	0.952	0.973
45	0.926	0.934	0.945	0.953	0.973
46	0.927	0.935	0.945	0.953	0.974
47	0.928	0.936	0.946	0.954	0.974
48	0.929	0.937	0.947	0.954	0.974
49	0.929	0.937	0.947	0.955	0.974
50	0.930	0.938	0.947	0.955	0.974

Source: After Shapiro and Wilk, 1965.

The null hypothesis of a normal distribution is rejected at the α significance level if the calculated W is less than W_α.

This table is used in Section 12.3.1.

TABLE A-3 Percentage points of the t distribution ($t_{u,d}$)*

Degrees of freedom, d	u								
	.75	.80	.85	.90	.95	.975	.99	.995	.9995
1	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	12.924
4	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	6.869
6	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850
21	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60	0.679	0.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460
120	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373
∞	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291

*The uth percentile of a t distribution with d degrees of freedom.

[Table 5 is taken from Table III of Fisher and Yates: "Statistical Tables for Biological, Agricultural and Medical Research," published by Longman Group Ltd., London (previously published by Oliver and Boyd Ltd., Edinburgh) and by permission of the authors and publishers.]

Table A-4 Values of $H_{1-\alpha} = H_{0.95}$ for Computing a One-Sided Upper 95% Confidence Limit on a Lognormal Mean

s_y	n = 3	5	7	10	12	15	21	31	51	101
0.10	2.750	2.035	1.886	1.802	1.775	1.749	1.722	1.701	1.684	1.670
0.20	3.295	2.198	1.992	1.881	1.843	1.809	1.771	1.742	1.718	1.697
0.30	4.109	2.402	2.125	1.977	1.927	1.882	1.833	1.793	1.761	1.733
0.40	5.220	2.651	2.282	2.069	2.026	1.968	1.905	1.856	1.813	1.777
0.50	6.495	2.947	2.465	2.220	2.141	2.068	1.989	1.928	1.876	1.830
0.60	7.807	3.287	2.673	2.368	2.271	2.181	2.085	2.010	1.946	1.891
0.70	9.120	3.662	2.904	2.532	2.414	2.306	2.191	2.102	2.025	1.960
0.80	10.43	4.062	3.155	2.710	2.570	2.443	2.307	2.202	2.112	2.035
0.90	11.74	4.478	3.420	2.902	2.738	2.589	2.432	2.310	2.206	2.117
1.00	13.05	4.905	3.696	3.103	2.915	2.744	2.564	2.423	2.306	2.205
1.25	16.33	6.001	4.426	3.639	3.389	3.163	2.923	2.737	2.580	2.447
1.50	19.60	7.120	5.184	4.207	3.896	3.612	3.311	3.077	2.881	2.713
1.75	22.87	8.250	5.960	4.795	4.422	4.081	3.719	3.437	3.200	2.997
2.00	26.14	9.387	6.747	5.396	4.962	4.564	4.141	3.812	3.533	3.295
2.50	32.69	11.67	8.339	6.621	6.067	5.557	5.013	4.588	4.228	3.920
3.00	39.23	13.97	9.945	7.864	7.191	6.570	5.907	5.388	4.947	4.569
3.50	45.77	16.27	11.56	9.118	8.326	7.596	6.815	6.201	5.681	5.233
4.00	52.31	18.58	13.18	10.38	9.469	8.630	7.731	7.024	6.424	5.908
4.50	58.85	20.88	14.80	11.64	10.62	9.669	8.652	7.854	7.174	6.590
5.00	65.39	23.19	16.43	12.91	11.77	10.71	9.579	8.688	7.929	7.277
6.00	78.47	27.81	19.68	15.45	14.08	12.81	11.44	10.36	9.449	8.661
7.00	91.55	32.43	22.94	18.00	16.39	14.90	13.31	12.05	10.98	10.05
8.00	104.6	37.06	26.20	20.55	18.71	17.01	15.18	13.74	12.51	11.45
9.00	117.7	41.68	29.46	23.10	21.03	19.11	17.05	15.43	14.05	12.85
10.00	130.8	46.31	32.73	25.66	23.35	21.22	18.93	17.13	15.59	14.26

Source: After Land, 1975.

This table is used in Section 13.2.

TABLE A-5

Tolerance Factors (k) for One-Sided Normal Tolerance Intervals With Probability Level (Confidence Factor) y=0.95 and Coverage P=95%

n	k
3	7.655
4	5.145
5	4.202
6	3.707
7	3.399
8	3.188
9	3.031
10	2.911
11	2.815
12	2.736
13	2.670
14	2.614
15	2.566
16	2.523
17	2.486
18	2.543
19	2.423
20	2.396
21	2.371
22	2.350
23	2.329
24	2.309
25	2.292
30	2.220
35	2.166
40	2.125
45	2.092
50	2.065
55	2.036
60	2.017
65	2.000
70	1.986

n	k
75	1.972
100	1.924
125	1.891
150	1.868
175	1.850
200	1.836
225	1.824
250	1.814
275	1.806
300	1.799
325	1.792
350	1.787
375	1.782
400	1.777
425	1.773
450	1.769
475	1.766
500	1.763
525	1.760
550	1.757
575	1.754
600	1.752
625	1.750
650	1.748
675	1.746
700	1.744
725	1.742
750	1.740
775	1.739
800	1.737
825	1.736
850	1.734
875	1.733
900	1.732
925	1.731
950	1.729
975	1.728
1000	1.727
∞	1.645

Source: EPA, 1989.

ATTACHMENT B

BACKGROUND SUMMARY STATISTICS (RUN 1*) FOR SOIL AND SEDIMENT

TABLE B-1

BACKGROUND SUMMARY STATISTICS FOR SOIL (RUN 1)
NAS KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Location of Maximum	Distribution	95% UCL	95% UTL	RBC Industrial	RBC Residential	Basis	Soil to Air	Soil to Ground-Water
Metals													
Aluminum	8/8	120	4,250	1,880	BG1SS-03	Lognormal	50,400	117,000	1,000,000	78,000	N	-	-
Antimony	1/9	0.26	0.26	0.445	S2SB-9	Assume Lognormal	0.750	2.44	820	31	N	-	-
Arsenic	5/9	0.63	2.7	1.39	BG1SS-03	Lognormal	2.63	8.58	3.8	0.43	C	380	15
Barium	9/9	4.4	17.7	10.1	BG1SS-03	Lognormal	14.47	35.5	140,000	5,500	N	350000	32
Beryllium	1/9	0.13	0.13	0.047	S2SB-9	Assume Lognormal	0.069	0.184	1.3	0.15	C	690	180
Cadmium	2/9	0.11	0.41	0.138	BG1SS-01	Lognormal	0.440	1.72	1,000	39	N	920	6
Calcium	8/8	284,000	449,000	384,000	BG2SS-02	Normal	421,000	561,000	-	-	-	-	-
Chromium (IV)	9/9	1.9	9.5	4.36	BG1SS-03	Lognormal	7.17	21.0	10,000	390	N	140 (VI)	19 (VI)
Cobalt	4/9	0.22	0.43	0.314	BG1SS-03	Lognormal	1.00	4.00	120,000	4,700	N	-	-
Copper	8/9	1.3	15.6	4.12	BG1SS-03	Lognormal	12.0	46.3	82,000	3,100	N	-	-
Iron	8/8	98.1	2,250	1,040	BG1SS-03	Normal	1,571	3,580	610,000	23,000	N	-	-
Lead	8/9	0.65	43.5	11.0	BG1SS-03	Lognormal	606	841	-	400 (OSWER)	-	-	-
Magnesium	8/8	1,340	24,600	8,530	BG2SS-01	Lognormal	27,200	106,000	-	-	-	-	-
Manganese	8/8	2.6	33.7	17.1	BG1SS-01	Lognormal	63.3	248	10,000	390	N	-	-
Nickel	5/9	0.63	3.3	1.22	BG1SS-03	Lognormal	3.72	14.4	41,000	1,600	N	6900	21
Potassium	8/8	48.6	944	336	BG1SS-02	Lognormal	954	3,620	-	-	-	-	-
Selenium	2/9	0.46	1.5	0.611	BG1SS-03	Assume Lognormal	0.816	1.85	10,000	390	N	-	3
Sodium	8/8	1,620	18,700	5,530	BG1SS-02	Lognormal	15,500	59,500	-	-	-	-	-
Tin	1/4	0.78	0.78	1.90	S2SB-9	Normal	2.8359	6.0098	1,000,000	47,000	N	-	-
Vanadium	9/9	0.8	7.8	3.02	BG1SS-03	Lognormal	6.49	22.8	14,000	550	N	-	-
Zinc	9/9	0.63	36.6	7.29	BG1SS-03	Lognormal	26.6	103	610,000	23,000	N	-	42,000

TABLE B-1

BACKGROUND SUMMARY STATISTICS FOR SOIL (RUN 1)
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Location of Maximum	Distribution	95% UCL	95% UTL	RBC Industrial	RBC Residential	Basis	Soil to Air	Soil to Ground-Water
Miscellaneous													
Sulfide	1/1	49	49	49	S3BG-1	NA	NA	NA					
Semivolatiles													
Anthracene	1/8	390	390	232	BG1SS-03	Assume Lognormal	279	489	610,000	23,000	N	6.8	4,300
Benzo(b) fluoranthene	1/8	390	390	232	BG1SS-03	Assume Lognormal	279	489	7.8	0.88	C	23	4
Bis(2-Ethylhexyl) phthalate	1/8	330	330	234	S3BG-1	Lognormal	266	413	410	46	C	210	11
Chrysene	1/8	280	280	219	BG1SS-03	Lognormal	243	342	780	88	C	3.6	1
Fluoranthene	1/8	660	660	266	BG1SS-03	Assume Lognormal	376	916	82,000	3,100	N	68	980
Pyrene	1/8	470	470	242	BG1SS-03	Assume Lognormal	307	608	61,000	2,300	N	56	1,400
Chloromethane	1/9	4	4	2.61	BG1SS-01	Assume Lognormal	5.56	19.7	440	49	C	0.063	0.0066
Methylene chloride	5/9	0.11	14	3.12	S3BG-1	Lognormal	24.0	84.0	760	85	C	7	0.01
Pesticides/PCBs													
4,4'-DDD	1/7	6.7	6.7	6.21	S2SB-9	Lognormal	122	340	24	2.7	C	37	0.7
4,4'-DDE	2/7	3.9	53.3	13.3	BG1SS-02	Lognormal	652	1,180	17	1.9	C	10	0.5
4,4'-DDT	3/7	2.6	9.3	8.04	BG2SS-02	Lognormal	52.9	207	17	1.9	C	80	1
Methyl parathion	1/6	2.2	2.2	9.27	BG2SS-02	Lognormal	517	70.4	510	20	N	28	0.041

1 EPA 1996b. Region III Risk Based Concentration Table, January - June 1996.
Concentrations of metals are mg/kg (ppm); concentrations of pesticides/PCBs and semivolatiles are ug/kg (ppb).
NA - not applicable due to low soil sample count (<4 samples).
N - non-carcinogenic
C - carcinogenic

TABLE B-2

BACKGROUND SUMMARY STATISTICS FOR SEDIMENT (RUN 1)
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Location of Maximum	Distribution	95% UCL	95% UTL	RBC Industrial	RBC Residential	Basis	Soil to Air	Soil to Ground-water
Metals													
Aluminum	3/3	497	3,350	2,070	BG1SD-01	Normal	4510	NA (1)	1,000,000	78,000	N	-	-
Arsenic	1/3	1.6	1.6	1.78	S4BG-1	Assume Lognormal	2.61	NA (1)	3.8	0.43	C	380	15
Barium	4/4	5	15.2	9.63	BG2SD-01	Lognormal	47.00	136	140,000	5,500	N	350,000	32
Cadmium	1/4	0.9	0.9	0.500	BG1SD-01	Lognormal	2,730	214	1,000	39	N	920	6
Calcium	3/3	223,000	393,000	327,000	BG3SD-01	Normal	481,000	NA (1)	-	-		-	-
Chromium (IV)	4/4	2.1	11.7	7.35	BG1SD-01	Normal	12.4	29.4	10,000	390	N	140 (VI)	19 (VI)
Cobalt	1/4	0.56	0.56	1.07	BG1SD-01	Lognormal	14,400	554	120,000	4,700	N	-	-
Copper	4/4	1.6	34.6	11.1	BG1SD-01	Lognormal	100,000	4,790	82,000	3,100	N	-	-
Iron	3/3	363	2,600	1,440	BG1SD-01	Normal	3,330	NA(1)	610,000	23,000	N	-	-
Lead	4/4	5.5	56.5	30.8	BG1SD-01	Normal	55.4	138	-	400 (OSWER)	-	-	-
Magnesium	3/3	4,680	20,000	10,200	BG2SD-01	Lognormal	3,170,000	NA (1)	-	-	-	-	-
Manganese	3/3	14.9	38.5	23.6	BG1SD-01	Lognormal	268	NA (1)	10,000	390	N	-	-
Nickel	3/4	0.7	5.5	2.91	BG1SD-01	Normal	5.27	13.2	41,000	1,600	N	6,900	21
Potassium	3/3	517	4,180	179	BG2SD-01	Lognormal	370,000,000	NA (1)	-	-	-	-	-
Sodium	3/3	9,650	86,900	36,550	BG2SD-01	Lognormal	21,900,000,000	NA (1)	-	-	-	-	-
Vanadium	4/4	2.8	8.9	5.13	BG1SD-01	Lognormal	22.40	65.80	14,000	550	N	-	-

TABLE B-2

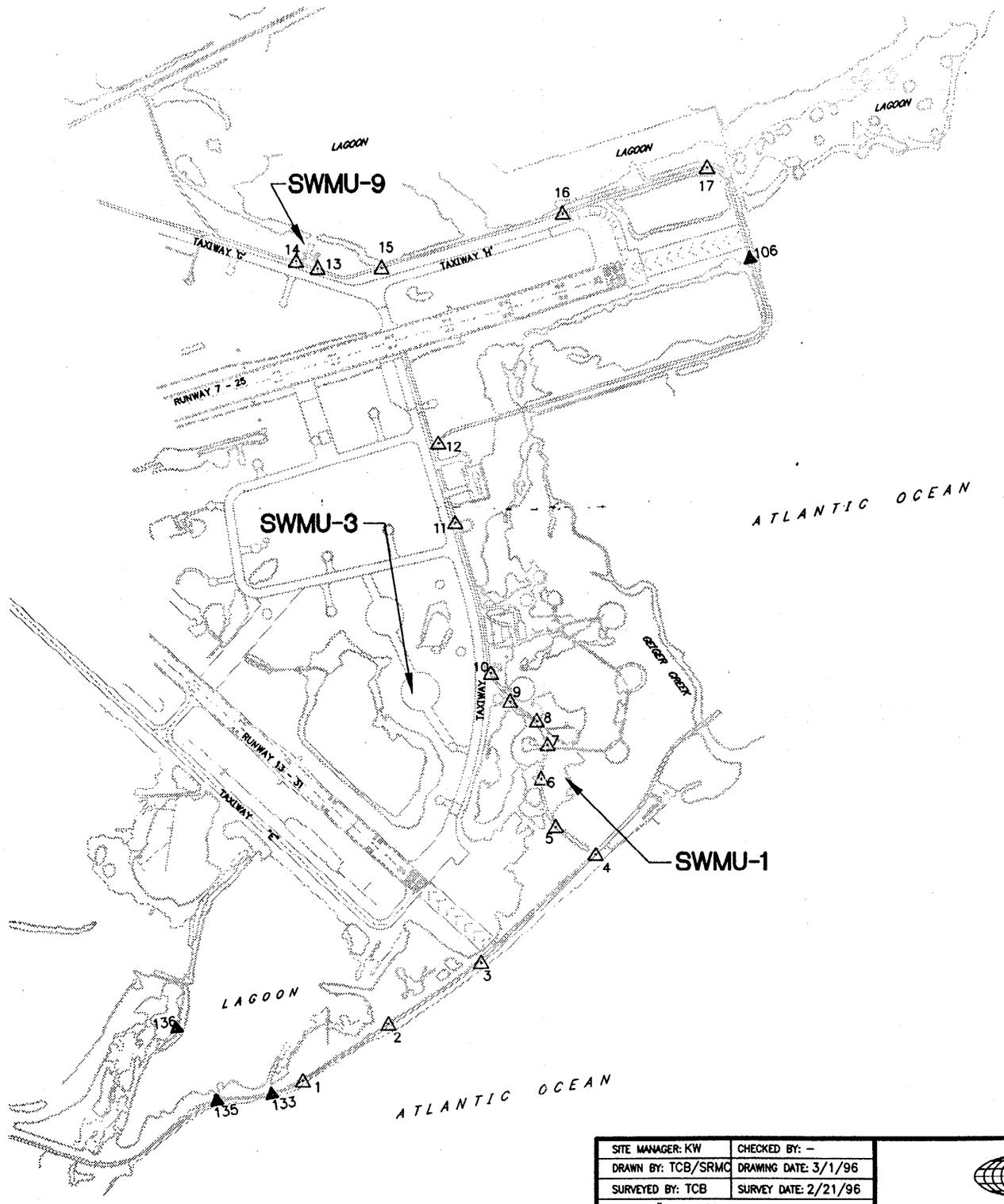
BACKGROUND SUMMARY STATISTICS FOR SEDIMENT (RUN 1)
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Frequency of Detection	Minimum	Maximum	Average of All Values	Location of Maximum	Distribution	95% UCL	95% UTL	RBC Industrial	RBC Residential	Basis	Soil to Air	Soil to Ground-water
Zinc	4/4	15.7	58.2	37.1	BG1SD-01	Lognormal	449	1,030	610,000	23,000	N	-	42,000
Miscellaneous													
Sulfide	1/1	340	340	340	S4BG-1	NA	NA	NA	-	-	-	-	-
Semivolatiles													
Bis(2-Ethylhexyl)-phthalate	1/4	4,500	4,500	276	S4BG-1	Lognormal	13,800	39,700	410	46	C	210	11
2-Butanone	1/4	4	4	9.13	S4BG-1	Lognormal	155	311	1,000,000	47,000	N	-	-
Acetone	3/4	4	120	41	S4BG-1	Lognormal	12,000,000,000	279,000	200,000	7,800	N	62,000	8
Methylene chloride	2/4	5	20	8.63	S4BG-1	Lognormal	1,110	846	760	85	C	7	0.01

1 EPA 1996b. Region III Risk Based Concentration Table, January - June 1996 (soil values assumed for sediment).
Concentrations of metals are mg/kg (ppm); concentrations of semivolatiles are ug/kg (ppb).
NA - not applicable due to low soil sample count (<4 samples).
N - non-carcinogenic
C - carcinogenic

APPENDIX K

FIELD DATA FORMS AND SURVEYING DATA



N

500 250 0 1000

Scale 1" = 1000'

LEGEND

133 ▲ AERIAL SURVEY CONTROL POINT

3 △ FIELD SURVEY TRAVERSE POINT

TRAVERSE DATA

POINT	NORTHING	EASTING
1	83635.3900	430374.5875
2	84108.5841	431100.0276
3	84609.3631	431881.0952
4	85503.0488	432846.2161
5	85734.5921	432513.0621
6	86137.5626	432388.5103
7	86418.9649	432444.5599
8	86620.9809	432351.0228
9	86781.6489	432125.1220
10	87017.7798	431964.6107
11	88273.3282	431668.4415
12	88937.1848	431527.5632
13*	90390.7232	430508.6954
14*	90448.4300	430325.3728
15	90398.8952	431046.5912
16	90857.3729	432575.0937
17	88739.7373	433773.4284
106*	90460.5230	434126.7280
133*	83523.55	430113.46
135*	83473.67	429655.07

*LOCATED BY GLOBAL POSITIONING SATELITE

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 3/1/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 1000'	
CAD DWG. NO.: HK7046-1	PROJ. NO.: HK7046

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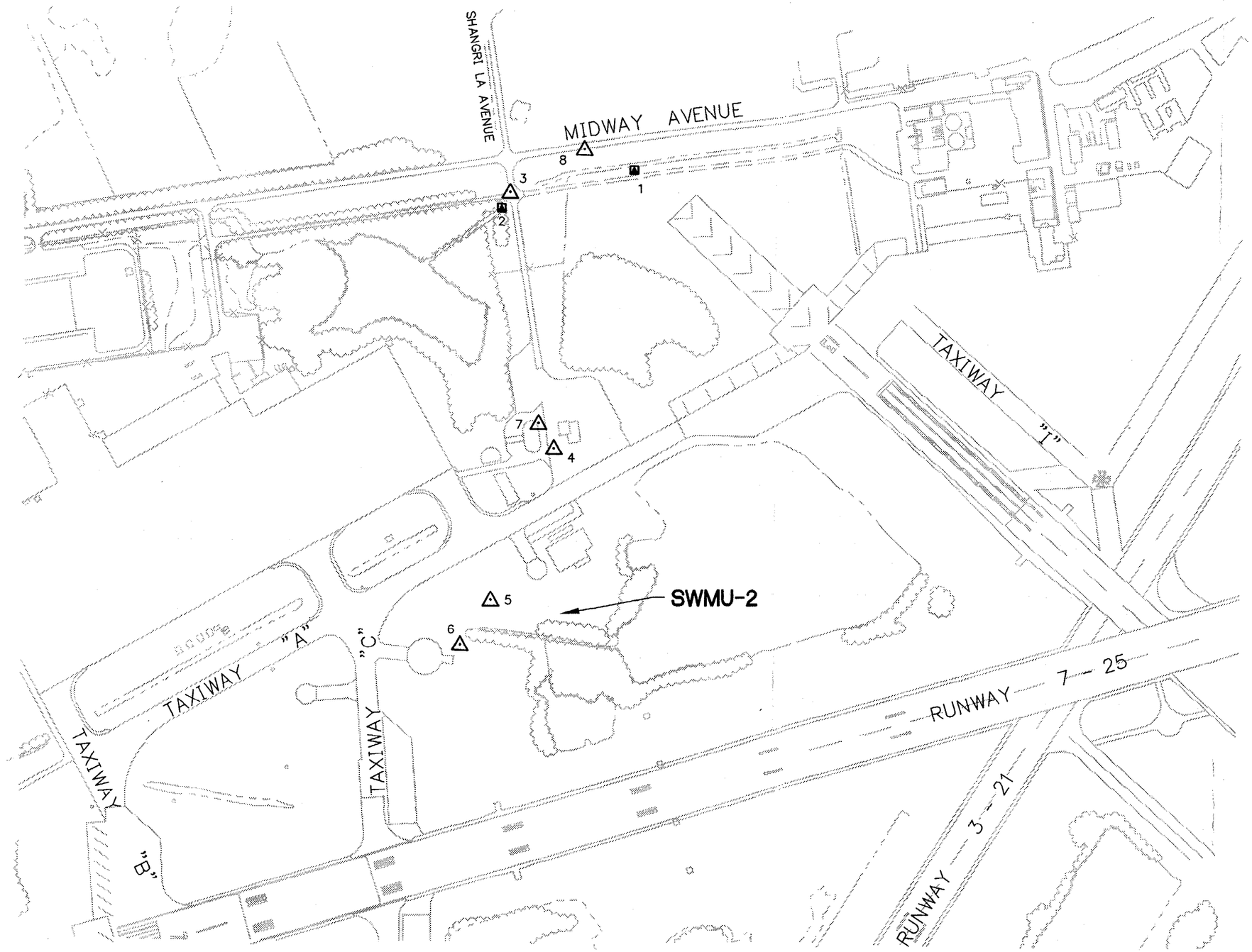
FIGURE 1

TRAVERSE CONTROL POINTS SWMU-1, SWMU-3 AND SWMU-9

NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



N

200 100 0 400

Scale 1" = 400'

TRAVERSE DATA

POINT	NORTHING	EASTING	DESCRIPTION
1*	90436.7829	425422.6212	P.S. DET 4 GSS
2*	90291.2507	424927.4871	USGS K271
3	90355.9625	424957.8176	TP
4	89401.7450	425132.7516	TP
5	88831.0797	424902.1674	TP
6	88663.3177	424789.7410	TP
7	89494.2782	425073.9784	TP
8	90516.7831	425234.1306	TP

* LOCATED BY GLOBAL POSITIONING SATELLITE

NOTE:	LATITUDE	LONGITUDE
1	24 34 50.24480 N	81 41 39.79768 W
2	24 34 47.67839 N	81 41 45.78307 W

LEGEND

△ 6 TRAVERSE POINT

■ FOUND MONUMENT

SITE MANAGER: KW	CHECKED BY: KW
DRAWN BY: TCB	DRAWING DATE: 2/29/96
SURVEYED BY: TCB	SURVEY DATE: 2/22/96
SCALE: 1" = 400'	
CAD DWG. NO.: HK7046-2	PROJ. NO.: HK7046

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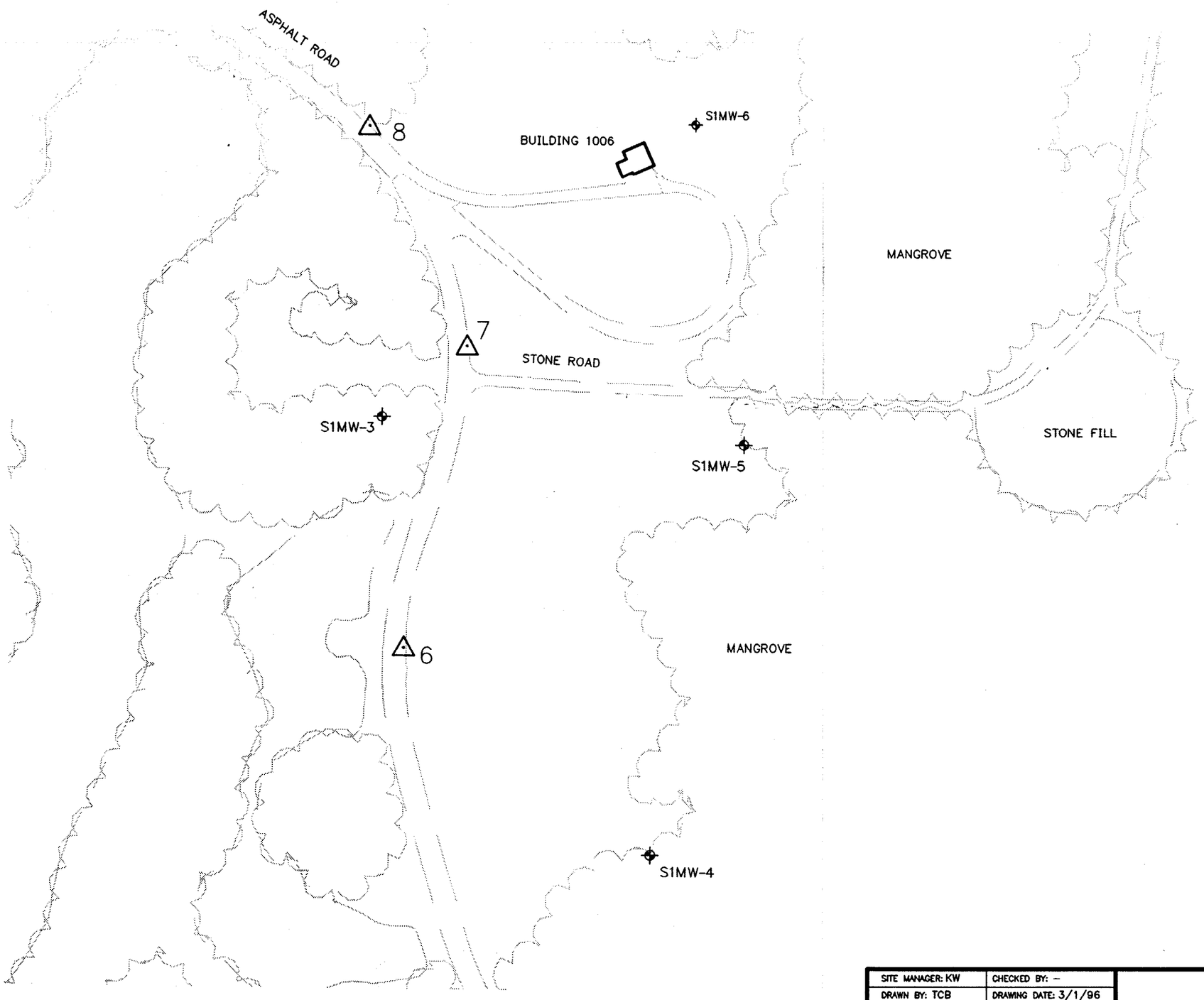
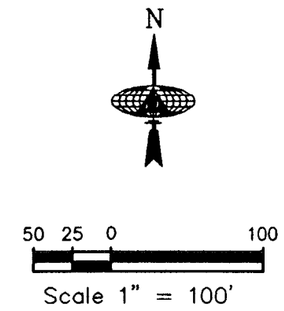
FIGURE 2

TRAVERSE CONTROL POINTS SWMU-2 (DDT MIXING AREA)

NAVAL AIR STATION
BOCA CHICA, FLORIDA





WELL DATA

WELL	NORTHING	EASTING	ELEVATIONS
S1MW-3	86352.7304	432365.7397	1.98 - GROUND 2.37 - CONC. PAD 4.82 - PVC
S1MW-4	85947.7413	432620.8652	1.99 - CONC. PAD 4.35 - PVC (GROUND BEING EXCAVATED)
S1MW-5	86329.0084	432704.7680	1.66 - GROUND 2.00 - CONC. PAD 4.44 - PVC
S1MW-6*	86624.7829	432656.1151	1.70 - GROUND 2.04 - CONC. PAD 4.82 - PVC
CONTROL 6	86137.5626	432388.5103	
CONTROL 7	86418.9649	432444.5599	
CONTROL 8	86620.9809	432351.0228	

* LOCATED BY GLOBAL POSITIONING SATELLITE

LEGEND

6 — FIELD SURVEY TRAVERSE POINT

S1MW-5 — MONITORING WELL

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB	DRAWING DATE: 3/1/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

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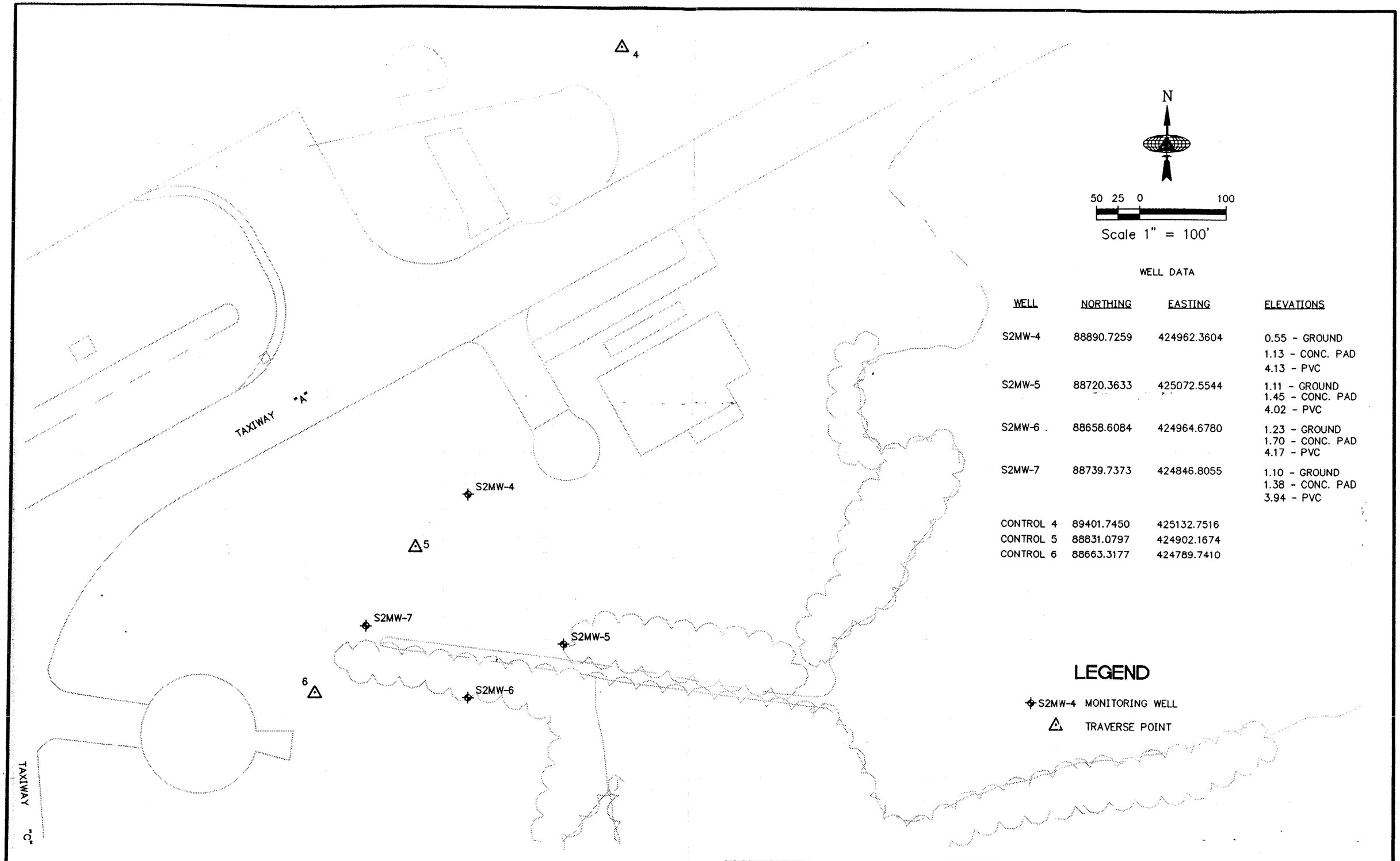
FIGURE 3

MONITORING WELL LOCATIONS
SWMU-1 (OPEN DISPOSAL AREA)

NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



WELL DATA

WELL	NORTHING	EASTING	ELEVATIONS
S2MW-4	88890.7259	424962.3604	0.55 - GROUND 1.13 - CONC. PAD 4.13 - PVC
S2MW-5	88720.3633	425072.5544	1.11 - GROUND 1.45 - CONC. PAD 4.02 - PVC
S2MW-6	88658.6084	424964.6780	1.23 - GROUND 1.70 - CONC. PAD 4.17 - PVC
S2MW-7	88739.7373	424846.8055	1.10 - GROUND 1.38 - CONC. PAD 3.94 - PVC
CONTROL 4	89401.7450	425132.7516	
CONTROL 5	88831.0797	424902.1674	
CONTROL 6	88663.3177	424789.7410	

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 3/15/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

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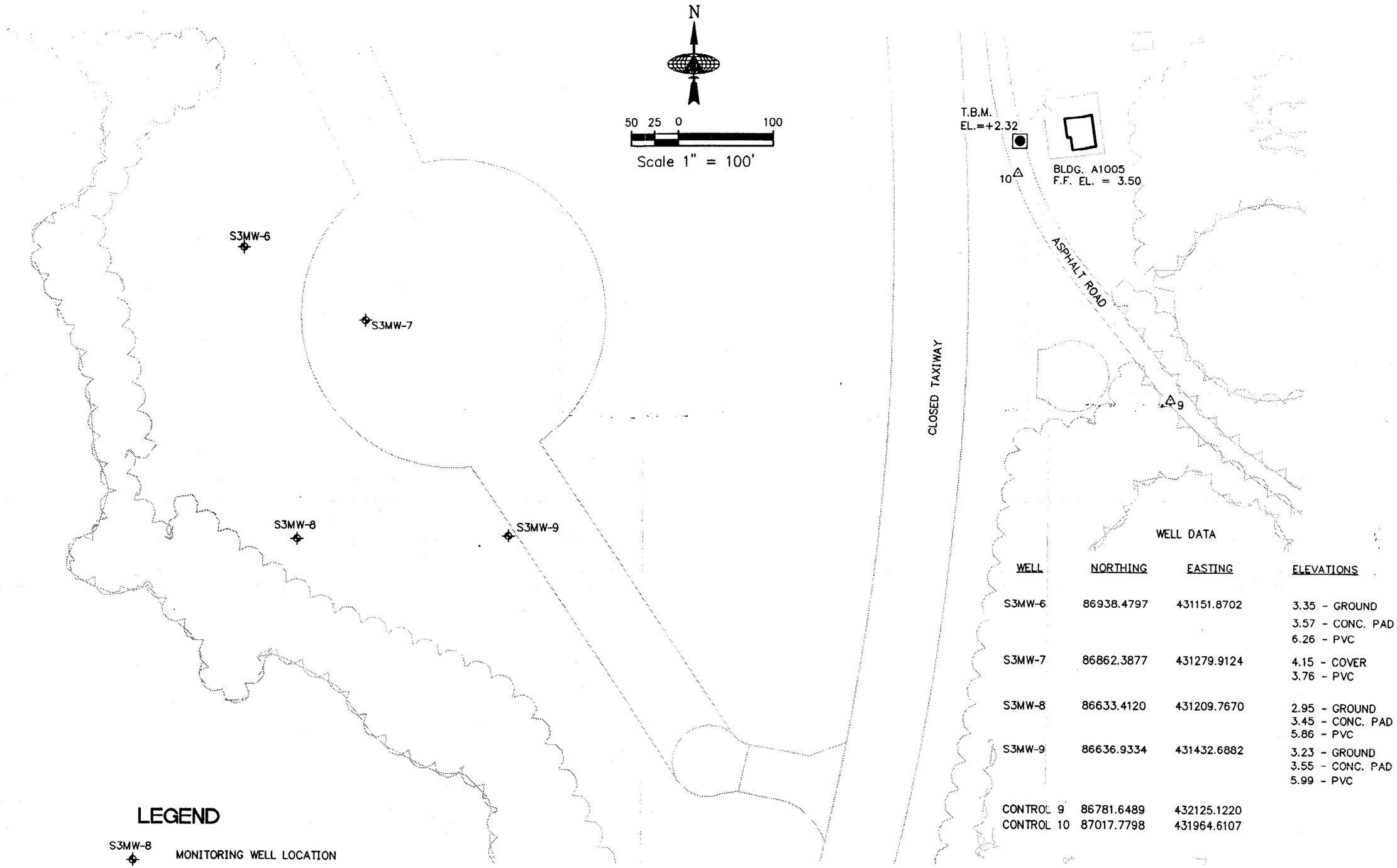
FIGURE 4

MONITORING WELL LOCATIONS SWMU-2 (DDT MIXING AREA)

NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



WELL DATA

WELL	NORTHING	EASTING	ELEVATIONS
S3MW-6	86938.4797	431151.8702	3.35 - GROUND 3.57 - CONC. PAD 6.26 - PVC
S3MW-7	86862.3877	431279.9124	4.15 - COVER 3.76 - PVC
S3MW-8	86633.4120	431209.7670	2.95 - GROUND 3.45 - CONC. PAD 5.86 - PVC
S3MW-9	86636.9334	431432.6882	3.23 - GROUND 3.55 - CONC. PAD 5.99 - PVC
CONTROL 9	86781.6489	432125.1220	
CONTROL 10	87017.7798	431964.6107	

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 3/1/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

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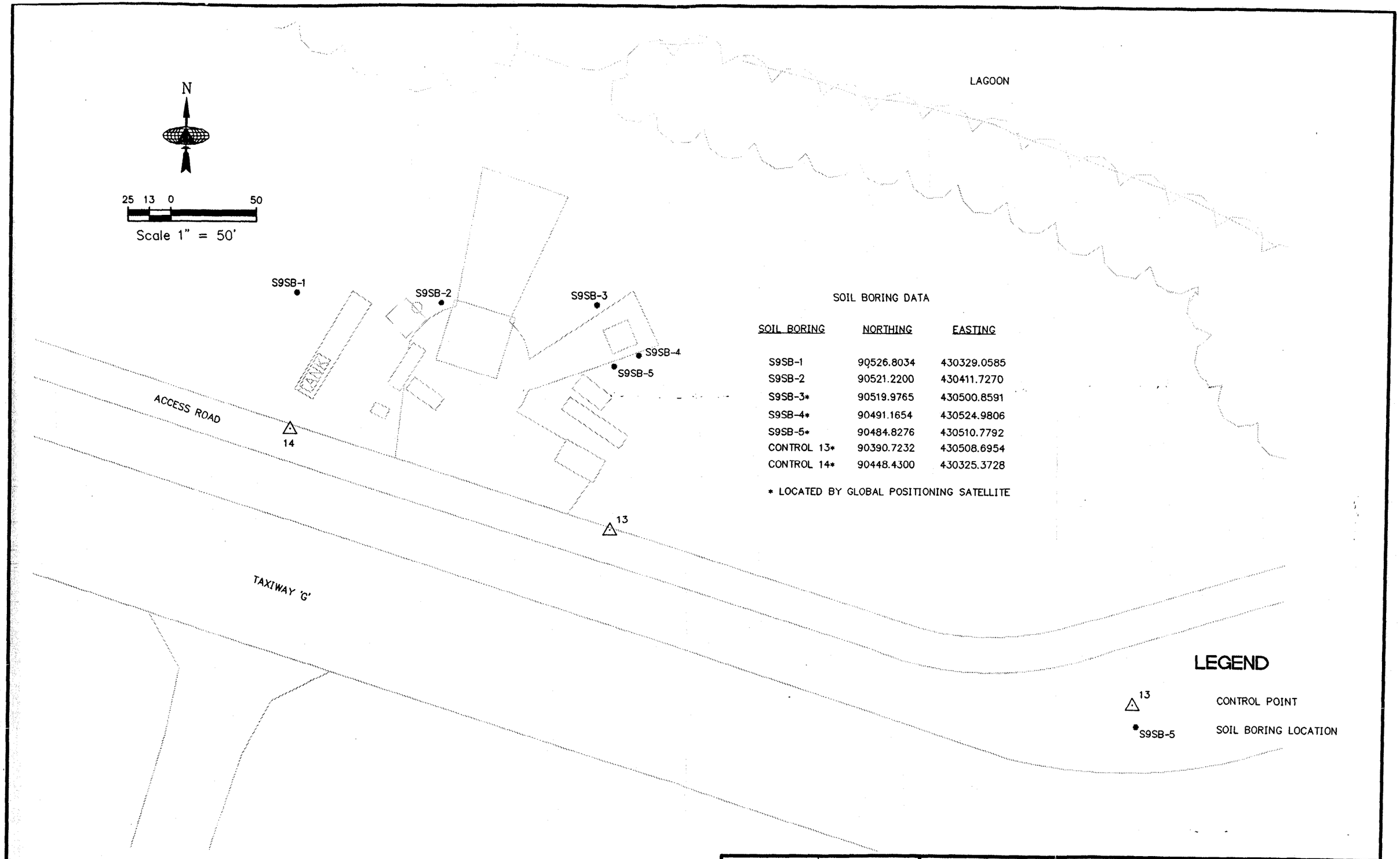
FIGURE 5

MONITORING WELL LOCATIONS SWMU-3 (FIRE FIGHTING TRAINING CENTER)

NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



SOIL BORING DATA

SOIL BORING	NORTHING	EASTING
S9SB-1	90526.8034	430329.0585
S9SB-2	90521.2200	430411.7270
S9SB-3*	90519.9765	430500.8591
S9SB-4*	90491.1654	430524.9806
S9SB-5*	90484.8276	430510.7792
CONTROL 13*	90390.7232	430508.6954
CONTROL 14*	90448.4300	430325.3728

* LOCATED BY GLOBAL POSITIONING SATELLITE

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 3/11/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

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FIGURE 6
SOIL BORING LOCATIONS SWMU-9 (JET ENGINE TEST CELL)
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

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SAMPLE LOG SHEET

Page 1 of 1

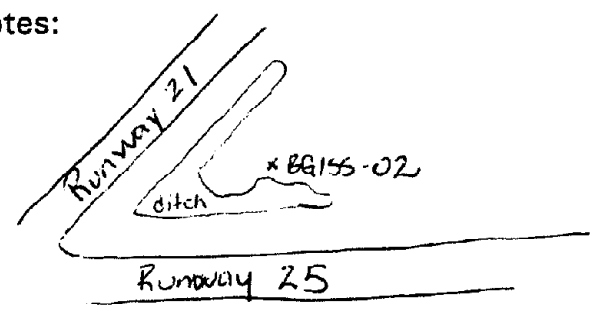
- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name NAS Key West Project Site Number 70416

HNUS Sample Name BG15S-02 Sample Source or Location Background 1 (between runways 21 and 25)

Sample Method: stainless steel trowel	Sample Date and Time: 2/2/96 0740
Sample Depth: 0-3"	Color: brownish grey / grey
Sampled By (Print): Rachel Layman	Sample Description: Fine to medium grey sand; trace silt (organics)
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



N

Rockland w/no to little grass cover

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide / PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	~~1/24/96 1730~~	~~92~~
	2/2/96 1200	9230386561

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SAMPLE LOG SHEET

Page 1

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

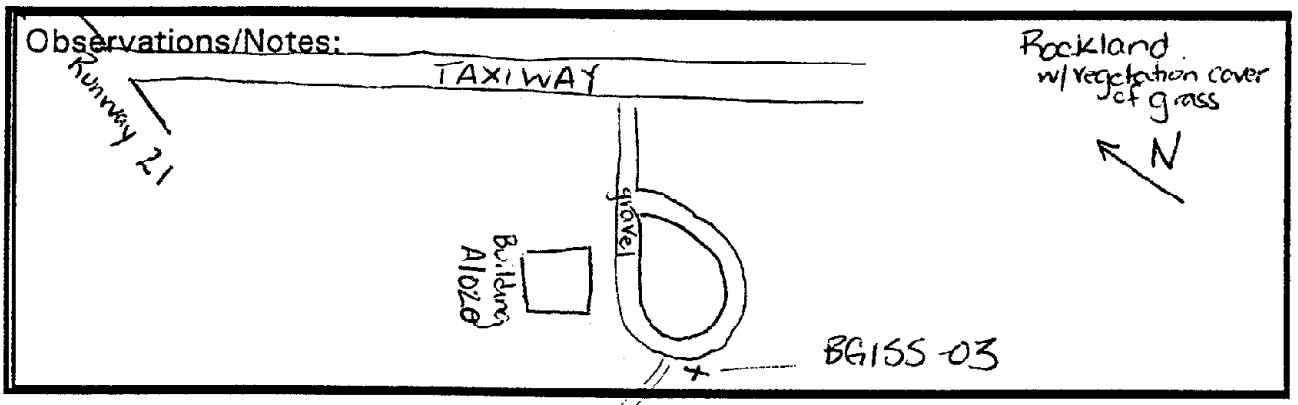
Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name BG1SS-03 Sample Source or Location

~~Background 3 (sub pit area)~~ RL 2/2/96
Background 1 (between runways 21 and 23)

Sample Method: stainless steel trowel	Sample Date and Time: 2/2/96 0800
Sample Depth: 0-4"	Color: brown
Sampled By (Print): Rachel M. Layman	Sample Description: Fine to medium sand and silt; some drk greyish brown clay.
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
Pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	2/2/96 1200	9230386561

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SAMPLE LOG SHEET

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name: NAS Key West

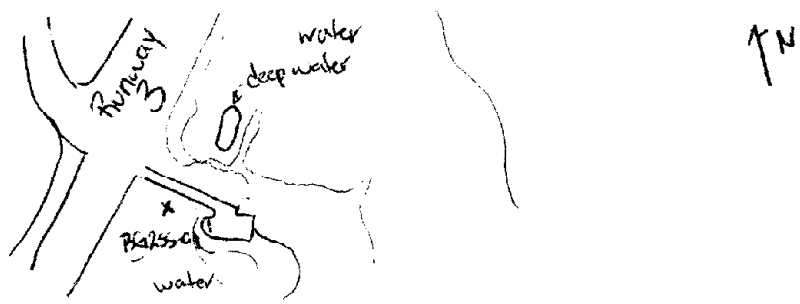
Project Site Number: 7046

HNUS Sample Name: BG2SS-01

Sample Source or Location: Background 2

Sample Method: stainless steel ~~1/26/96~~ trowel	Sample Date and Time: 1/26/96 1340
Sample Depth: 0-5"	Color: lt brown
Sampled By (Print): Phil Moore	Sample Description: fine to med sand ; some crushed shell
Sampled By (Signatures): Philip N Moore	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



Manmade compacted (near road + runway) 150 yards from NW of blast deflector

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide /PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Earthworm toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/26/96 1730	9230388516 1
ESI	1/26/96 1730	9230385172

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SAMPLE LOG SHEET

Page 1 of

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name NAS Key West

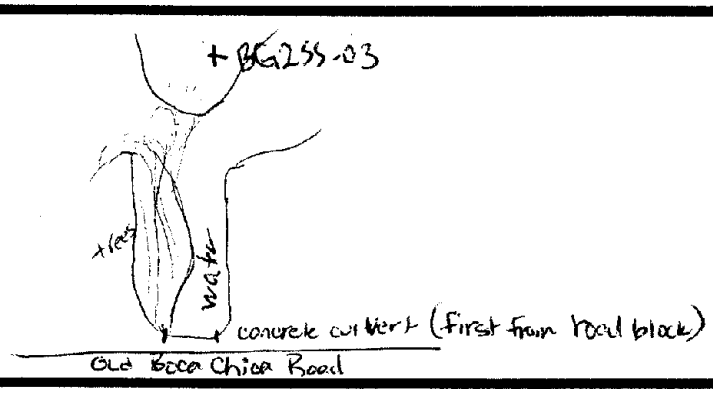
Project Site Number 7046

HNUS Sample Name BG25S-03

Sample Source or Location Background 2

Sample Method: stainless steel trowel	Sample Date and Time: 1/31/96 1031
Sample Depth: 0-3"	Color: lt grey
Sampled By (Print): Rachel Layman	Sample Description: moist fine to med sand
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	~~2/2/96 1200~~	~~9230386561~~
	1/31/96 1230	9230385076

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SAMPLE LOG SHEET

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name: NAS Key West

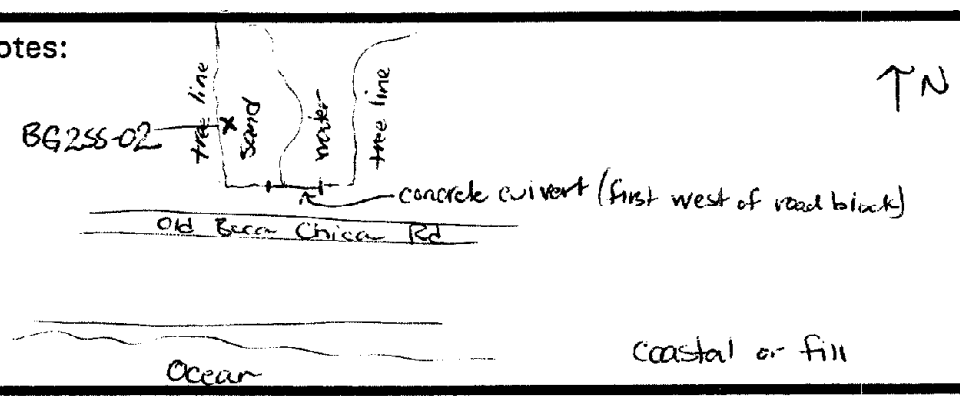
Project Site Number: 7046

HNUS Sample Name: BG255-02

Sample Source or Location: Background 2

Sample Method: Stainless steel trowel	Sample Date and Time: 1/31/96 1030
Sample Depth: 2-6"	Color: lt brown
Sampled By (Print): Rachel Layman	Sample Description: Med sand
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/herbicides	✓
PCBs	✓
TAL metals	✓
cyanide	✓

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/31/96 1230	9230385076

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SAMPLE LOG SHEET

Page 1 o.

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West

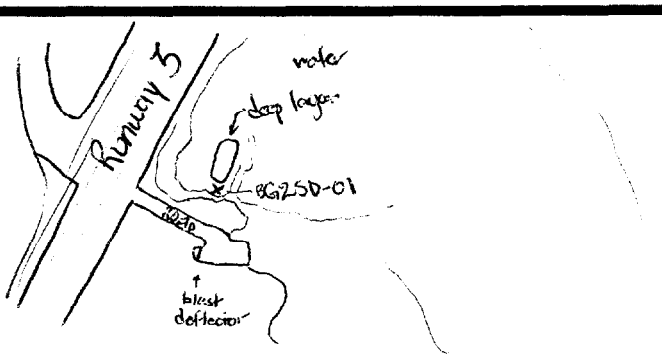
Project Site Number 7046

HNUS Sample Name BG25D-01

Sample Source or Location Background 2

Sample Method: stainless steel trowel/bowl	Sample Date and Time: 1/26/96 1340
Sample Depth: 1'	Color: dark grey
Sampled By (Print): Rachel Layman	Sample Description: silt (organics), some fine sand
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Mysid shrimp toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/26/96 1730	9230388516 1
ESI	1/26/96 1730	9230385172

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SAMPLE LOG SHEET

☒ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name: NAS Key West
Project Site Number: 70416
HNUS Sample Name: BG25W-01
Sample Source or Location: Background 2

Surface Water Data

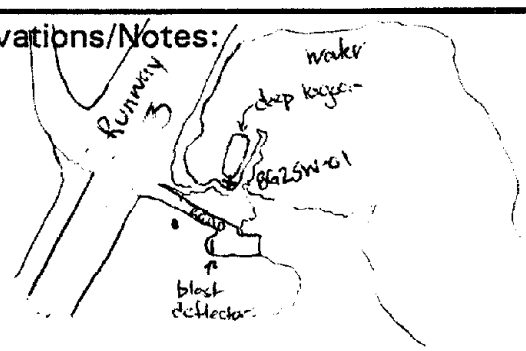
pH	Temp. (°C)	Dissolv. O_2	Color Turb	Elect. Conduct.(mS/cm)	Salinity
7.63	25.6	6.32 mg/l	clear NOT RECORDED	47.2	3.12%

Sample Date and Time: 1/26/96 1340

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel M Layman, Julea J Bradley

Observations/Notes:



3' deep in water body
1' at sample location
↑N

MS/MSD

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOCs	HCl	✓	GEL	1/26/96 1730	9230385161
App IX SVOCs	—	✓	ESI	1/26/96 1730	9230385172
pesticide/PCBs	—	✓			
herbicides	—	✓			
TAL metals	HNO_3	✓			
cyanide	NaOH	✓			
Silverside toxicity					
oyster toxicity					
sea urchin toxicity					

COC # 12;6

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SAMPLE LOG SHEET

Page 1 of

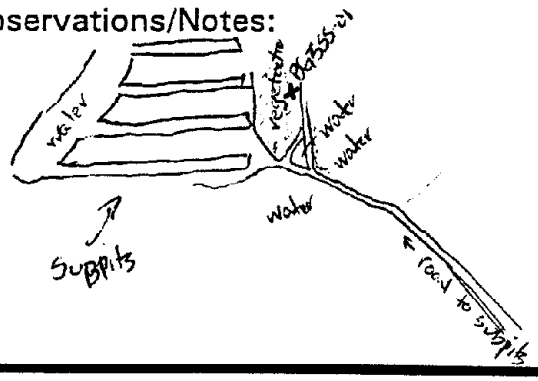
- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name BG355-01 Sample Source or Location Background 3 (subpit area)

Sample Method: stainless steel trowel	Sample Date and Time: 1/26/96 1340
Sample Depth: 0-4" 1/26/95	Color: brown
Sampled By (Print): Phil Moore	Sample Description: Organics (silt), some fine sand
Sampled By (Signatures): Phil Moore	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



↑N

Rock under 4" soil
BG355-01 collected from ~ 125 yrds from intersection of road to subpits.
Pine tree cover; pineneedle layer.

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide / PCBs	✓
herbicides	✓
TAL metals	✓
Cyanide	✓
Earthworm toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEI	1/26/96 1730	9230385161
ESI	1/26/96 1730	9230385172

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SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name NAS Key West

Project Site Number 7046

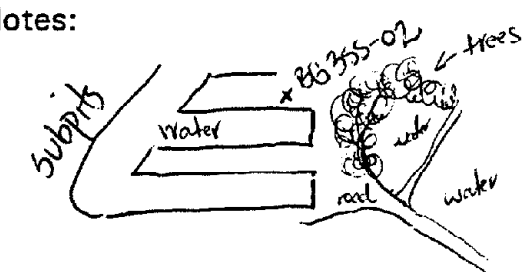
HNUS Sample Name BG355-02

Sample Source or Location Background 3 (subpit area)

Sample Method: stainless steel trowel	Sample Date and Time: 2/2/96 0900
Sample Depth: 0-4"	Color: H tan to white
Sampled By (Print): Rachel Layman	Sample Description: Med sand/crushed subpit excavation
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:

MS/MSD



↑N

MS/MSD

Compacted manmade

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	2/2/96 1200	9230386561

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name: NAS Key West

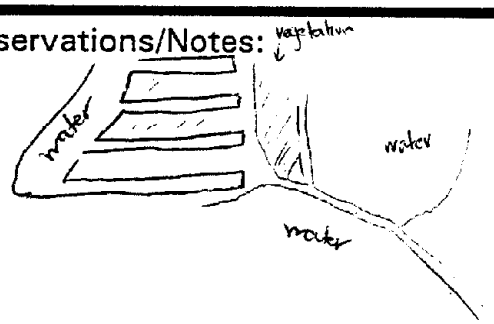
Project Site Number: 7041b

HNUS Sample Name: BG35S-03

Sample Source or Location: Background 3 (Subpit area)

Sample Method: stainless steel trowel	Sample Date and Time: 2/2/96 0930
Sample Depth: 0-2"	Color: Grey; orange brown
Sampled By (Print): Rachel Layman	Sample Description: fine to med sand; some clay
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



2" soil
Rockland

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
Pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	2/2/96 1200	9230386561

Brown & Root Environmental

SAMPLE LOG SHEET

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name: NAS Key West

Project Site Number: 70416

HNUS Sample Name: BG3SW-01

Sample Source or Location: Background 3 (Suppit area)

Surface Water Data

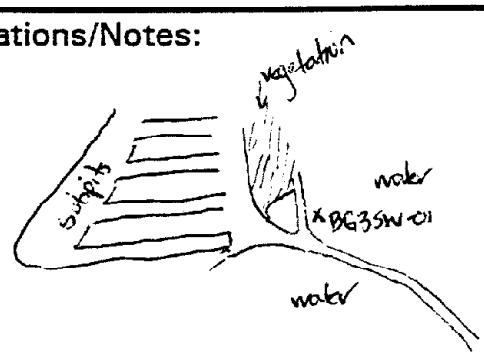
pH	Temp. (°C)	Dissolv. O_2	Color Turb	Elect. Conduct.(mS/cm)	Salinity
7.47	22.4°C	6.23 mg/l	102	44.5	2.92%

Sample Date and Time: 1/26/95 1145

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel Layman, Julea Bradley

Observations/Notes:



↑N

1' sample depth off shore

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOCs	HCl	✓	GEL	1/26/96 1730	9230388516 1
App IX SVOCs	—	✓	ESI	1/26/96 1730	9230385172
Pesticide/PCBs	—	✓			
herbicides	—	✓			
TAL metals	HNO_3	✓			
cyanide	NaOH	✓			
Silverside toxicity					
Oyster toxicity					
sea urchin toxicity					

COC # 12; 6

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS KeyWest

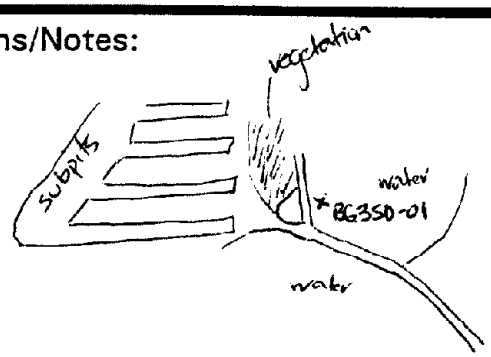
Project Site Number 7046

HNUS Sample Name BG35D-01

Sample Source or Location Background 3 (Suppits)

Sample Method: petite ponar	Sample Date and Time: 1/26/96 1145
Sample Depth: 1.5'	Color: Grey
Sampled By (Print): Rachel Layman, Julia Bradley	Sample Description: Silt, some shell and crushed shell
Sampled By (Signatures): Rachel M Layman, Julia Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



↑N

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Mysid shrimp toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/26/96 1730	9230388 5161
ESI	1/26/96 1730	9230385172

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number SIMW-3

Site Name SWMU-1 NAS Key West

Date and Time Well Installed 1/13/96 10:35

Well Stickup 3 ft above/below grade

Total Depth Of Well 14.75 ft below top of casing

Static Level Before Purging 4.09 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.7 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 1:15

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	24.8	7.64	16.2	white/light brown	999	0
5	24.3	7.47	16.3	gl white	999	20
15	24.5	7.48	17.7	opaque/white	999	50
20	24.7	7.53	15.8	translucent	880	70
30	24.8	7.46	18.4	"	800	90.
40	25.2	7.41	17.4	"	810	110

Casing Volumes Removed ≈64

Time Completed 1:55

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number: SIMW-4

Site Name: SWMU-1 NAS Key West

Date and Time Well Installed: 1/17/96 9:30

Well Stickup: 3 ft above/below grade

Total Depth Of Well: 14.30 ft below top of casing

Static Level Before Purging: 3.83 ft below top of casing

Inside Diameter of Well: 2 inches

One Casing Volume: 1.7 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 12:00

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	24.3	6.95	62.4	Slite	999	0
10	26.7	6.84	46.4	Sl-Slite	999	55
15	26.3	6.78	46.1	translucent	999	75
20	26.4	6.77	47.4	"	999	110

Casing Volumes Removed ≈64

Time Completed 12:20

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number SIMW-5

Site Name SWMU-1 NAS Key West

Date and Time Well Installed 1/13/96 11:50

Well Stickup 3 ft above/below grade

Total Depth Of Well 14.90 ft below top of casing

Static Level Before Purging 3.76 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.81 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 2:10

Developed By GWP

Method(s) Used Centrifugal pump

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	25.2	6.80	32.3	white	999	0
10	26.2	6.88	34.6	white	999	35
15	26.0	6.91	34.6	clear	65	68
20	26.0	6.91	34.6	clear	42	90

Casing Volumes Removed ≈ 49

Time Completed 2:30

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number SIMW-6

Site Name SWMU-1 NAS Key West

Date and Time Well Installed

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.25 ft below top of casing

Static Level Before Purging 5.37 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.7 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 11:10

Developed By GWP

Method(s) Used Centrifugal pump

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	24.3	7.28	17.4	light brown	999	
10	25.6	7.29	22.6	light brown	999	
20	25.4	7.15	23.7	translucent	999	
30	26.1	7.11	25.6	"	600	
40	26.5	7.15	22.2	"	550	110

Casing Volumes Removed ≈64

Time Completed 11:50

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S2MW-4

Site Name SWMU-2 NAS Key West.

Date and Time Well Installed 1/11/96 12:30 p.m.

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.26 ft below top of casing

Static Level Before Purging 4.69 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.88 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 7:10

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	25.5	7.35	15.7	opaque/white	999	0
5	25.6	7.17	19.8	white	999	12
15	24.5	7.32	16.7	white	999	26
30	24.1	7.24	10.3	translucent	999	48
40	25.2	7.17	14.4	translucent	999	72
50	25.7	7.16	17.4	translucent	999	110

Casing Volumes Removed ≈58

Time Completed 8:00

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S2MW-5

Site Name SWMU-2 NAS Key West

Date and Time Well Installed 1/11/96 2:30

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.15 ft below top of casing

Static Level Before Purging 4.12 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.96 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 9:00

Developed By GWP

Method(s) Used Centrifugal pump

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	24.6	7.40	19.7	white	999	0
5	24.8	7.38	24.0	white	999	25
10	24.9	7.34	22.4	white	999	55
20	23.7	7.46	23.9	translucent	999	68
30	25.2	7.45	22.2	translucent	999	75
50	25.5	7.45	24.0	"	999	100

Casing Volumes Removed 51

Time Completed 9:50

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S2MW-6

Site Name SWMU-2 NAS

Date and Time Well Installed 1/11/96 8:15

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.35 ft below top of casing

Static Level Before Purging 5.01 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.8 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 10:00

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	25.7	7.36	19.2	white/red	999	0
10	26.8	7.38	21.5	white red	999	10
20	27.1	7.34	22.7	translucent	999	25
30	26.6	7.30	23.1	translucent	999	37
35	27.5	7.28	23.5	"	999	43
40	27.1	7.28	23.8	"	999	55 gal.

Casing Volumes Removed 30.5

Time Completed 10:40.

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S2MW-7

Site Name SWMU-2 NAS Key West

Date and Time Well Installed 1/11/96 3:33 p.m.

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.30 ft below top of casing

Static Level Before Purging 4.50 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.92 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 8:15

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
0	25.0	7.53	24.8	Clear	620	0
10	25.6	7.46	34.3	"	550	15
20	26.2	7.52	24.6	"	600	26
30	26.1	7.53	24.4	Translucent	610	35
40	25.9	7.55	24.2	"	620	55

Casing Volumes Removed ≈28

Time Completed 8.50

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S3MW-6

Site Name SWMU-3 NAS Key West

Date and Time Well Installed 1/12/96 1:40.

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.30 ft below top of casing

Static Level Before Purging 5.70 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.7 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 4.50

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
5	25.1	7.53	40.3	white	999	17
15	24.3	7.54	40.5	white	999	30
25	24.8	7.53	41.0	translucent	680	40
35	25.1	7.50	44.3	translucent	648	55

Casing Volumes Removed ≈31

Time Completed 5:25

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S3MW-7

Site Name SWMU-3 NAS Key West

Date and Time Well Installed _____

Well Stickup 3 ft above/below grade

Total Depth Of Well 13 ft below top of casing

Static Level Before Purging 3.43 ft below top of casing

Inside Diameter of Well 3 inches

One Casing Volume 1.5 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 4:10

Developed By GWP

Method(s) Used Centrifugal pump

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
5	24.6	7.50	39.1	white	999	12
15	26.6	7.51	40.8	translucent	999	28
25	27.8	7.54	41.0	translucent	480	40
35	28.0	7.54	40.9	grey/translucent	480	55

Casing Volumes Removed ~36

Time Completed 4:45

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S3MW-8

Site Name SWMU-3 NAS Key West

Date and Time Well Installed 1/12/96 3:30

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.10 ft below top of casing

Static Level Before Purging 5.20 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.7 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20/96 Time Begun 5:40

Developed By EWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
5	25.9	7.02	21.0	white	999	20
15	25.7	6.93	22.4	white	999	45
25	26.8	6.84	30.2	white	999	68
35	26.0	6.84	31.9	translucent	999	85
40	25.8	6.83	30.9	clear	550	110

Casing Volumes Removed ≈64

Time Completed 6:20

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number S3MW-9

Site Name SWMU-3 NAS Key West

Date and Time Well Installed 1/12/96 11:30

Well Stickup 3 ft above/below grade

Total Depth Of Well 16.10 ft below top of casing

Static Level Before Purging 5.58 ft below top of casing

Inside Diameter of Well 2 inches

One Casing Volume 1.7 gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date 1/20 Time Begun 3:10

Developed By GWP

Method(s) Used Centrifugal pump.

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)
5	25.2	7.38	23.8	white	999	20
15	25.1	7.46	27.0	white	999	35
25	25.3	7.23	27.8	translucent	999	50
35	25.8	7.24	28.1	translucent	420	72
45	26.0	7.20	28.5	translucent	259	90

Casing Volumes Removed ≈ 52

Time Completed 3:55

BROWN and ROOT ENVIRONMENTAL

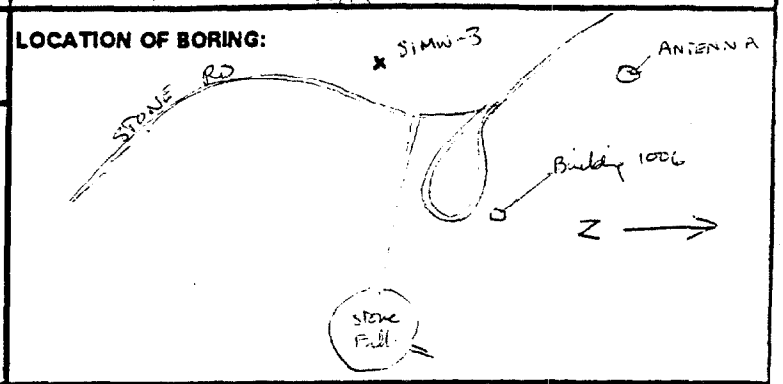
FIELD LOG OF BORING

WELL NO. SIMW-3

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: SIMW-3	
	LOGGED BY: GB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.: N/A	DATUM: N/A
DRILLER'S NAME: Robert Miller		START, TIME: 9:30	DATE: 1/13/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 10:25	DATE: 1/13/96
BORING METHOD: HSA		WATER DEPTH: ≈2.5 ft	
HOLE DIAMETER: 8.25		DATE: 1/13/96	
SAMPLING METHOD: Split spoon		TIME:	
HAMMER WGT.: 140	DROP HGT: 30"	BACKFILLED, TIME: N/A	DATE:
CONDITIONS: Sunny, 56°			

LOCATION OF BORING:



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
										0	limestone boulders and cobbles unable to split spoon and get hole dugout
										1.5	clayey limestone, brown to dark brown
2								2		2.0	minor sand coarse grained consolidated
2-4		17 15 11 13									limestone, oolitic, beige to white microcrystalline well consolidated
5								2			
4-6		7 8 20 22									
6-8		35 33 24 23									
10								ND			
10-12		8 33 30 31								13 ft	

NOTES: _____ EDITED BY/DATE: _____

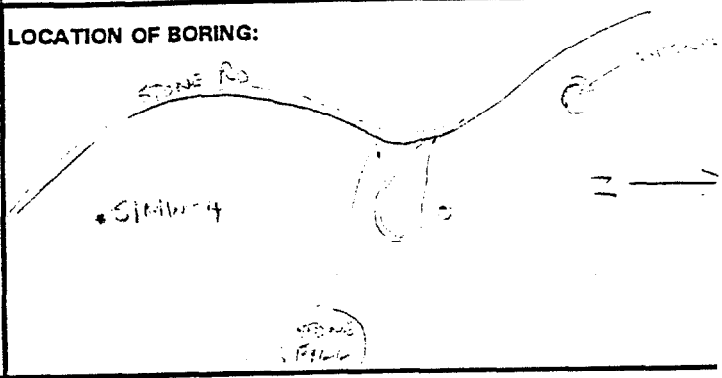
BROWN and ROOT ENVIRONMENTAL

FIELD LOG OF BORING

WELL NO. SIMW-4

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: SIMW-4	
	LOGGED BY: GB	TOTAL DEPTH: 12 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 8:15	DATE: 1/17/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 9:30	DATE:
BORING METHOD: Hollow Stem Auger		WATER DEPTH: surface	
HOLE DIAMETER: 8 1/4		DATE: 1/17/96	
SAMPLING METHOD: split spoon		TIME: 8:00	
HAMMER WGT.: 140	DROP HGT: 30"	BACKFILLED, TIME:	DATE:
CONDITIONS: partly cloudy 65-70°		LOCATION OF BORING:	



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
1	GH							70		0	
										1	
2-4	SS	[illegible]									
4	SS							ND			
4-6	SS	[illegible]									
6-8	SS	[illegible]									
8-10	SS	[illegible]									
10	SS							ND			
10-12	SS	[illegible]									
										12	

Dark brown top soil mixed with very moist limestone cobbles and boulders in sand poorly sorted - debris - metal glass (oily sheen & petroleum product) limestone, biogen to off white color well consolidated, porous, micritic few shell fragments.

NOTES: [illegible] split spoon GH - not hole

EDITED BY/DATE:

BROWN and ROOT ENVIRONMENTAL

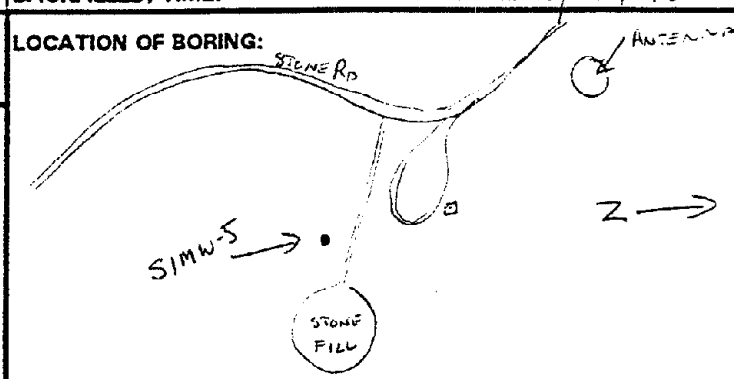
FIELD LOG OF BORING

WELL NO. SIMW-5

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: SIMW-5	
	LOGGED BY: GB	TOTAL DEPTH: 12 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 8:10	DATE: 1/13/96
DRILL RIG TYPE: Quadrich D 120		FINISH, TIME: 9:05	DATE: 1/13/96
BORING METHOD: Hollow Stem Auger		WATER DEPTH: ≈ 2 ft	
HOLE DIAMETER: 8 1/4 inches		DATE: 1/13/96	
SAMPLING METHOD: split spoon		TIME:	
HAMMER WGT.: 140	DROP HGT: 30 inches	BACKFILLED, TIME:	DATE: 1/13/96
CONDITIONS: Sunny, 51°			

LOCATION OF BORING:



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
*										0	limestone cobbles and boulders (unable to split spoon)
2	SS	22 22 25 24						80		2	limestone, oolitic, light to light brown, microfossil, small shell fragments, porous, well consolidated
2-4	SS	22 26 28 30									
5	SS							70			
4-6	SS	30 36 17 26									
6-8	SS	13 15 14 12									
8 - 10	SS	16 12 10 10						100			
10 - 12	SS	13 10 13 15									
										12 ft	

NOTES: _____ EDITED BY/DATE: _____

BROWN and ROOT ENVIRONMENTAL

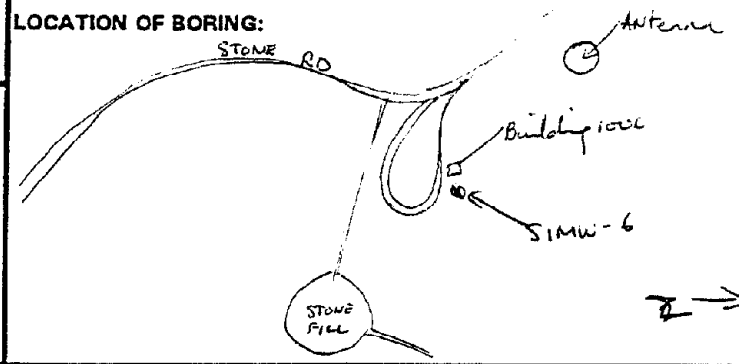
FIELD LOG OF BORING

WELL NO. SIMW-6

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: SIMW-6	
	LOGGED BY: GB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.: N/A	DATUM: N/A
DRILLER'S NAME: Robert Miller		START, TIME: 10:55	DATE: 1/13/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 11:50	DATE: 1/13/96
BORING METHOD: HSA		WATER DEPTH: ≈2.5 ft	
HOLE DIAMETER: 8.25		DATE: 1/13/96	
SAMPLING METHOD: Split spoon		TIME:	
HAMMER WGT.: 140	DROP HGT: 30 inches	BACKFILLED, TIME: N/A	DATE:
CONDITIONS: Sunny 56°			

LOCATION OF BORING:



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
										0	
2	SS.							ND		2	
2-4	SS	32 26 40 42									
4-6	SS	13 15 16 13									
5	SS							ND			
6-8	SS	15 12 14 16									
10	SS							ND			
8-10	SS	9 11 12 10									
10-12	SS	7 9 11 10								13	

Limestone boulders - Hummocky topo
loamy soil - post holed, trouble
metal board at
limestone, cuttings brown to gray
white, not well consolidated
few shell fragments

NOTES: SS = split spoon

EDITED BY/DATE:

BROWN and ROOT ENVIRONMENTAL

FIELD LOG OF BORING

WELL NO. S2 MW-4

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7016	BORING NO.: S2 MW-4	
	LOGGED BY: KB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: FWP		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 11:35	DATE: 1/11/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 12:30	DATE: 1/11/96
BORING METHOD: HSA		WATER DEPTH: [illegible] ft	
HOLE DIAMETER: 8 25		DATE:	
SAMPLING METHOD: 3 ft split spoon		TIME:	
HAMMER WGT.: 140#	DROP HGT: 30"	BACKFILLED, TIME:	DATE:
CONDITIONS: Sunny, 60°		LOCATION OF BORING: S2 MW-4	

SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
1	SS							3 ppm		1	
5								2 ppm			
								ND			
										13	

Sand, [illegible] fine to [illegible] sand to [illegible] [illegible]

NOTES: [illegible]

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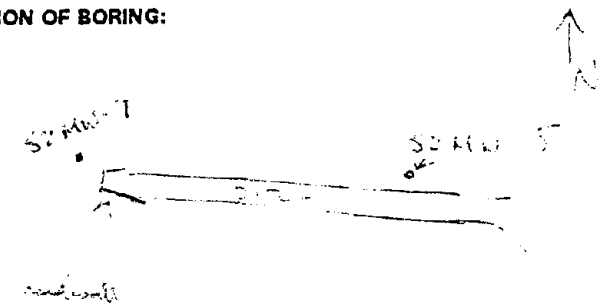
BROWN and ROOT ENVIRONMENTAL

FIELD LOG OF BORING

WELL NO. [illegible]

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: [illegible]	
	LOGGED BY: [illegible]	TOTAL DEPTH: 13'	
DRILLING CONTRACTOR: [illegible]		SURFACE ELEV.: N/A	DATUM: N/A
DRILLER'S NAME: [illegible]		START, TIME: 1:45	DATE: [illegible]
DRILL RIG TYPE: [illegible] D-120		FINISH, TIME: 2:30	DATE: [illegible]
BORING METHOD: HSA		WATER DEPTH: ≈2.5'	
HOLE DIAMETER: 8.25"		DATE:	
SAMPLING METHOD: split spoon		TIME:	
HAMMER WGT.: 140#	DROP HGT: 30"	BACKFILLED, TIME:	DATE:
CONDITIONS: Sunny, 62°		LOCATION OF BORING:	



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
1	SS							1ppm			
2-2	SS	19 [illegible]								4	
2-4	SS	[illegible]								4	
5	SS							ND			
6-8	SS	[illegible]									
8-8	SS	[illegible]									
10	SS							ND			
12-12	SS	[illegible]									
14-17	SS	14 15 17 [illegible]									
										13	

[illegible]

NOTES: _____ EDITED BY/DATE: _____

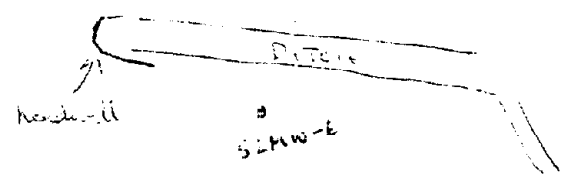
BROWN and ROOT ENVIRONMENTAL

FIELD LOG OF BORING

WELL NO. 52MW-6

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: 52MW-6	
	LOGGED BY: GB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Muller		START, TIME: 5:17	DATE: 1/11/96
DRILL RIG TYPE: ~~Robert Muller~~ Dietrich 120		FINISH, TIME: 6:15	DATE: 1/11/96
BORING METHOD: Hollow Stem		WATER DEPTH: ≈1 ft	
HOLE DIAMETER: 8.25"		DATE:	
SAMPLING METHOD: Split spoon		TIME:	
HAMMER WGT.: 140 lbs	DROP HGT: 30 in	BACKFILLED, TIME:	DATE: 1/11/96
CONDITIONS: Sunny 68°		LOCATION OF BORING:	



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
0-1	SS	35 30 14 12									
1-2	SS	13 18 10									
2	SS							3		1	
3-4	SS	15 20 13 12								2.5	
5	SS							2		5	
6-8	SS	10 8 8									
8-10	SS	10 12 15 15									
10	SS							ND			
10-12	SS	12 12 18 16								13 ft	

~~mostly~~ coarse sand, brown
grading to light brown poor
sorted, sub angular to angular
roots + decaying plant matter
limestone sandy oolite
light brown not well consolid
few shell fragments
limestone, oolite less sand l
soil constituent but brittle
very porous
sandy limestone some
stone oolite
limestone, oolite well consol
hard minutes

NOTES: SS = split spoon

EDITED BY/DATE:

BROWN and ROOT ENVIRONMENTAL

FIELD LOG OF BORING

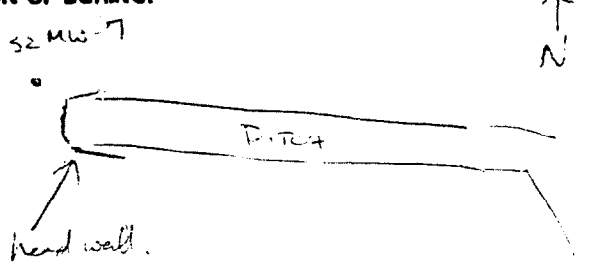
WELL NO.: _____

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: S2 MW-7	
	LOGGED BY: GB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: [illegible]		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 3:33	DATE: 1/11/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 4:25	DATE: 1/11/96
BORING METHOD: Hollow Stem		WATER DEPTH: ≈1 ft	
HOLE DIAMETER: 8.25"		DATE: 1/11/96	
SAMPLING METHOD: Split spoon		TIME:	
HAMMER WGT.: 140 lb	DROP HGT: 30 in.	BACKFILLED, TIME:	DATE:

CONDITIONS: Sunny 76°

LOCATION OF BORING:



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
0-2	SS	35 30 26 30									Limestone, light brown, hard well consolidated, porous, fossil shell fragments.
2	SS							10			
2-4	SS	30 35 26 35									
4-6	SS	[illegible] 25 30 [illegible]									
6	SS							2			
6-8	SS	27 38 36 [illegible]									
8-10	SS	[illegible]									
10	SS							2			
10-12	SS	[illegible]									

NOTES: SS = split spoon

EDITED BY/DATE: _____

BROWN and ROOT ENVIRONMENTAL

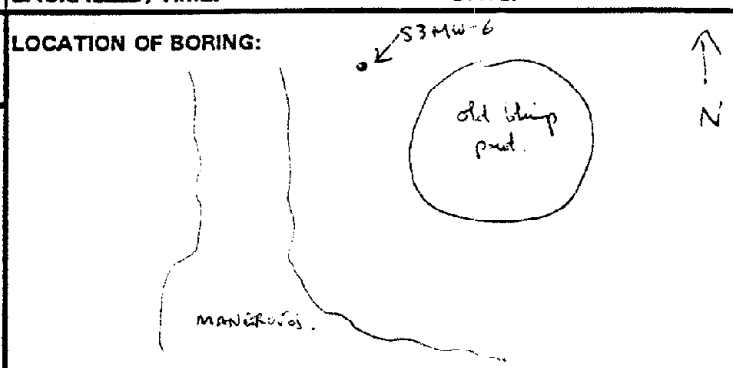
FIELD LOG OF BORING

Julian Burrows
John

WELL NO. S3MW-6

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: S3MW-~~B~~ 6	
	LOGGED BY: GP	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 1:05	DATE: 1/12/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 1:40	DATE: 1/12/96
BORING METHOD: Hollow stem Auger		WATER DEPTH:	≈2.5 ft
HOLE DIAMETER: 8 1/4 inches		DATE:	1/12/96
SAMPLING METHOD: split spoon.		TIME:	
HAMMER WGT.: 140 lbs	DROP HGT: 30 inches	BACKFILLED, TIME:	DATE:
CONDITIONS: Partly cloudy 61°		LOCATION OF BORING:	



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
2	SS							10		1	
0-2	SS	25 34 17 12								1	
5	SS							8			
2-4	SS	13 18 10 11								8	
4-6	SS	8 7 6 6								8.9 9	
10	SS	3 4 4 8						2		10	
6-8	SS	3 4 4 8								11	
8-10	SS	2 2 3 2									
10-12	SS	4 2 4 4								13 ft	
12											

Road base - sand and gravel loosely consolidated, poorly sorted limestone, oolitic, same as previous

Peat, wood, dark brown, nothing, root

clayey limestone dark gray brown sand, coarse grained, wood fragments @ limestone oolitic, light brown clayey 20%, coarse sand, well cemented clay with depth

NOTES: SS -

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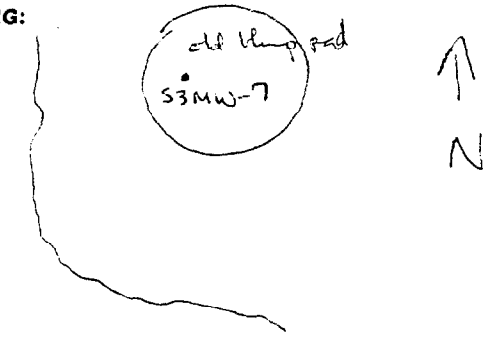
BROWN and ROOT ENVIRONMENTAL

FIELD LOG OF BORING

WELL NO. S3MW-7

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: S3MW-7	
	LOGGED BY: GB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: GWP		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 9:15	DATE: 1/12/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 10:15	DATE: 1/12/96
BORING METHOD: Hollow stem		WATER DEPTH: ~2 ft	
HOLE DIAMETER: 8.25		DATE:	
SAMPLING METHOD: split spoon		TIME:	
HAMMER WGT.: 140	DROP HGT: 30 inches	BACKFILLED, TIME:	DATE:
CONDITIONS: partly cloudy 70°		LOCATION OF BORING:	



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
2	SS							ND		1	Road base material, white to off white poorly sorted sand and gravel
0-2	SS	25 29 19 19								1.5	limestone, oolitic, beige to light brown, micritic, porous, few shell fragments
2-4	SS	15 22 18 20								5	same as above, more shell fragments (larger) solution cavities greater
5	SS							ND			
4-6	SS	10 14 18 30									
6-8	SS	17 17 15 30									
10	SS							ND			
8-10	SS	15 15 16 35									
10-12	SS	15 18 35 25									
										13 ft	

NOTES: SS = split spoon

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BROWN and ROOT ENVIRONMENTAL

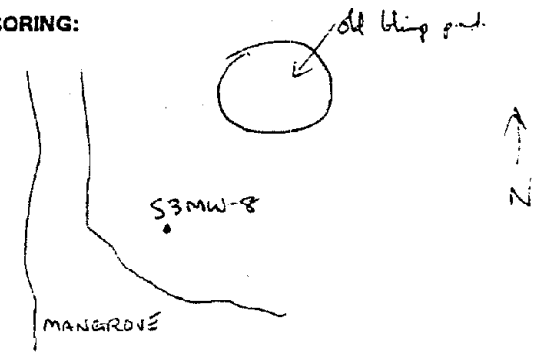
FIELD LOG OF BORING

windy + cloudy 2:50

WELL NO. S3 MW-8

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: S3 MW-8	
	LOGGED BY: GB	TOTAL DEPTH: 13 ft.	
DRILLING CONTRACTOR: GNP		SURFACE ELEV.: N/A	DATUM:
DRILLER'S NAME: Robert Miller		START, TIME: 2:10	DATE: 1/12/96
DRILL RIG TYPE: Diedrich D-120		FINISH, TIME: 3:30	DATE: 1/12/96
BORING METHOD: Hollow Stem Auger		WATER DEPTH: ≈2 ft	
HOLE DIAMETER: 8.25		DATE: 1/12/96	
SAMPLING METHOD: Split spoon.		TIME:	
HAMMER WGT.: 140 lbs	DROP HGT: 30".	BACKFILLED, TIME:	DATE:
CONDITIONS: Sunny, 60°		LOCATION OF BORING:	



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
1	ph							100		1	
0-2	SS	12 16 33 19								1	
5	SS							500			
2-4	SS	18 58 35 19									
10	SS							80		7	
4-6	SS	11 14 18 20									
6-8	SS	16 13 15 14									
8-10	SS	13 9 10 12									
10-12	SS	14 13 16 18									
										13 ft	

Lead base material of unsorted sand and gravel.

Limestone oolitic, light to light brown, shell fragments, sulphur rotting vegetation like odor.

Same as above increasing shell & limestone with log.

NOTES: SS= split spoon, ph= post hole

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BROWN and ROOT ENVIRONMENTAL

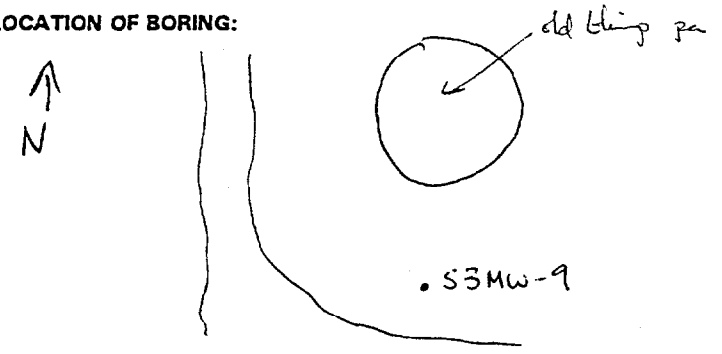
FIELD LOG OF BORING

WELL NO. S3 MW-9

SHEET 1 OF 1

PROJECT: NAS Key West	JOB NO.: HK 7046	BORING NO.: S3 MW-9	
	LOGGED BY: GrB	TOTAL DEPTH: 13 ft	
DRILLING CONTRACTOR: Groundwater Protection	SURFACE ELEV.: N/A	DATUM:	
DRILLER'S NAME: Robert Miller	START, TIME: 10:40	DATE: 1/12/96	
DRILL RIG TYPE: Diedtrich D-120	FINISH, TIME: 11:30	DATE: 1/12/96	
BORING METHOD: Hollow Stem Auger	WATER DEPTH: ~2 ft		
HOLE DIAMETER: 8.25	DATE:		
SAMPLING METHOD: Split spoon	TIME:		
HAMMER WGT.: 140 lbs DROP HGT: 30"	BACKFILLED, TIME:	DATE:	
CONDITIONS: pretty sunny - 68°			

LOCATION OF BORING:



SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET	LITHOLOGY
0-2	SS	13 14 18 8								1	
1	SS							ND		1	
5	SS							ND		4	
10	SS							ND		5	
2-4	SS	9 17 13 15								7	
4-6	SS	15 16 16 20								7	
6-8	SS	15 20 20 20									
8-10	SS	15 14 15 20									
10-12	SS	20 26 28 28									
										13 ft	

Lithology:

hard base material coarse sand and gravel, light brown, poorly sorted

Sandy limestone, brown, poorly cem. sand coarse to medium grained poorly sorted.

limestone, oolitic, brown, well consolidated pores, moderate solution cavities, abundant shell fragments, increasing with depth

shell and limestone matrix, shell fragments and whole shell - bracking pelecypods and worm tubes, well consolidated

NOTES: SS split spoon

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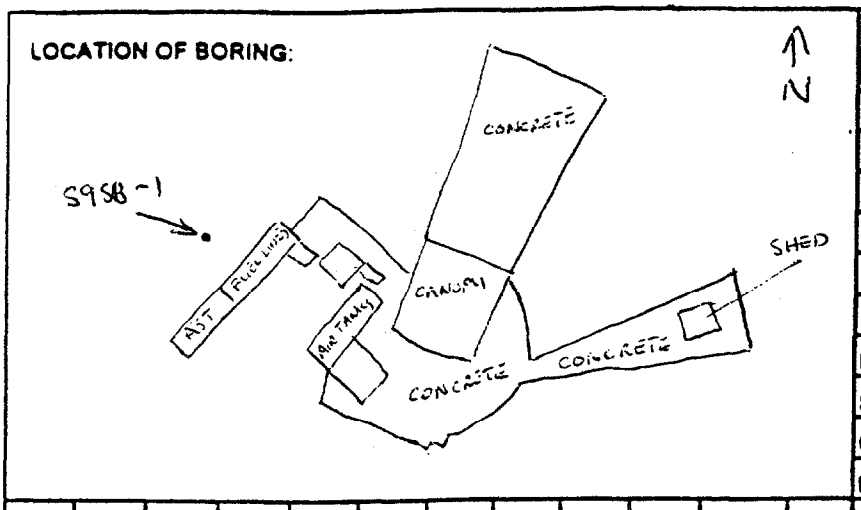
APRIL 1

FIELD LOG OF BORING

SHEET 1 OF 2

LOCATION OF BORING:



PROJECT: HK 7046		BORING NO. S958-	
		TOTAL DEPTH: 2	
JOB NO. HK 7046		LOGGED BY:	
PROJ. MGR: Rachael Layman		EDITED BY:	
DRILLING CONTRACTOR: GPI			
DRILL RIG TYPE: Dedrich D-120			
DRILLERS NAME: Robert Miller			
SAMPLING METHODS: Split Spoon			
HAMMER WT: 140 lbs		DROP: 30"	
STARTED TIME: 5:00 p.m.		DATE: 1/17/96	
COMPLETED TIME: 6:05		DATE: 1/17/96	
BORING DEPTH (ft.)	12 ft		
CASING DEPTH (ft.)	N/A		
WATER DEPTH (ft.)	≈ 2 ft		
TIME:			
DATE:			
BACKFILLED TIME:	DATE:	BY:	
SURFACE ELEV.: N/A		DATUM: N/A	
CONDITIONS: Sunny, 70°			

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	MOISTURE	ODOR	UNFILTERED OVA (PPM)	FILTERED OVA (PPM)	PID CORRECTED ~~OVA~~ (PPM)	DEPTH IN FEET	USCS CODE
										1	
0-2	SS	23 12 40 43							200	2	
										3	
2-4	SS	60 65 60 80							700	4	
										5	
4-6	SS	40 46 56 50							400	6	
										7	
6-8	SS	80 96 100 90							400	8	
										9	
8-10	SS	96 98 80 86							300	10	

oolitic limestone, beige to off-white
micritic, minor shell fragments
well consolidated

SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

DEPTH	TYPE	BLOWS	DRIVEN	RECV'D	MOISTURE	ODOR	UNFILTER	FILTERED	CORRECT	DEPTH	USCS CODE	PROJECT: NAS Key West	NO. HK 7046	BORING NO. S95E-
												oolitic limestone		
										11				
10-12	SS	40 30 28 25							500	12				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				
										1				
										2				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				

SOIL//SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

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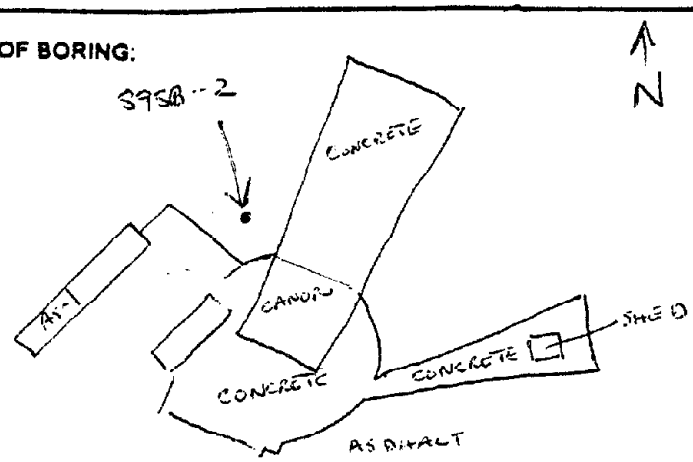
APRIL

FIELD LOG OF BORING

SHEET 1 OF 2

LOCATION OF BORING:



PROJECT: HK 7046/NAS KEY WEST		BORING NO. S95B	
JOB NO. HK 7046		TOTAL DEPTH: 12 ft	
PROJ. MGR: Rachael Layman		LOGGED BY: GTG	
DRILLING CONTRACTOR: GPI		EDITED BY:	
DRILL RIG TYPE: Diedrich D-120			
DRILLERS NAME: Robert Muller			
SAMPLING METHODS: Split spoon			
HAMMER WT: 140		DROP: 30"	
STARTED TIME: 4:10		DATE: 1/17/96	
COMPLETED TIME: 4:45		DATE: 1/17/96	
BORING DEPTH (ft.)	12 ft		
CASING DEPTH (ft.)	N/A		
WATER DEPTH (ft.)	≈ 2.5 ft		
TIME:			
DATE:			
BACKFILLED TIME:	DATE:	BY:	
SURFACE ELEV.:		DATUM:	
CONDITIONS: Sunny, 65°			

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	MOISTURE	ODOR	UNFILTERED OVA (PPM)	FILTERED OVA (PPM)	PID CORRECTED OVA (PPM)	DEPTH IN FEET	USCS CODE
										1	
0-2		22 14 35 44							50	2	
										3	
2-4		65 93 82							500	4	
										5	
4-6		105 100 110 110							100	6	
										7	
6-8		48 70 60 61							75	8	
										9	
8-10		40 70 65 70							50	10	

oolitic limestone, beige with shell fragments, well indurated

SOIL//SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

PROJECT: NAS KEY WEST | NO. HK 7046 | BORING NO. 5956-

DEPTH	TYPE	BLOWS	DRIVEN	REC'VD	MOISTURE	ODOR	UNFILTER	FILTERED	CORRECT	DEPTH	USCS CODE	
												oolitic limestone
										11		
10-12	SS	30 21 40 45							50	12		
										3		
										4		
										5		
										6		
										7		
										8		
										9		
										0		
										1		
										2		
										3		
										4		
										5		
										6		
										7		
										8		
										9		
										0		

SOIL//SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

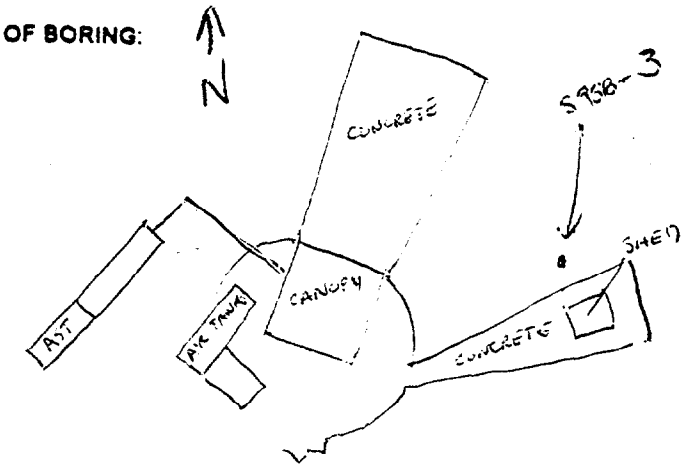
Brown & Root Environmental

APRIL.

FIELD LOG OF BORING

SHEET 1 OF 2

LOCATION OF BORING:



PROJECT: NAS KEY WEST		BORING NO. S958F -	
JOB NO. HK 7046		TOTAL DEPTH: 12	
PROJ. MGR: Rachael Hanna		LOGGED BY: SB	
DRILLING CONTRACTOR: GPI		EDITED BY:	
DRILL RIG TYPE: Diedrich D-120			
DRILLERS NAME: Robert Miller			
SAMPLING METHODS: Split spoon			
HAMMER WT: 140 lbs		DROP: 30 inches	
STARTED TIME: 12:10		DATE: 1/17/96	
COMPLETED TIME: 12:55		DATE: 1/17/96	
BORING DEPTH (ft.)	12		
CASING DEPTH (ft.)	N/A		
WATER DEPTH (ft.)	≈2.5 ft		
TIME:			
DATE:			
BACKFILLED TIME:	DATE:	BY:	
SURFACE ELEV.:		DATUM:	
CONDITIONS: Partly cloudy 67°			

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	MOISTURE	ODOR	UNFILTERED OVA (PPM)	FILTERED OVA (PPM)	CORRECTED OVA (PPM)	DEPTH IN FEET	USCS CODE	SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY
										1		Oolitic limestone, beige & tan white, micritic, medium and fine matrix, minor shell fragments well consolidated
0-2	SS	23 21 16 45							2	2		
										3		
2-4	SS	50 40 40 48							2	4		
										5		
4-6	SS	38 40 37 55							2	6		
										7		
6-8	SS	50 55 52 55							2	8		
										9		
8-10	SS	36 43 40 75							2	10		

DEPTH	TYPE	BLOWS	DRIVEN	RECV'D	MOISTURE	ODOR	UNFILTER	FILTERED	CORRECT	DEPTH	USCS CODE	PROJECT: NAS KEY WEST	NO. HK 7046	BORING NO. 595 B
												oolitic limestone		
										11				
10-12	SS	24 30 24 38							2	12				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				
										1				
										2				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				

SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

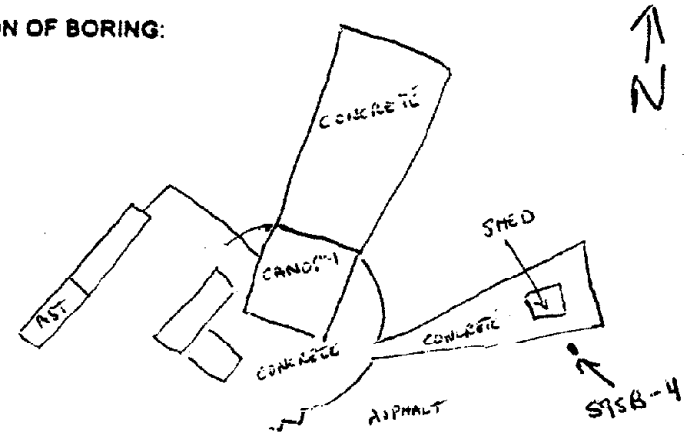
Brown & Root Environmental

APRIL, 19

FIELD LOG OF BORING

SHEET 1 OF 2

LOCATION OF BORING:



PROJECT: NAS/KEY WEST	BORING NO. SYSB-4
JOB NO. HK 7046	TOTAL DEPTH: 12
PROJ. MGR: Rachael Layman	LOGGED BY: GTO
DRILLING CONTRACTOR: GPI	EDITED BY:
DRILL RIG TYPE: Diedrich D-120	
DRILLERS NAME: Robert Muller	
SAMPLING METHODS: Split spoon	
HAMMER WT: 140	DROP: 30 inches
STARTED TIME: 2:35	DATE: 1/17/96
COMPLETED TIME: 3:50	DATE: 1/17/96
BORING DEPTH (ft.) 12 ft	
CASING DEPTH (ft.) N/A	
WATER DEPTH (ft.) ≈25 ft	
TIME:	
DATE:	
BACKFILLED TIME: — DATE: — BY: —	
SURFACE ELEV.: N/A	DATUM:
CONDITIONS: partly cloudy 68°	

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	MOISTURE	ODOR	UNFILTERED OVA (PPM)	FILTERED OVA (PPM)	PID CORRECTED ~~OVA~~ (PPM)	DEPTH IN FEET	USCS CODE	SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY
										1		Oolitic limestone, beige & off white, micritic, medium to fine grain sand in matrix, few shell fragments, well consolidated
0-2	SS	23 21 16 45							1,500	2		
										3		
2-4	SS	50 40 40 48							10	4		
										5		
4-6	SS	38 40 37 55							7	6		
										7		
6-8	SS	50 55 52 55							30	8		
										9		
8-10	SS	30 43 40 70							20	10		

SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

DEPTH	TYPE	BLOWS	DRIVEN	RECV'D	MOISTURE	ODOR	UNFILTER	FILTERED	CORRECT	DEPTH	USCS CODE	PROJECT: NAS KEY WEST	NO. HK 7046	BORING NO. 5958 -
												oolitic limestone		
										11				
10-12	SS	24 30 24 38							50	12				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				
										1				
										2				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				

SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

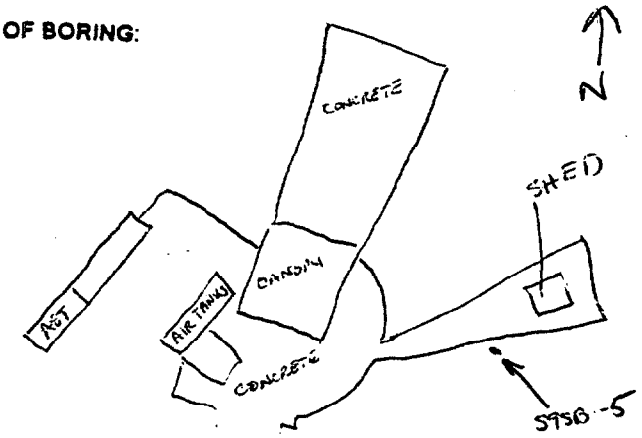
Brown & Root Environmental

APRIL.

FIELD LOG OF BORING

SHEET 1 OF 2

LOCATION OF BORING:



PROJECT: NAS KEY WEST	BORING NO. S9SB-5
JOB NO. HK 7046	TOTAL DEPTH: 12 ft
PROJ. MGR: Rachael Layman	LOGGED BY: GB
DRILLING CONTRACTOR: GPI	EDITED BY:
DRILL RIG TYPE: Diedrich D-120	
DRILLERS NAME: Robert Miller	
SAMPLING METHODS: Split spoon	
HAMMER WT: 140 lbs	DROP: 30"
STARTED TIME: 1:10	DATE: 1/17/96
COMPLETED TIME: 2:15	DATE: 1/17/96
BORING DEPTH (ft.) 12 ft	
CASING DEPTH (ft.) N/A	
WATER DEPTH (ft.) ≈ 2.5 ft	
TIME:	
DATE:	
BACKFILLED TIME: DATE:	BY:
SURFACE ELEV.:	DATUM:
CONDITIONS: partly sunny 69°	

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	MOISTURE	ODOR	UNFILTERED OVA (PPM)	FILTERED OVA (PPM)	CORRECTED OVA (PPM) PID	DEPTH IN FEET	USCS CODE	
										1		oolitic limestone, beige to off-white, micritic, fine to medium sand in matrix, few shell fragments well consolidated
0-2		16 20 14 14							ND	2		
										3		
2-4		24 20 24 30							ND	4		
										5		
4-6		20 25 35 35							ND	6		
										7		
6-8		30 50 70 50							ND	8		
										9		
8-10		20 26 25 25							ND	10		

SOIL/SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

DEPTH	TYPE	BLOWS	DRIVEN	RECV'D	MOISTURE	ODOR	UNFILTER	FILTERED	CORRECT	DEPTH	USCS CODE	PROJECT: NAS/KEY WEST	NO. HK 7046	BORING NO. S95B -
												oolitic limestone		
										11				
10-12	SS	60 60 30 28							ND	12				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				
										1				
										2				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										0				

SOIL//SEDIMENT DESCRIPTION, GRAIN SIZE, COLOR, ANGULARITY, DENSITY/CONSISTANCY

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: 32MW-6

DATE INSTALLED: 1/11/96

DRILLER: Groundwater Protection

LOCATION: SWMU-2

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2 IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

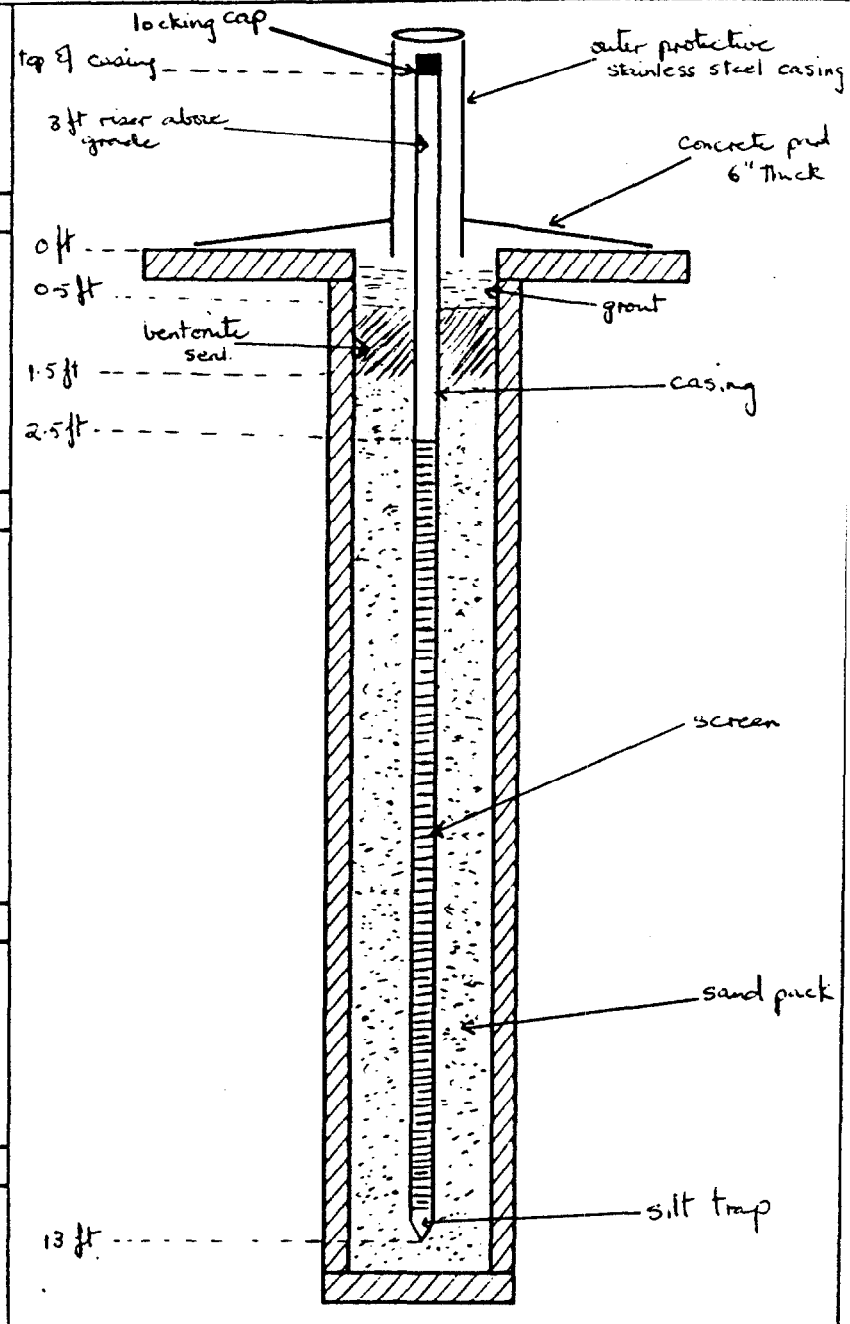
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: 11K 7046

WELL NO.: S2MW-7

DATE INSTALLED: 1/11/96

DRILLER: Groundwater Protection

LOCATION: SWMU-2

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2 IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

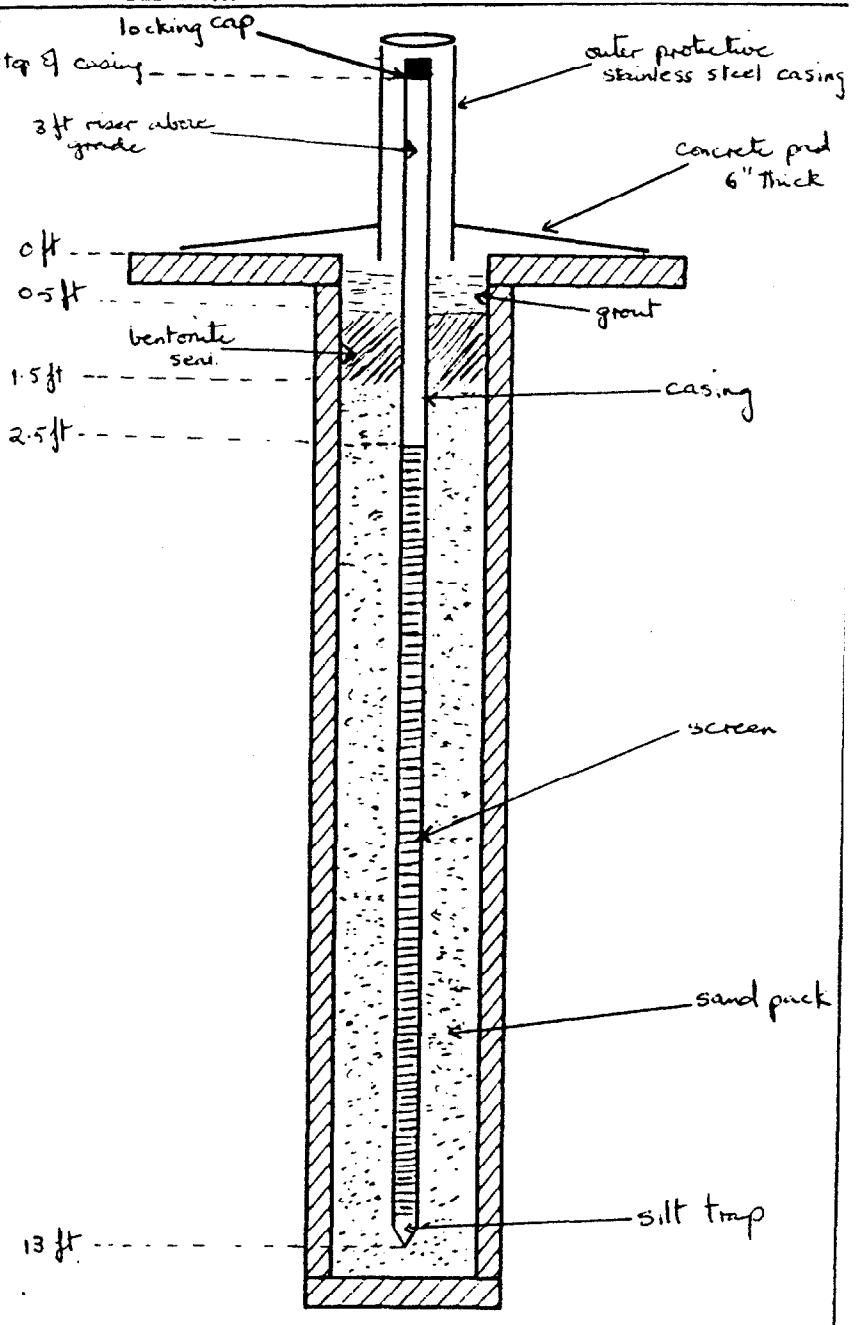
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: S2MW-5

DATE INSTALLED: 1/11/96

DRILLER: Groundwater Protection

LOCATION: SWMU-2

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

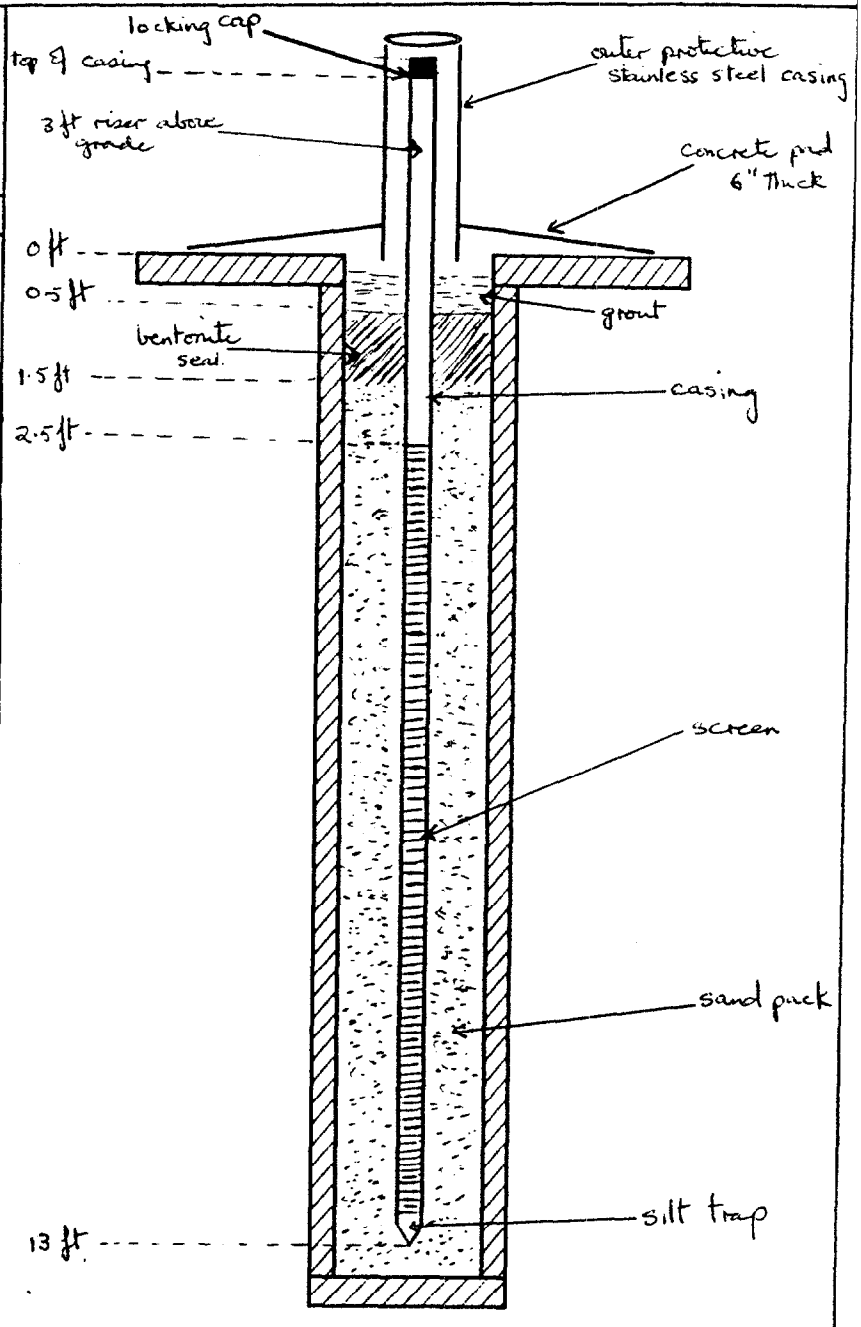
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: SIMW-4

DATE INSTALLED: 1/17/96

DRILLER: Groundwater Protection

LOCATION: SWMU-1

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 12 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 15 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 1.5 TO 11.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50lb bags

LENGTH: 10.5 FT.

BENTONITE (PELLETS) SEAL

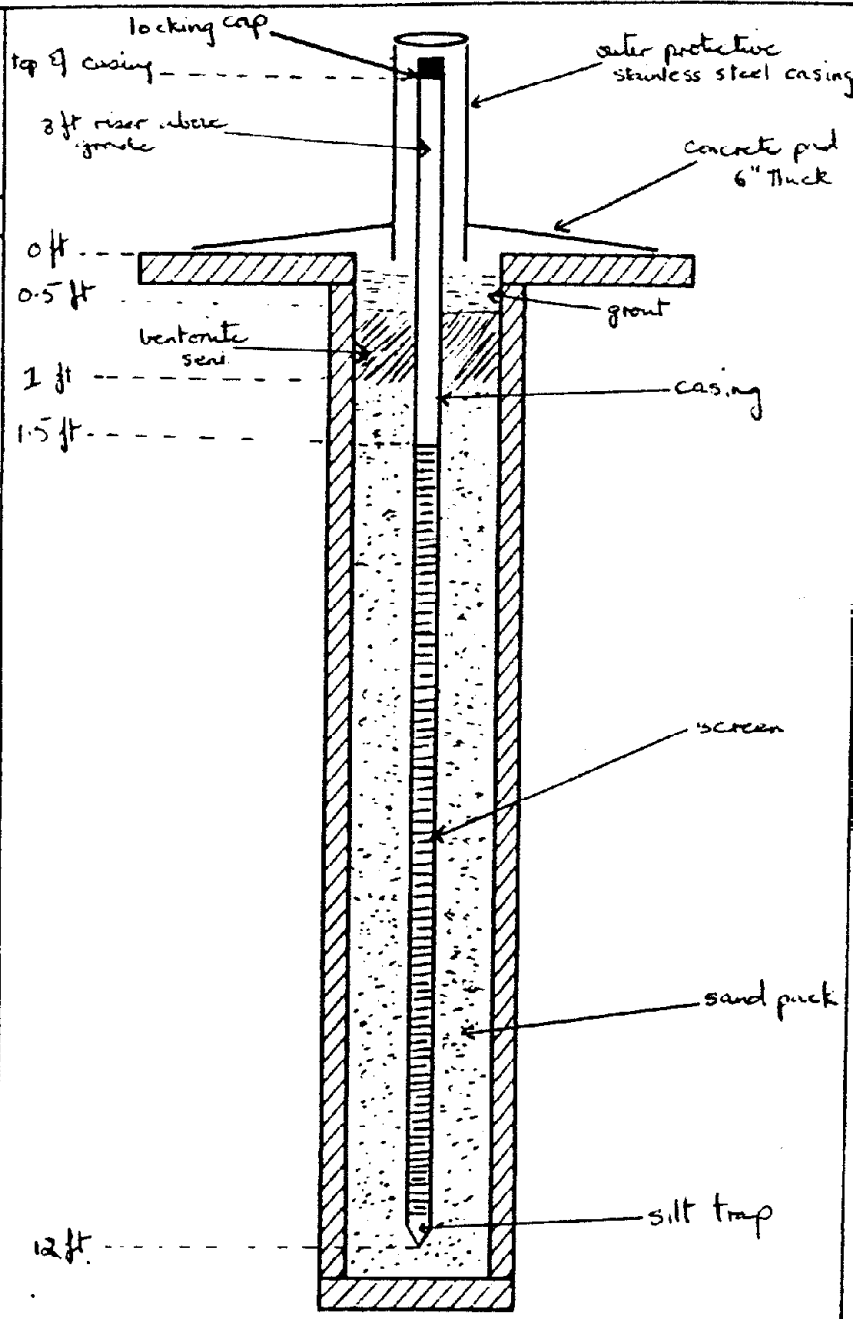
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: S1MW-3

DATE INSTALLED: 1/13/96

DRILLER: Groundwater Protection

LOCATION: S1MW-1

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 15 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

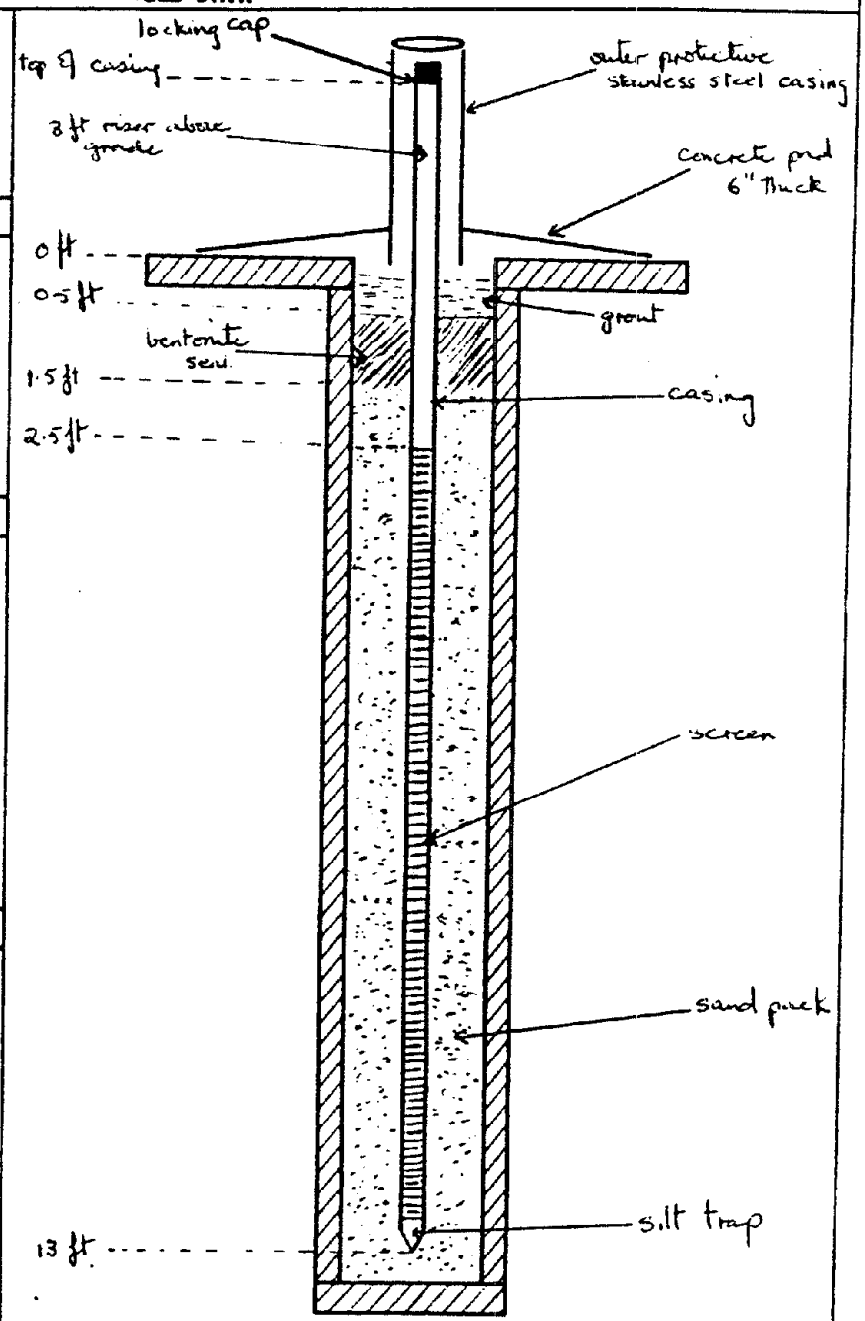
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: SIMW-6

DATE INSTALLED: 1/13/96

DRILLER: Groundwater Protection

LOCATION: SWMU-1

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

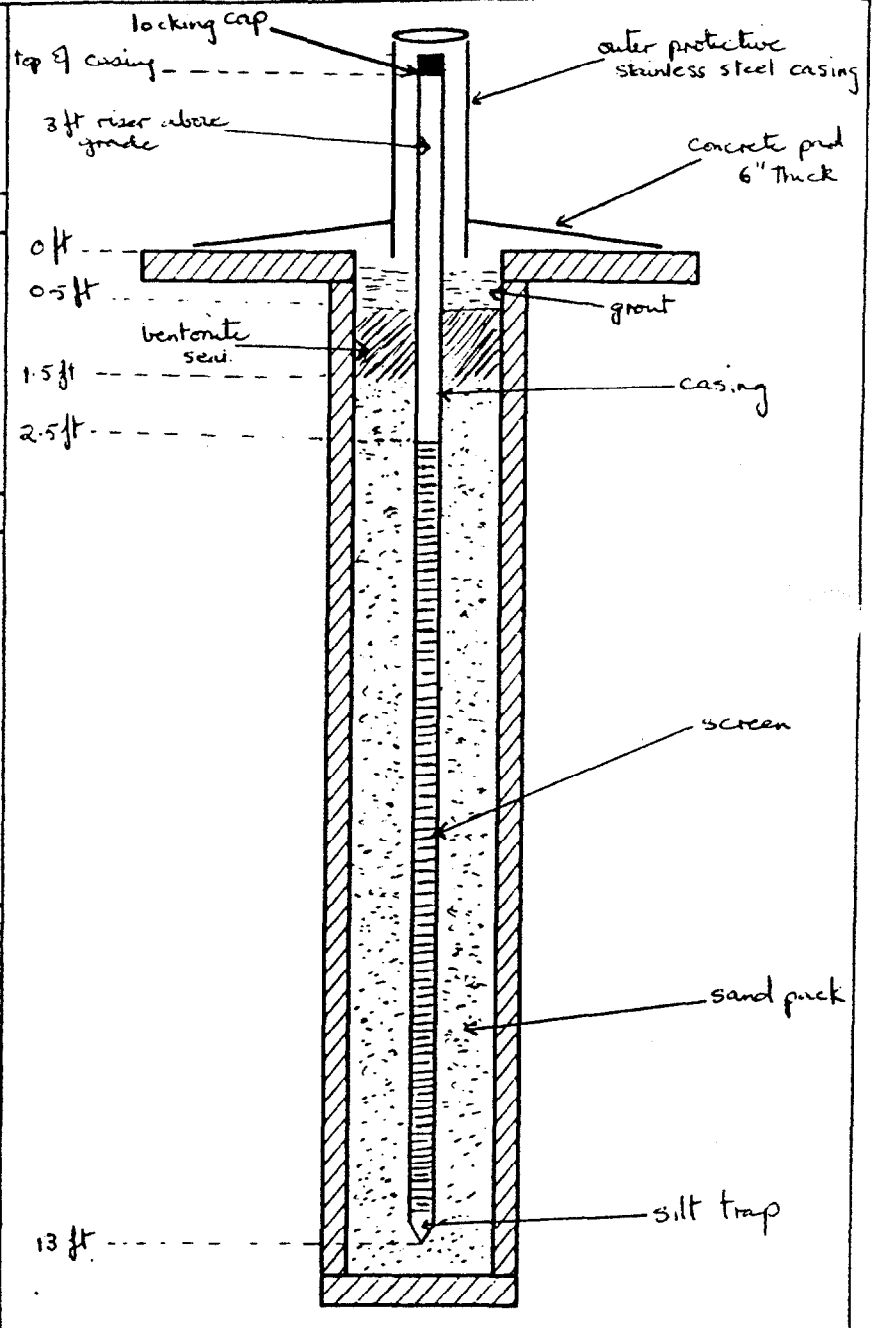
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: 11K.7046

WELL NO.: SIMW-5

DATE INSTALLED: 1/13/96

DRILLER: Groundwater Protection

LOCATION: SWMU-1

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 12 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2 IN.

LENGTH: 15 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 1.5 TO 11.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 10.5 FT.

BENTONITE (PELLETS) SEAL

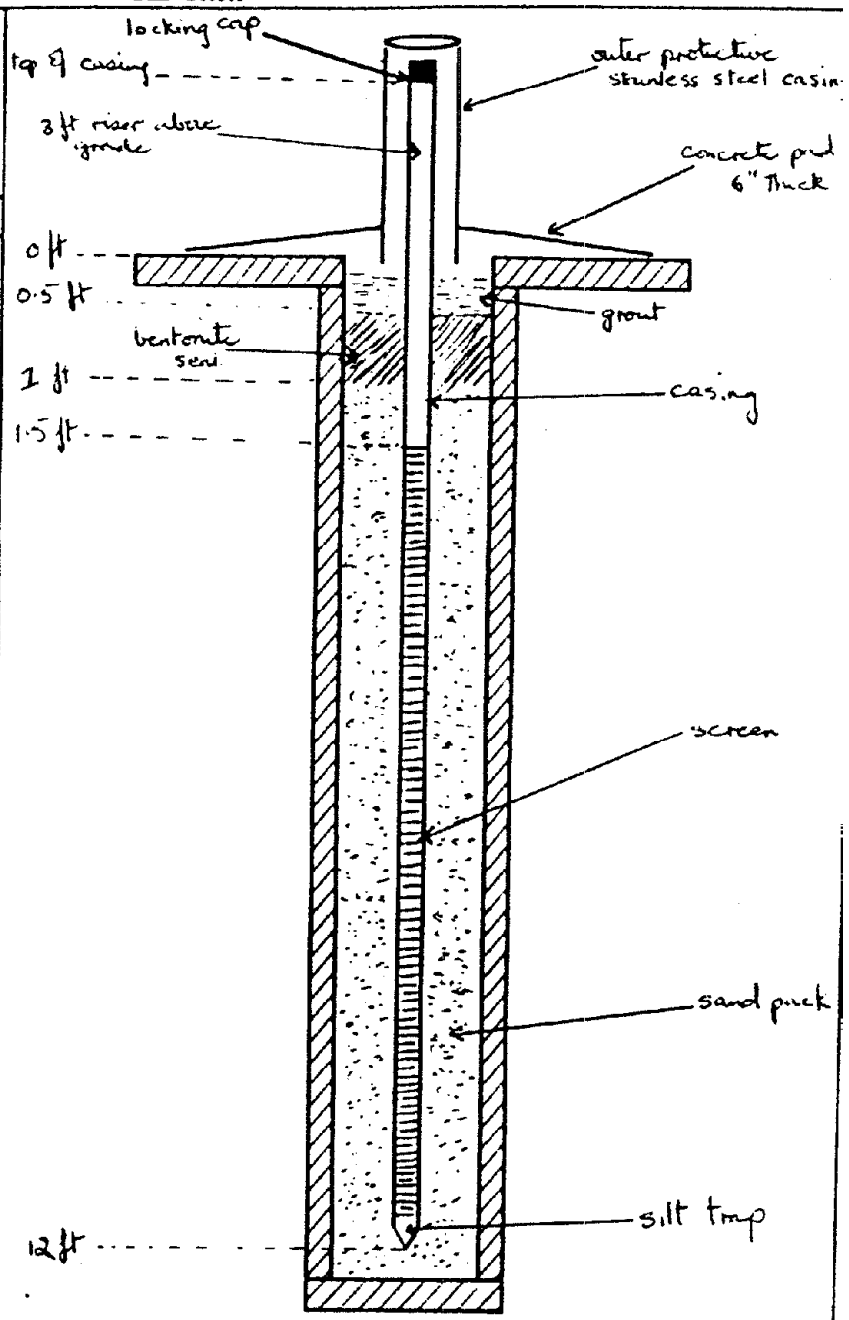
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK. 7046

WELL NO.: S3MW-8

DATE INSTALLED: 1/12/96

DRILLER: Groundwater Protection

LOCATION: SWMU-3

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

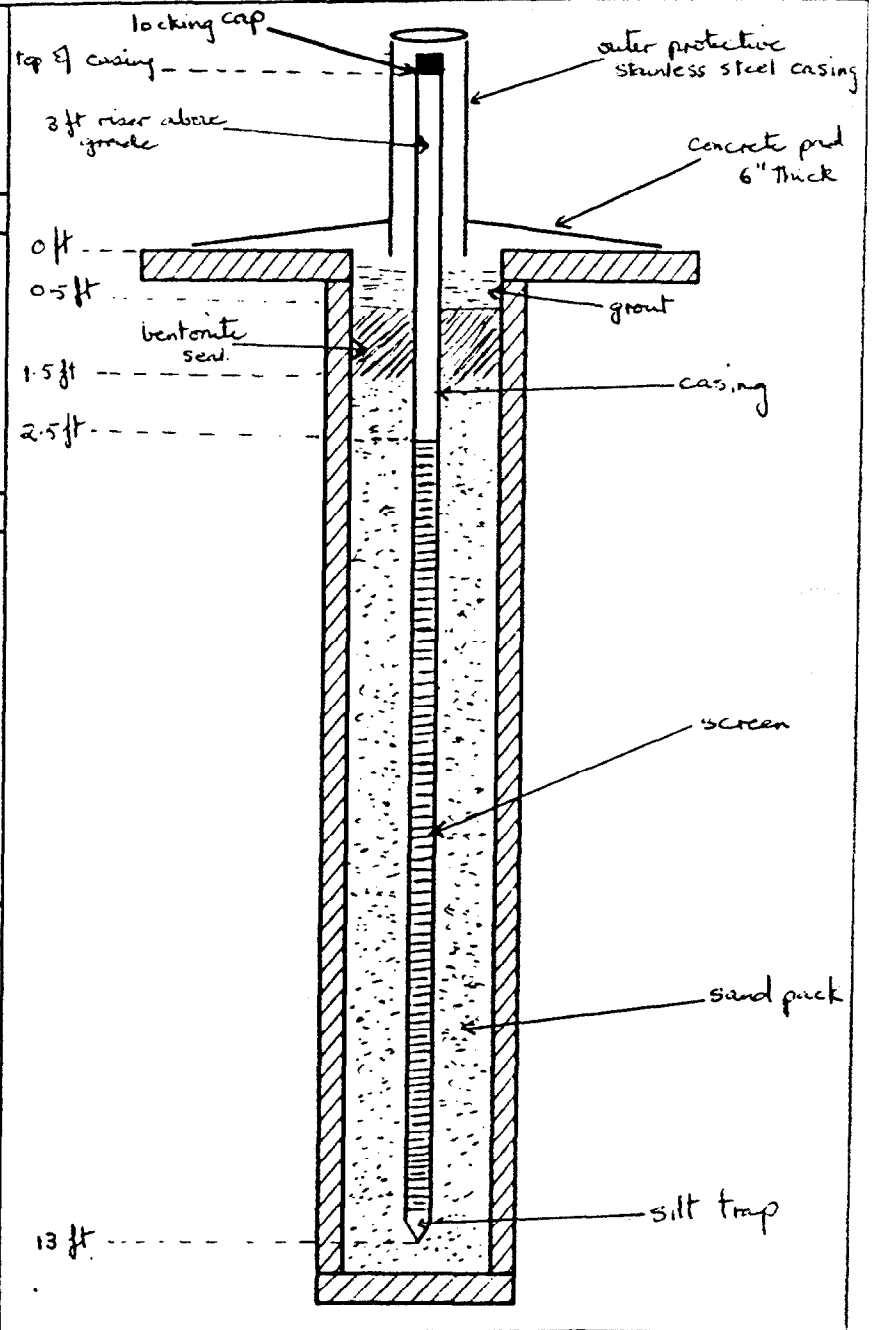
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

A Division of Brown & Root, Inc.

RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: S3MW-6

DATE INSTALLED: 1/12/96

DRILLER: Groundwater Protection

LOCATION: SWMU-3

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

____ IN. FROM ____ TO ____ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ____ TO ____ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

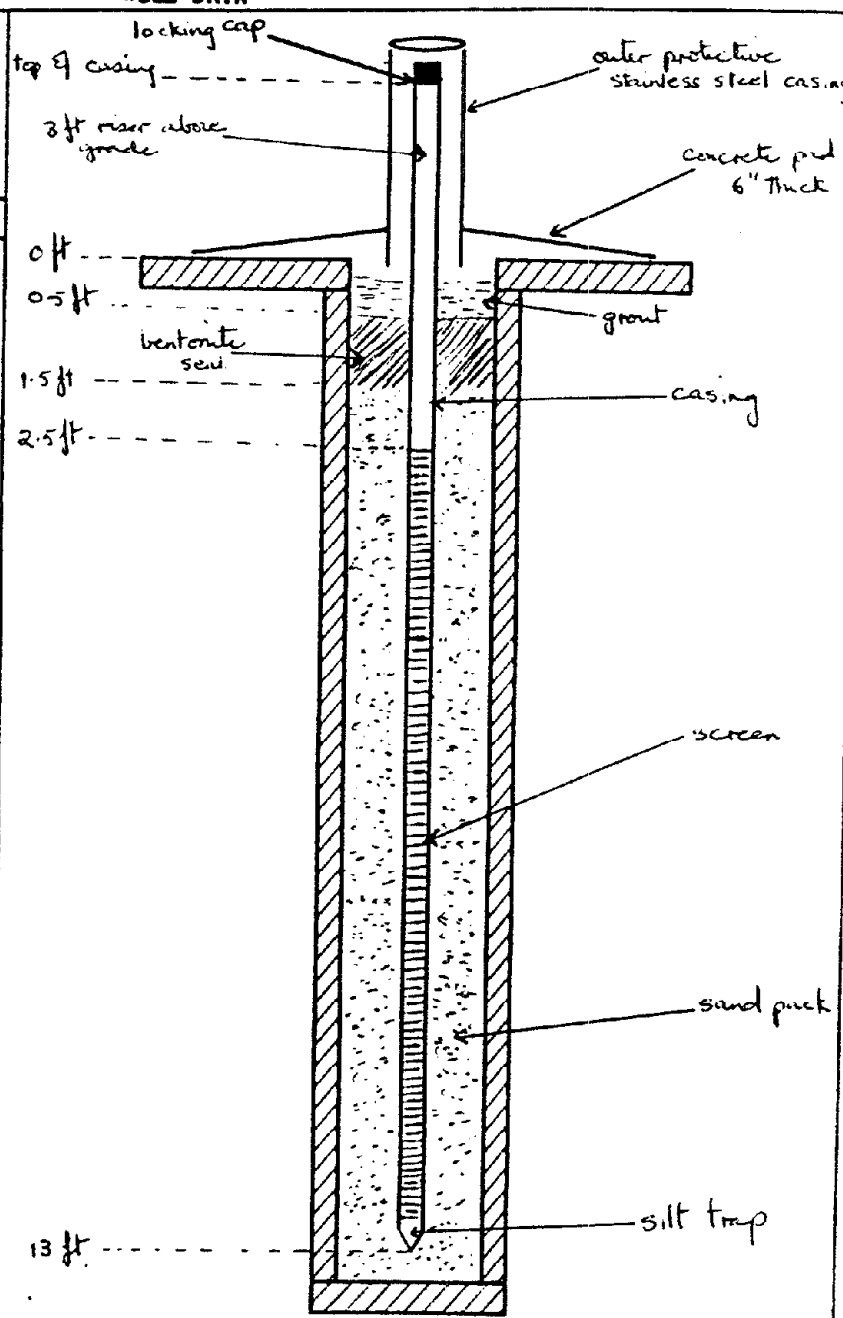
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ____



COMMENTS

Brown & Root Environmental

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RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: S3MW-9

DATE INSTALLED: 1/12/96

DRILLER: Groundwater Protection

LOCATION: SWMU-3

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2 IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

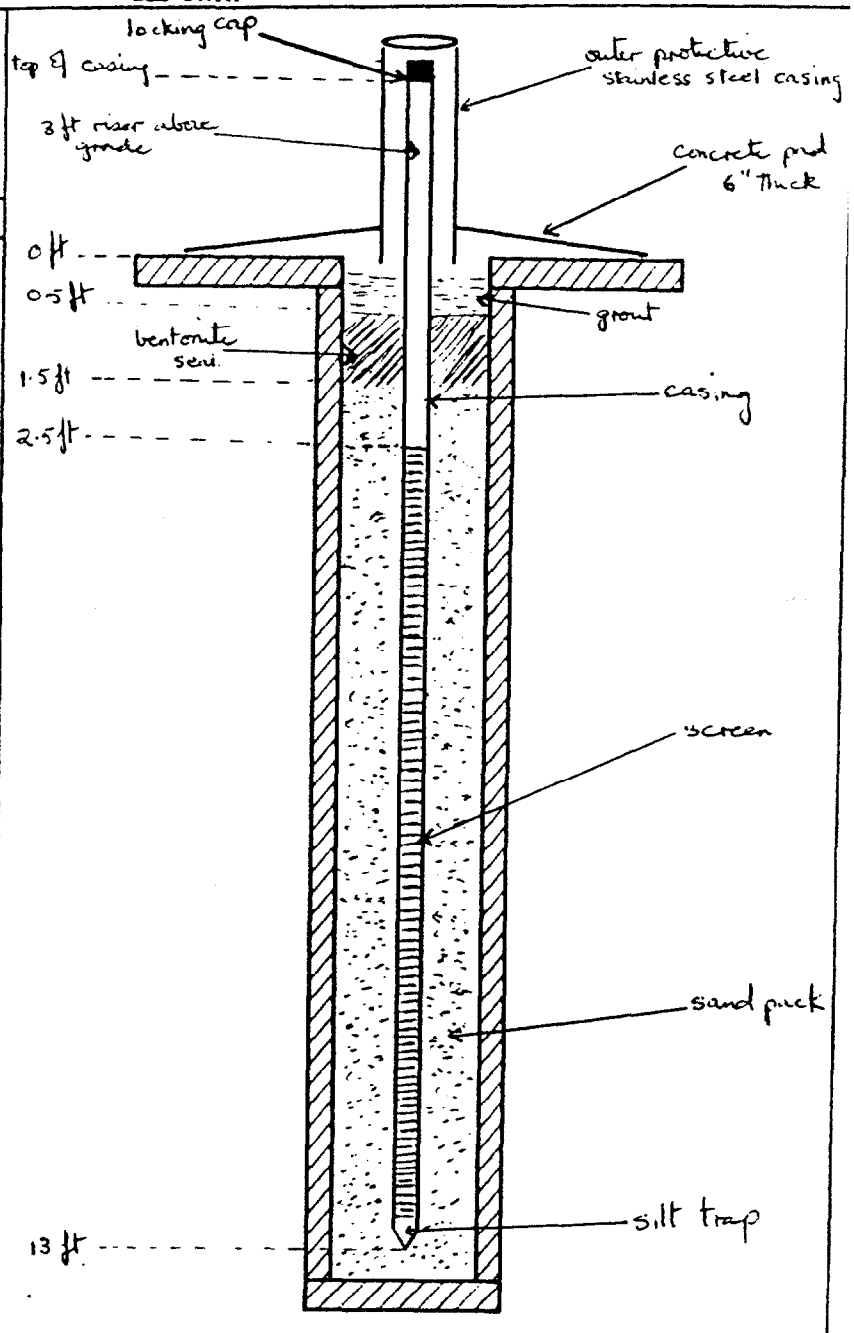
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

A Division of Brown & Root, Inc.

RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: S3MW-4

DATE INSTALLED: 1/12/96

DRILLER: Groundwater Protection

LOCATION: SWMU-3

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2" IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

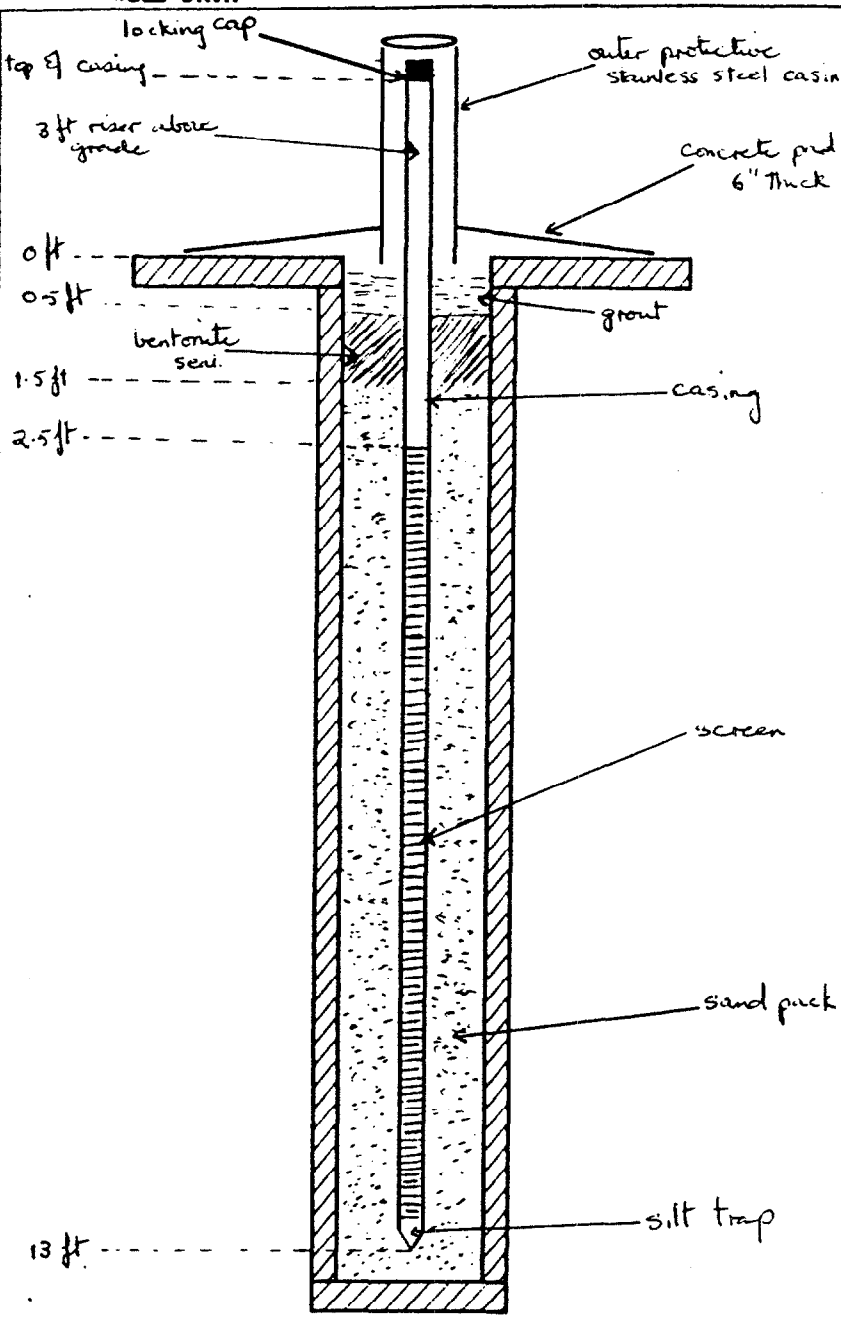
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

Brown & Root Environmental

A Division of Brown & Root, Inc.

RECORD OF WELL CONSTRUCTION

PROJECT NAME: NAS Key West

PROJECT NUMBER: HK 7046

WELL NO.: S2MW-4

DATE INSTALLED: 1/11/96

DRILLER: Groundwater Protection

LOCATION: SWMU-2

WELL DATA

BORE HOLE

DIAMETER: 8.25 IN. FROM 0 TO 13 FT.

___ IN. FROM ___ TO ___ FT.

CASING

TYPE: Schedule 40 PVC

DIAMETER: 2 IN.

LENGTH: 16 FT.

NO. OF COUPLINGS: None

SCREEN

TYPE: Schedule 40 PVC

SLOT: 0.01 in

DIAMETER: 2 IN.

LENGTH: 10 FT.

INTERVALS: FROM 2.5 TO 12.5 FT.

FROM ___ TO ___ FT.

SAND/GRAVEL PACK

TYPE: 20/30 Grade

QUANTITY: 7/50 lb bags

LENGTH: 11.5 FT.

BENTONITE (PELLETS) SEAL

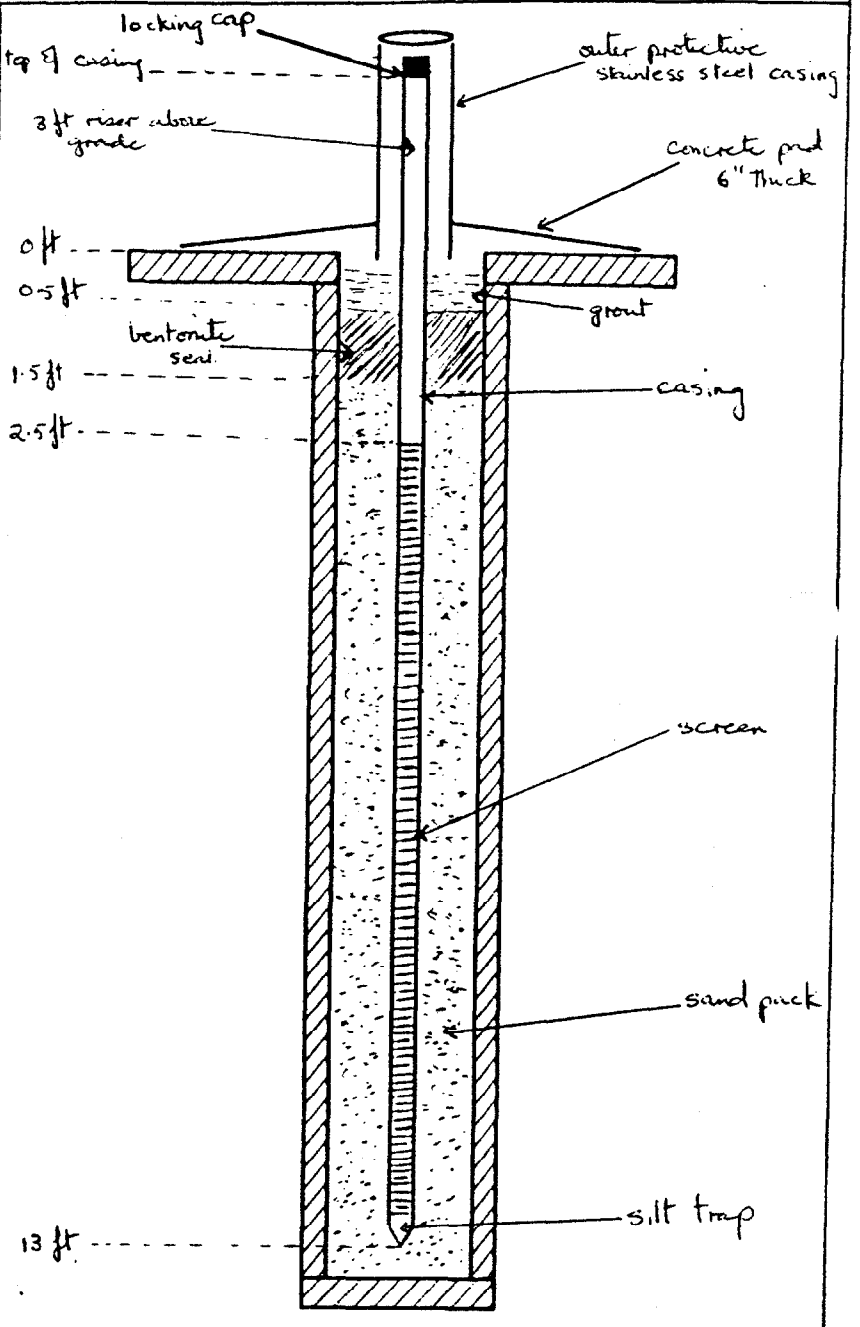
NO. CONTAINERS: <1

LENGTH: 0 FT.

GROUT

CEMENT: <1 BAGS

BENTONITE: ___



COMMENTS

BROWN & ROOT ENVIRONMENTAL

SAMPLE LOG SHEET

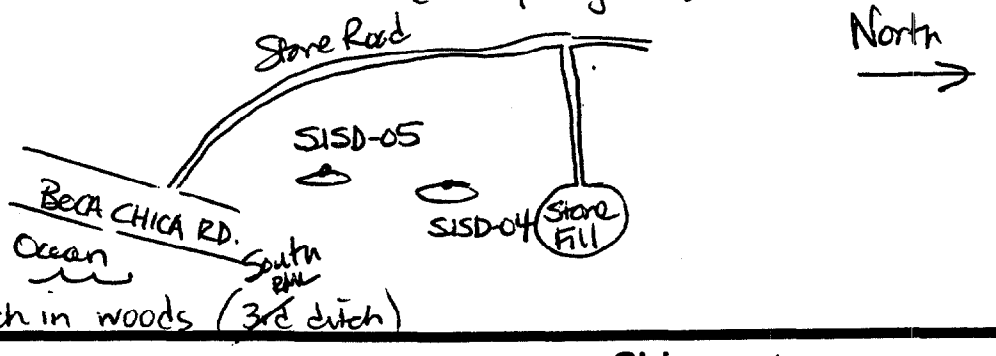
- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name: NAS Key West Project Site Number: 7046

HNUS Sample Name: SISD-05 Sample Source or Location: SWMU-1

Sample Method: Petit ponar	Sample Date and Time: 1/24/96 1045
Sample Depth: 2'	Color: drk grey
Sampled By (Print): Rachel Layman, Julia Bradley	Sample Description: silt, some fine sand and organic matter
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☒ Composite ☒ Grab

Observations/Notes: obvious odor (decomposing odor)



Analyses

Analysis	Bottle Lot #
Mysid toxicity	NA

Shipment

Laboratory	Ship Date/Time	Airbill #
ESI	1/24/96 1630	9230385091

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL JTB

Project Site Name NAS Key West
Project Site Number 7040
B&RE Sample ID MW5-1
Source Location SWMU-2

Total Well Depth:	12.22' BTOC
Well Stickup:	
Well Casing Size:	2"
Static Water Level:	4.65' BTOC
One Casing Volume:	1.23 gal
Start Purge (hrs.):	
End Purge (hrs.):	1550
Total Purge Time (min.):	35'
Total Amount Purged (gal.):	6.5 gal
Monitoring Reading:	70 ppm
Purge Method:	peristaltic pump
Sample Method:	bailer/peristaltic
Depth Sampled:	9'
Sample Data & Time:	1-29-96 1555
Sampled By:	Rachel Layman, Julia Bradley
Signature(s):	Julia Bradley, Rachel Layman

Purge Data

Volume	pH	S.C.	Temp. (°C)	Color & Turbidity	* D.O.
0	6.87	11.3	[illegible]	166 yellowish	[illegible]
1	6.71	10.1	24.4	125 yellowish	[illegible]
2	6.68	9.8	24.4	118 "	[illegible]
3.5	6.64	9.5	24.2	106 "	[illegible]
4.5	6.62	9.5	24.2	104 "	[illegible]
5.5	6.62	9.5	24.2	104 "	[illegible]
6.5	6.62	9.5	24.2	104 "	[illegible]

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.62	9.5	24.2	104 yellowish	[illegible]

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
Pesticides PCBs	—
herbicides	—
TAL metals	HNO_3
cyanide	NaOH

Observations/Notes:
fuel odor
salinity - 0.57%
* D.O. probe in error

Dup #
MSMSD ☐

Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL or JB

Project Site Name: NAS Key West
Project Site Number: 704a
B&RE Sample ID: S2MW-1
Source Location: SMW-2

Total Well Depth:	14.04' BTOC
Well Stickup:	2.69 top pad BTOC
Well Casing Size:	2"
Static Water Level:	5.21' BTOC
One Casing Volume:	1.44 gal
Start Purge (hrs.):	1607
End Purge (hrs.):	1637
Total Purge Time (min.):	30
Total Amount Purged (gal.):	6
Monitoring Reading:	0 ppm
Purge Method:	peristaltic pump
Sample Method:	bailer peristaltic pump
Depth Sampled:	~10'
Sample Data & Time:	1-25-96 1640
Sampled By:	Julia Bradley, Rachel Layman
Signature(s):	Julia Bradley, Rachel Layman

Purge Data

(gallons) Volume	pH	(mS/cm) S.C.	Temp. (°C)	Color & Turbidity	(mg/L) *D.O.
0	7.16	18.2	24.4	140 clear	0.31
1	7.62	4.62	23.3	135 clear	-0.12
2	7.48	4.38	23.3	482 cloudy	-0.41
3	7.35	4.33	23.5	754 cloudy	-1.09
4	7.39	4.37	23.2	6[illegible] cloudy	-0.16
4.5 Δ	6.89	22.5	25.2	279 clearer	-0.58
6.0	7.36	4.75	23.6	372 cloudy	-0.12

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.
7.36	4.75	23.6	cloudy 372	-0.12

Type of Sample

☑ Low Concentration
☐ High Concentration
☑ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
Pesticides/PCBs	—
herbicides	—
TAL metals	HNO_3
cyanide	NaOH

Observations/Notes:

[illegible] salinity; 0.24%; 0.22%.

Δ tubing lowered since turbid water has typically been @ surface

*D.O. meter in error.

Dup # S2DPGW-01
MSMSD ☐

Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID MW5-1
Source Location SWMU-2

Total Well Depth: 12.22' BTOC
Well Stickup:
Well Casing Size: 2"
Static Water Level: 4.65' BTOC
One Casing Volume: 1.23 gal
Start Purge (hrs.): [illegible]
End Purge (hrs.): 1550
Total Purge Time (min.): 35'
Total Amount Purged (gal.): 6.5 gal
Monitoring Reading: 70 ppm
Purge Method: peristaltic pump
Sample Method: bailer/peristaltic
Depth Sampled: 9'

Purge Data

Volume	pH	S.C.	Temp. (°C)	Color & Turbidity	* D.O.
[illegible]	6.87	11.3	[illegible]	166 yellowish	-1.31
1	6.71	10.1	24.4	125 yellowish	-0.8[illegible]
2	6.68	9.8	24.4	118 "	-0.82
3.5	6.64	9.5	24.2	106 "	-0.89
4.5	6.62	9.5	24.2	104 "	-0.94
5.5	6.62	9.5	24.2	104 "	-1.21
6.5	6.62	9.5	24.2	104 "	-1.15

Sample Data & Time: 1-29-96 1555
Sampled By: Rachel Layman, Julia Bradley
Signature(s): Julia Bradley, Rachel Layman

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.62	9.5	24.2	104 yellowish	-1.15

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Observations/Notes:
fuel odor
salinity - 0.57%
* D.O. probe in error.

Analysis:	Preservative:
Pesticides/PCBs	—
herbicides	—
TAL metals	HNO_3
cyanide	NaOH

Dup #
MSMSD ☐
Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name: NAS Key West
Project Site Number: 7646
B&RE Sample ID: 52MW-4
Source Location: SWMU-2

Total Well Depth: 16.21' BTOC
Well Stickup: 2.38' Top of pail to TOC
Well Casing Size: 2"
Static Water Level: 4.97' BTOC
One Casing Volume: 1.83 gal
Start Purge (hrs.): ~~1325~~ 1425
End Purge (hrs.): 1453
Total Purge Time (min.): 28'
Total Amount Purged (gal.): 6
Monitoring Reading: ~5 ppm
Purge Method: peristaltic pump
Sample Method: bailer / peristaltic
Depth Sampled: ~12' BTOC
Sample Data & Time: 1/28/96 1455
Sampled By: Rachel Layman, Julia Bradley
Signature(s): Julia Bradley, Rachel Layman

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	*mg/l D.O.
0	6.88	27.8	26.2	103 clear	-0.55
1	6.99	13.3	25.1	101 clear	-1.23
2	6.98	12.6	25.0	79 yellowish	-1.18
3	6.99	11.3	24.6	78 "	-1.25
4.5	6.90	12.7	24.6	78 " clear	-1.62
5.5	6.90	12.8	24.6	80 " clear	-0.99

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.90	12.8	24.6	80 yellow clear	-0.99

Observations/Notes:
Obvious fuel odor. Wind strong, possibly interfering with FID readings.
Salinity 1.72%, 0.76%, 0.72%, 0.64%, 0.73%
* D.O. probe in error

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
metals	HNO_3
cyanide	NaOH
pesticides/PCBs	—
herbicides	—

Dup #
MSMSD ☐
Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL JB

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID SZMW-5
Source Location SKVMW-2

Total Well Depth: 11.24' BTOC
Well Stickup: 2.25' top pad - BTOC
Well Casing Size: 2" inches
Static Water Level: 4.80' BTOC
One Casing Volume: 1.86 gal
Start Purge (hrs.): ~~1235~~ 1335
End Purge (hrs.): 1410
Total Purge Time (min.): 35'
Total Amount Purged (gal.): 6
Monitoring Reading: HRS reading 250 ppm
Purge Method: peristaltic pump
Sample Method: bailer / peristaltic pump
Depth Sampled: ~13' BTOC

Sample Data & Time: 1-28-96 1410
Sampled By: Rachel Layman, Julia Bradley
Signature(s): Julia Bradley, Rachel Layman

Type of Sample
☒ Low Concentration
☐ High Concentration
☐ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
metals	HNO_3
cyanide	NaOH
pesticides/PCBs	—
herbicides	—

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.
0	7.22	25.1	26.3	292 clear HRS	-0.78
1	7.04	23.4	25.3	250 cloudy	-1.21
2	7.12	19.8	24.9	185 cloudy	-1.41
3	7.04	19.0	24.8	105 clear	-0.98
4	7.02	18.6	24.6	78 clear	-1.24
5	6.99	18.9	24.6	70 clear	-1.09
~~5.5~~ 6	6.96	18.9	24.6	58 clear	-0.97

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/L
6.96	18.9	24.6	58 clear	-0.97

Observations/Notes: * D.O. probe in error
Obvious fuel odor.
Salinity 1.54%, 1.42%, 1.19%

Dup #
MSMSD ☐

Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL + JB

Project Site Name NAS Key West
Project Site Number 70416
B&RE Sample ID S2MW16
Source Location SHOW-2

Total Well Depth:	16.17' BTOC
Well Stickup:	2.30'
Well Casing Size:	2"
Static Water Level:	5.08' BTOC
One Casing Volume:	1.81 gal
Start Purge (hrs.):	1142
End Purge (hrs.):	1220
Total Purge Time (min.):	38
Total Amount Purged (gal.):	5.5
Monitoring Reading:	sensidyne 150 ppm ~~HNu~~ RL 1/28/96
Purge Method:	peristaltic pump
Sample Method:	peristaltic pump; Teflon bailer
Depth Sampled:	~13' ; 5-7' BTOC
Sample Data & Time:	1/28/96 12:20
Sampled By:	Julia Bradley, Rachel Layman
Signature(s):	Rachel M Layman, Julia Bradley

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.
0	6.78	24.4	26.1	257 cloudy	—
*2.5	6.60	22.7	26.0	32	*
3.5	6.88	22.8	25.5	11	-1.19 *
4.5	7.01	22.9	25.9	45	-0.68 *
5.5	7.02	22.8	25.8	2	-0.70

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/L
7.02	22.8	25.8	2	-0.70

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
metals	HNO_3
cyanide	NaOH
pesticides/PCBs	—
herbicides	—

Observations/Notes:
Obvious fuel odor on water level probe after measuring water level and depth of well.
Well stick up measured from top of casing to top of concrete.
Salinity 1.35%
*1-gallon reading not taken - changing DO probe and recalibration. Still reading negative readings after change.

Dup #
MSMSD ☐

Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL + JB

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID S2MW-7
Source Location SWMU-2

Total Well Depth: 12.11' BTOC
Well Stickup: 2.26' Top of pad to TOC
Well Casing Size: 2"
Static Water Level: 4.84' BTOC
One Casing Volume: 1.84 gal
Start Purge (hrs.): 1238
End Purge (hrs.): 1320
Total Purge Time (min.): ~~1320~~ 42' JPB 1-28-96
Total Amount Purged (gal.): 6.0 g
Monitoring Reading: 550 ppm
Purge Method: peristaltic pump
Sample Method: peristaltic pump + teflon bailer
Depth Sampled: ~13 BTOC

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	*mg/l D.O.
0	7.26	23.7	25.8	181 cloudy	-0.97
1	7.22	21.4	24.4	130 clear	-1.20
2	7.24	21.3	24.6	69 clear	-1.10
3	7.18	21.3	24.5	58 clear	-0.87
4	7.23	21.2	24.4	19 clear	-0.95
5.5	7.09	21.4	24.6	23 clear	-1.44
6.0	7.05	21.5	24.7	22 clear	-1.59

Sample Data & Time: 1-28-96 1330

Sampled By: Rachel Layman, Julea Bradley

Signature(s): Julea Bradley, Rachel Layman

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
7.05	21.5	24.7	clear 22	-1.59

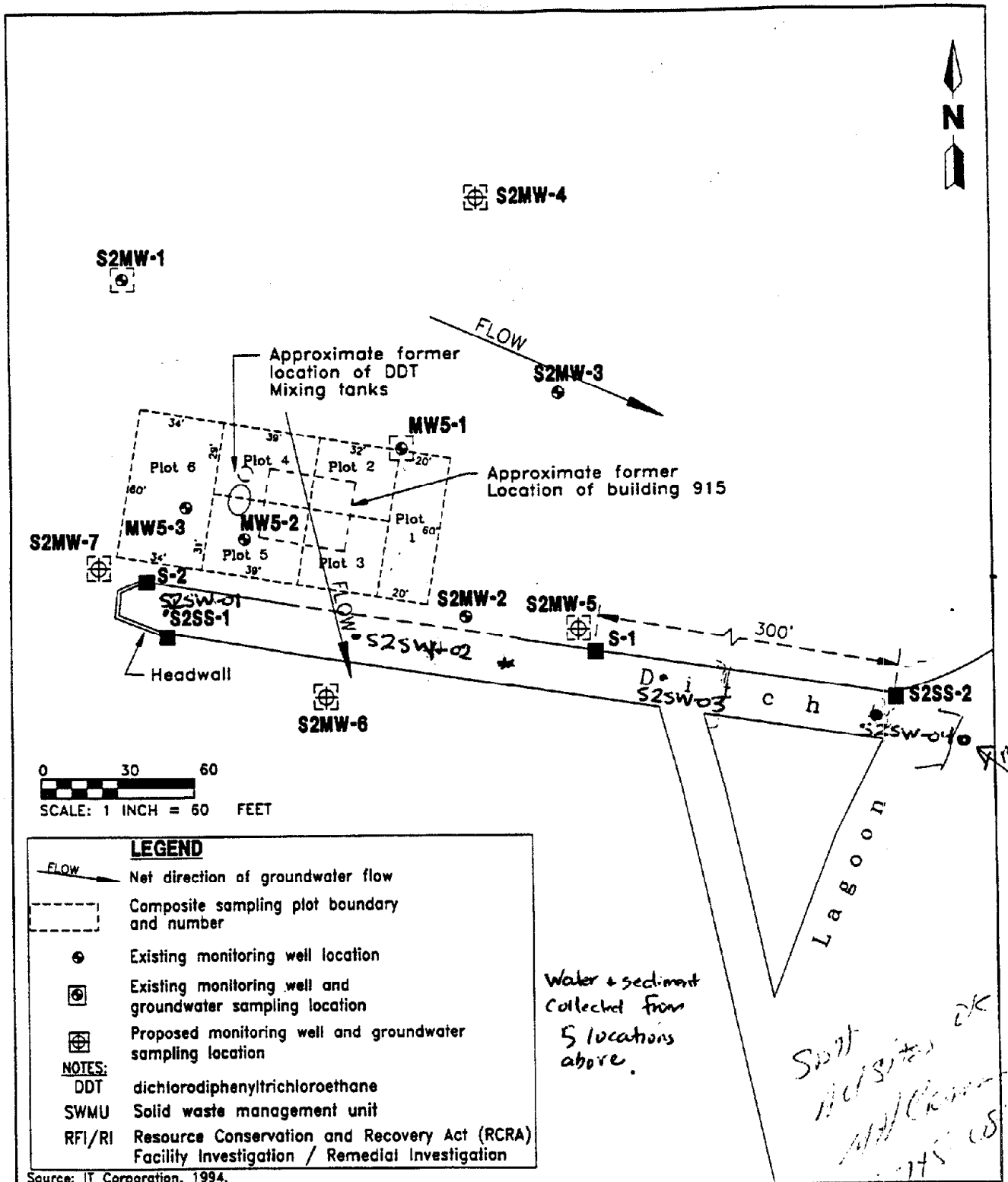
Observations/Notes: * D.O. probe in error.
Obvious fuel odor.
1.45 % salinity
1.28 %

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
metals	HNO_3
cyanide	NaOH
pesticides/PCBs	—
herbicides	—

Dup #
MSMSD ☐

Air Bill # 9230385205
Date Shipped 1/29/96
Time Shipped 1000
Lab GEL
Other



Source: IT Corporation, 1994.

FIGURE 3-6
PROPOSED AND PRE-EXISTING MONITORING WELL LOCATIONS
SWMU NO. 2, BOCA CHICA
DDT MIXING AREA

H:\9560\120100\CCK-NP-NAB\12-05-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S2SW-01

Sample Source or Location SWMU-2

Surface Water Data

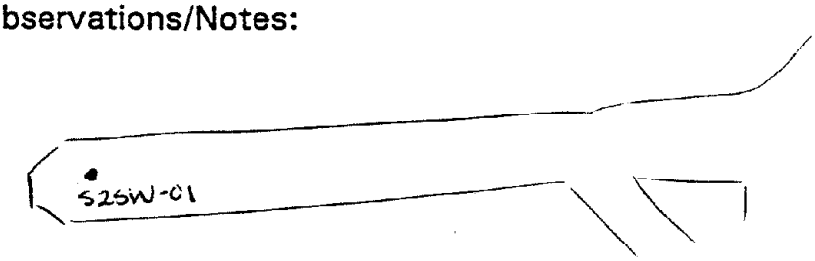
pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)	salinity
7.40	23.8	2.00	clear 70	19.8	1.91%

Sample Date and Time: 1-24-96 1415

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:



Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside toxicity			ESI	1/24/96 1630	9230385091

COC # 3

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S2SW-02

Sample Source or Location SWMU-2

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)
6.50	21.0	2.21	clear -10	15.8

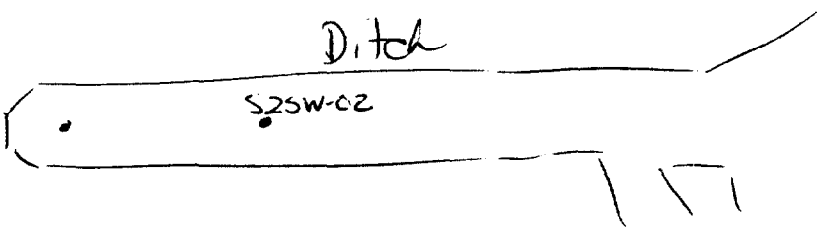
Salinity 0.92%

Sample Date and Time: 1-25-96 0900

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:



water depth 34feet
Water quality taken after sediment sampling for this sample

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside toxicity			ESI	1/25/96 1730	9230385146

COC # 4

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S25W-03

Sample Source or Location SWMU-2

Surface Water Data

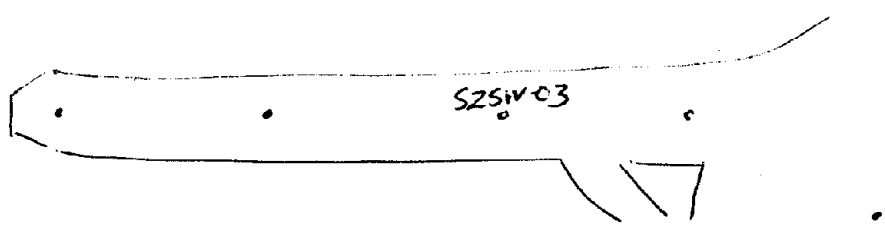
pH	Temp. (°C)	Dissolv. O_2	Color	turbidity	Elect. Conduct.(mS/cm)	Salinity
7.45	21.3	2.28	clear	-10	16.4	0.96%

Sample Date and Time: 1-25-96 0925

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:



Water depth 3.5

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside toxicity			ESI	1/25/96 1730	9230385146

COC # 4

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S25W-04

Sample Source or Location SWMU-2

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Turbidity	Elect. Conduct.(mS/cm)
7.64	21.1	2.35	Clear	~10	16.5

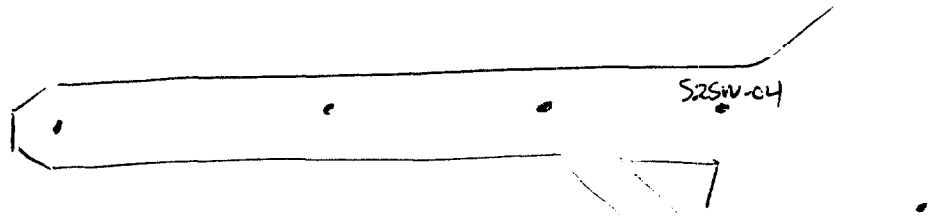
Salinity 0.96%

Sample Date and Time: 1-25-96 1005

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:



Sample depth: 2'
Water depth: 3'

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside toxicity			ESI	1/25/96 1730	9230385146

COC # 4

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S2SW-05

Sample Source or Location SWMU-2

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)
7.81	23.2	7.32	clear/turbid 85	15.0

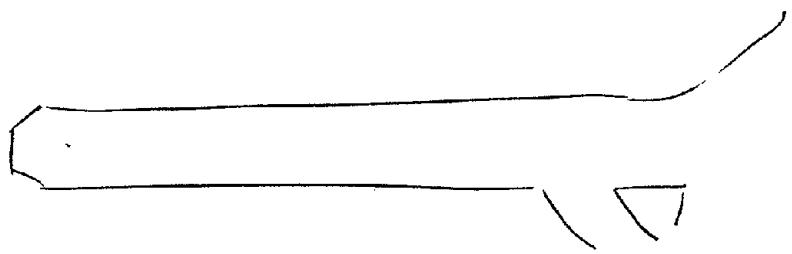
Salinity 0.87%

Sample Date and Time: 1-24-96 1445

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel Layman

Observations/Notes:



Depth of sample: 2' Water depth 6'

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside toxicity			ESI	1/24/96 1630	923 0385091

COC # 3

Brown & Root Environmental

SAMPLE LOG SHEET

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name: NAS Key West

Project Site Number: 7046

HNUS Sample Name: S25W-01

Sample Source or Location: SWMU-2

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Elect. Conduct.(mS/cm)
Not recorded for resample.				

Sample Date and Time: 1-31-96 0950

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layma

Observations/Notes:

S25W-01

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside toxicity			ESI	1/31/96 1430	9230385231

COC # 7

Brown & Root Environmental

SAMPLE LOG SHEET

Page _____ of ____

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S25W-05

Sample Source or Location SWMU-2

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Elect. Conduct.(mS/cm)
Not recorded for resample				

Sample Date and Time: 1-31-96 0940

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes: Resample due to only 80% survival in controls. Need 95%

S25WC5 Resample

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
Silverside	toxicity		ESI	1/31/96 1430	9236385231

COC # 7

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Soil
- [ ] Subsurface Soil
- [x] Sediment
- [ ] Other

Project Site Name NAS Key West

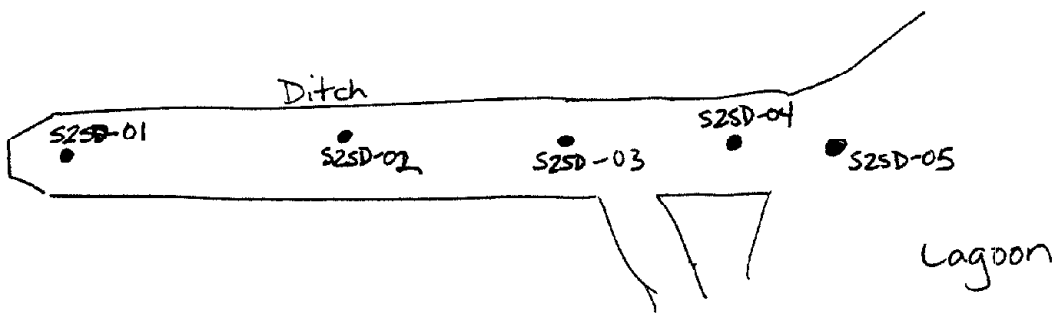
Project Site Number 7046

HNUS Sample Name S2SD-02

Sample Source or Location SWMU-2

Sample Method: stainless steel ponar	Sample Date and Time: 1/25/96 0900
Sample Depth: 2'	Color: drk grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: fine to med sand, some crushed shell, some organic matter
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☑ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☐ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
ES1		

Brown & Root Environmental

SAMPLE LOG SHEET

Page _____ c _

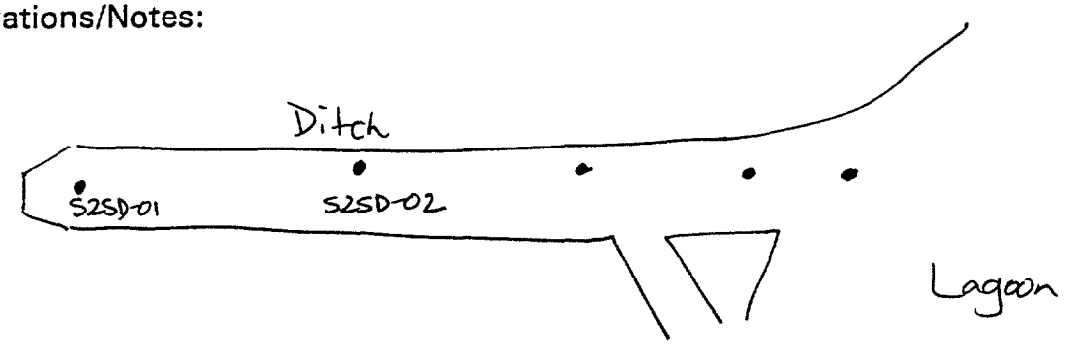
- ☐ Surface Soil
- ☐ Subsurface Soil
- ☑ Sediment
- ☐ Other

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name S2SD-02 1 RJ 1/24/96 Sample Source or Location SWMU-2

Sample Method: stainless steel ~~trowel~~ RJ pour	Sample Date and Time: 1-24-96 1415
Sample Depth: ~1'	Color: dark grey
Sampled By (Print): Rachel Layman Julea Bradley	Sample Description: Silt, some med to fine sand and crushed fine shell. Several leaves in sample
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☑ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
ESI		

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☑ Sediment
- ☐ Other

Project Site Name NAS Key West

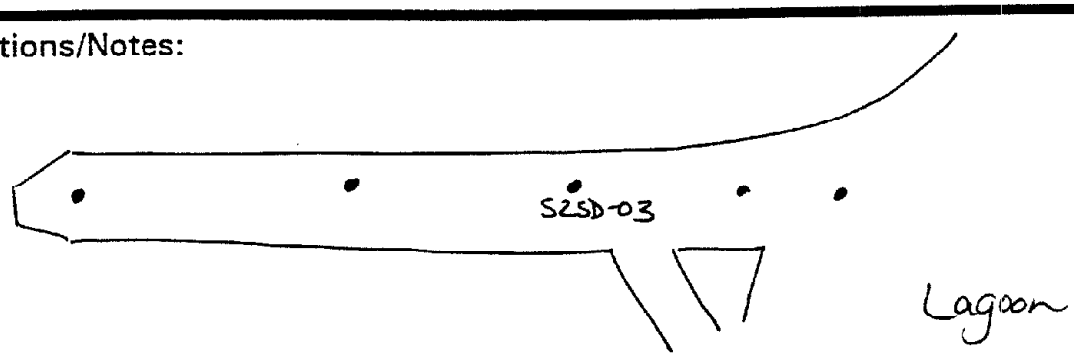
Project Site Number 7046

HNUS Sample Name S2SD-03

Sample Source or Location SWMU-2

Sample Method: stainless steel ponar dredge	Sample Date and Time: 1-25-96 0925
Sample Depth: 1.5'	Color: drk grey
Sampled By (Print): Rachel Layman; Julea Bradley	Sample Description: fine sand, some crushed shells overlaying grey silt, some fine sand
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☑ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
ES1		

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☑ Sediment
- ☐ Other

Project Site Name: NAS Key West

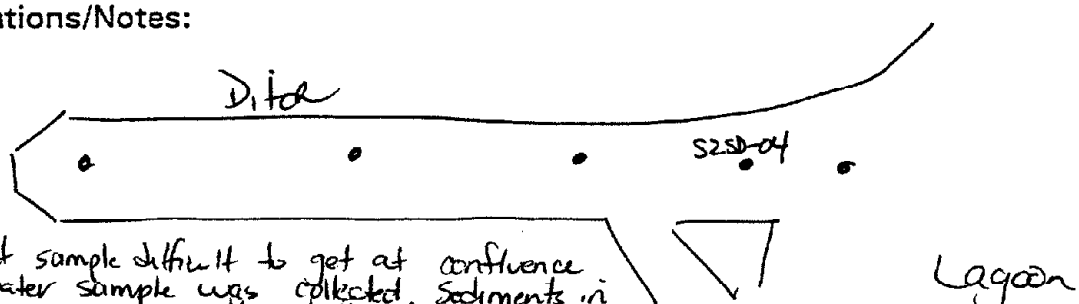
Project Site Number: 7046

HNUS Sample Name: S2SD-04

Sample Source or Location: SWMU-2

Sample Method: Stainless steel ponar dredge	Sample Date and Time: 1-25-96 1005
Sample Depth: 2'	Color: grey
Sampled By (Print): Rachel Layman	Sample Description: silt w/ fine to medium sand
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☑ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☐ Grab

Observations/Notes:



Sediment sample difficult to get at confluence where water sample was collected. Sediments in that area were mostly shell. Sediment sample taken 50' inside opening to dike

Analyses

Analysis	Bottle Lot #
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
ESI		

Brown & Root Environmental

SAMPLE LOG SHEET

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☑ Sediment
- ☐ Other

Project Site Name: NAS Key West

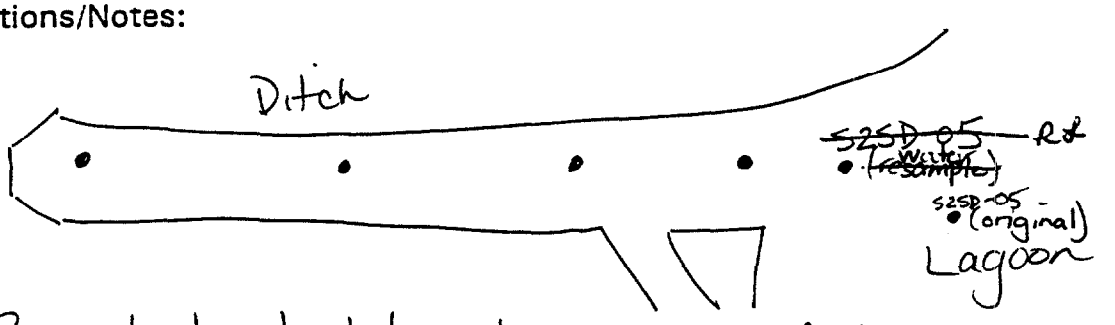
Project Site Number: 7046

HNUS Sample Name: S2SD-05

Sample Source or Location: SWMU-2

Sample Method: stainless steel ponar	Sample Date and Time: 1-24-96 1445
Sample Depth: 2'	Color: dark gray
Sampled By (Print): Rachel Layman; Joka Bradley	Sample Description: silt, some fine sand
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☑ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



~~Resample due to lab controls death~~ RL (surface water resampled)

Analyses

Analysis	Bottle Lot #
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
ESI		

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West

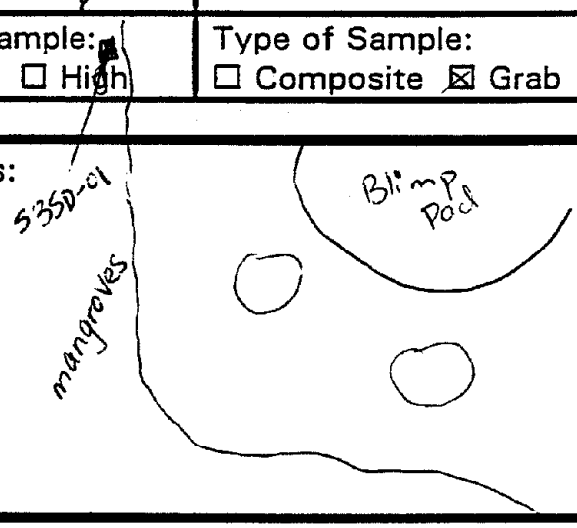
Project Site Number 7046

HNUS Sample Name 535D-01

Sample Source or Location SWMU-3

Sample Method: petite ponar	Sample Date and Time: 1/25/96 1215
Sample Depth: 1'	Color: lt grey
Sampled By (Print): Rachel Layman, Julee Bradley	Sample Description: fine to med sand; some organic matter
Sampled By (Signatures): Rachel Layman, Julee Bradley	FID Reading of Sample (If appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



~~Collected~~ RL, [illegible]

Analyses

Analysis	Bottle Lot #
TAL metals	~~HNO3~~ ✓
cyanide	~~NaOH~~ 1/25/96 ✓
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/25/96 1730	9230385150
ESI	1/25/96 1730	9230385146

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

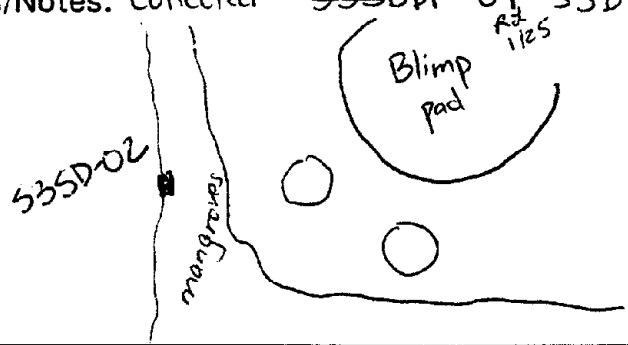
- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name S35D-02 Sample Source or Location SWMU-3

Sample Method: petite ponar	Sample Date and Time: 1/25/96 1240
Sample Depth: 10"	Color: Grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: Silt (organics), some fine crushed shell
Sampled By (Signatures): Rachel Layman, Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes: Collected ~~S3SDDP-01~~ S3DPSD-01 at 1125



Analyses

Analysis	Bottle Lot #
TAL metals	~~HNO3~~ ✓
cyanide	~~NaOH~~ ✓
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/25/96 1730	9230385150
ESI	1/25/96 1730	9230385146

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS KeyWest Project Site Number 7046

HNUS Sample Name S3DPSD-01 Sample Source or Location SWMU-3

Sample Method:	Sample Date and Time: 1/25/96 1240
Sample Depth:	Color:
Sampled By (Print): Rachel Layman	Sample Description:
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate):
Concentration of Sample: ☐ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☐ Grab

Observations/Notes:

Duplicate of S3SD-02 sample.
Refer to S3SD-02 Sample Log Sheet.

Analyses

Analysis	Bottle Lot #

Shipment

Laboratory	Ship Date/Time	Airbill #

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of ___

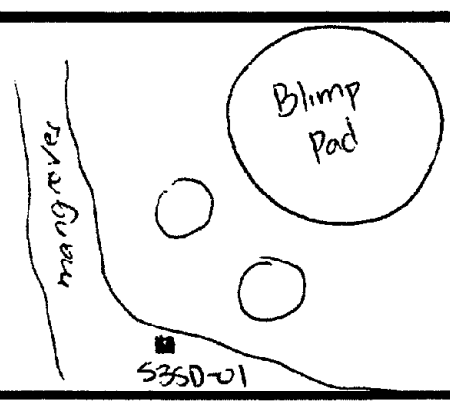
- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name 535D-03 Sample Source or Location SWMU-3

Sample Method: stainless steel trowel	Sample Date and Time: 1/25/96 1420
Sample Depth: 3-4"	Color: grey
Sampled By (Print): Rachel Layman	Sample Description: fine to medium crushed shell and silt
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
TAL metals	~~HNO3~~ 1/25/96 ✓
cyanide	~~NaOH~~ 1/25/96 ✓
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/25/96 1730	9230385150
ESI	1/25/96 1730	9230385146

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of

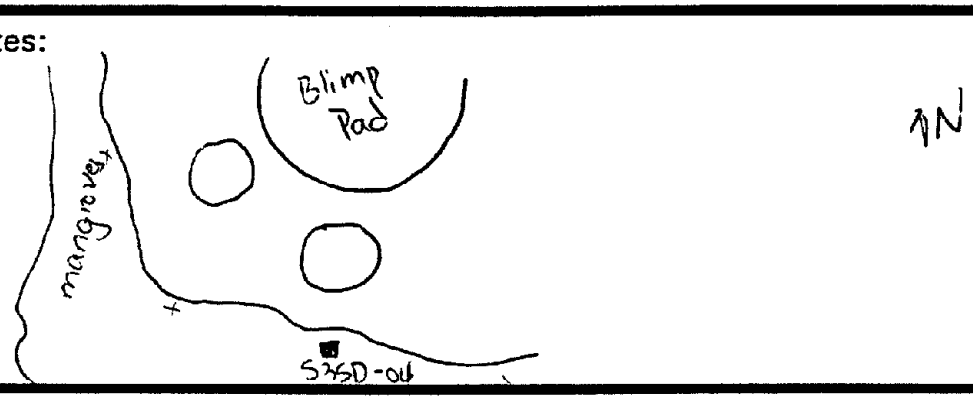
- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name 535D-04 Sample Source or Location SWMU-3

Sample Method: stainless steel trowel	Sample Date and Time: 1/25/96 1430
Sample Depth: 3"	Color: grey
Sampled By (Print): Julea Bradley	Sample Description: In mangrove root mass Fine to med crushed shell, silt, trace clay
Sampled By (Signatures): Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
TAL metals	~~HAS~~ 1/25/96 ✓
cyanide	~~HAO~~ 1/25/96 ✓
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/25/96 1730	9230385150
ESI	1/25/96 1730	9230385146

Brown & Root Environmental

SAMPLE LOG SHEET

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name: NAS Key West

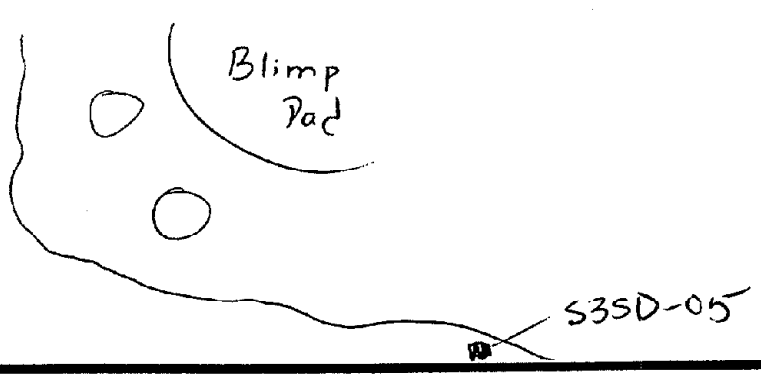
Project Site Number: 7046

HNUS Sample Name: S35D-05

Sample Source or Location: SWMU-3

Sample Method: stainless steel trowel	Sample Date and Time: 1/25/96 1515
Sample Depth: 4"	Color: grey
Sampled By (Print): Rachel Layman	Sample Description: In mangrove root mass; Med to fine sand w/ trace lt colored clayey silt
Sampled By (Signatures): Rachel Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
TAL metals	✓
cyanide	✓
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/25/96 1730	9230385150
ESI	1/25/96 1730	9230385146

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL

Project Site Name: NAS Key West
Project Site Number: 7046
B&RE Sample ID: 53MW-6
Source Location: SWMU-3

Total Well Depth: 16.31' BTOC
Well Stickup: 2.50' Top of pad to TOC
Well Casing Size: 2"
Static Water Level: 5.69' BTOC
One Casing Volume: 1.73 gallons
Start Purge (hrs.): 1720
End Purge (hrs.): 1728
Total Purge Time (min.): 8 min
Total Amount Purged (gal.): 5.5 gal
Monitoring Reading: 150 ppm Sensidyne
Purge Method: peristaltic pump
Sample Method: bailer/peristaltic pump
Depth Sampled: 6.7' BTOC; 13' BTOC
Sample Data & Time: 1/31/96 1730 45 RL 1/31/96
Sampled By: Rachel Layman
Signature(s): Rachel McLayman

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/l D.O.
0	6.75	38.1	26.0	23	-0.94
1	6.93	38.8	25.7	5	-1.47
2	6.94	39.3	25.6	15	-1.05
3	7.11	38.8	25.5	5	-1.58
4	6.94	39.8	25.5	2	-1.48
~~5~~			~~25.4~~		
RL 1/31 5.5	6.94	39.9	25.4	5	-1.40

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.94	39.9	25.4	5	-1.40

Observations/Notes: * D.O. meter in error.
Salinity: 2.42%, 2.49%, 2.52%, 2.49%, 2.56%, 2.56%, 2.56%

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX VOCs	HCl
App IX SVOCs	–

Dup #
MSMSD ☑
Air Bill # 9230386616
Date Shipped 2/1/96
Time Shipped 1630
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL

Project Site Name NAS Key West
Project Site Number 70416
B&RE Sample ID S3MW-2
Source Location SWMU-3

Total Well Depth: 11.56' BTOC
Well Stickup: ~~1.46' top of pad to TOC~~
Well Casing Size: 2"
Static Water Level: 2.61' BTOC
One Casing Volume: 1.416 gal
Start Purge (hrs.): 0711
End Purge (hrs.): 0740
Total Purge Time (min.): 29
Total Amount Purged (gal.): 6
Monitoring Reading: 150 ppm Sensidyne
Purge Method: peristaltic pump
Sample Method: bailer / peristaltic p.
Depth Sampled: 2-3' BTOC / ~9' BTOC

Purge Data

(gallons) Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	*mg/l D.O.
0	6.47	4.93	23.6	clear -10	-1.60
1	6.59	4.42	24.5	clear -10	-2.07
2	6.57	4.68	24.9	clear -10	-1.00
3	6.55	6.15	25.2	clear -10	-1.88
4.5	6.57	7.17	25.1	clear -10	-1.42
5.5	6.56	7.41	25.2	clear -10	-1.69
6	6.56	7.67	25.2	clear -10	-1.50

Sample Data & Time: 2/1/96 0745

Sampled By: Rachel Layman

Signature(s): Rachel Layman

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.56	7.67	25.2	clear -10	-1.50

Observations/Notes: * D.O. meter in error
Salinity: 0.25%, 0.22%, 0.24%, 0.32%, 0.38%, 0.40%, 0.41%

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX VOCs	HCl
App IX SVOCs	-

Dup #
MSMSD ☐
Air Bill # 9230381666 16
Date Shipped 2/1/96
Time Shipped 1630
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID S3MW-1
Source Location SWMU-3

Total Well Depth:	11.59' BTOC
Well Stickup:	-
Well Casing Size:	2"
Static Water Level:	1.15' BTOC
One Casing Volume:	1.70 gal
Start Purge (hrs.):	0806
End Purge (hrs.):	0838
Total Purge Time (min.):	32
Total Amount Purged (gal.):	8
Monitoring Reading:	50 ppm Sensidyne
Purge Method:	peristaltic pump
Sample Method:	peristaltic pump & teflon bailer
Depth Sampled:	~3 BTOC
Sample Data & Time:	2/1/96 0840
Sampled By:	Rachel Layman
Signature(s):	Rachel Layman

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L * D.O.
0	6.90	21.6	25.3	clear -10	-1.36
1	6.87	20.6	24.4	clear -10	-1.24
2	6.90	20.6	24.4	clear -10	-1.08
3	6.81	25.3	25.9	cloudy 999	-1.16
4	6.84	23.4	25.9	cloudy 866	-0.80
5	6.86	21.2	25.2	cloudy 229	-1.06
6	6.87	21.3	25.2	clearer 185	-1.60
7	6.89	21.3	25.1	clearer 98	-1.64

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/L
6.89	21.3	25.1	98	-1.64

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX VOCs	HCl
App IX SVOCs	—

Observations/Notes: * D.O. meter in error.
Water got turbid after 3 gallons
Salinity: 1.30%, 1.23%, 1.24%, 1.55%, 1.42, 1.28, 1.28, 1.25%

Dup #
MSMSD ☐

Air Bill # 9230386616
Date Shipped 2/1/96
Time Shipped 1630
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL

Project Site Name: NAS Key West
Project Site Number: 7046
B&RE Sample ID: S3MW-8
Source Location: SWMU-3

Total Well Depth:	16.32' BTOC
Well Stickup:	~~4.96'~~ 2.15' top pad to TOC
Well Casing Size:	2"
Static Water Level:	4.96' BTOC
One Casing Volume:	1.85 gal
Start Purge (hrs.):	0855
End Purge (hrs.):	0930
Total Purge Time (min.):	35
Total Amount Purged (gal.):	5.5
Monitoring Reading:	3000 ppm Sensidyne
Purge Method:	peristaltic pump
Sample Method:	bailer / peristaltic pump
Depth Sampled:	5-7' BTOC / ~13' BTOC
Sample Data & Time:	2/1/96 0940
Sampled By:	Rachel Layman
Signature(s):	Rachel Layman

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L * D.O.
0	6.57	28.7	25.6	clear -10	-1.49
1	6.55	27.0	25.6	clear -10	-1.52
2	6.55	26.8	25.7	clear -10	-1.99
3	6.55	26.5	25.8	clear -10	-1.60
4	6.55	26.6	26.2	clear -10	-1.33
5.5	6.55	26.6	26.1	clear -10	-1.57

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/L
6.55	26.6	26.2	clear -10	-1.57

Observations/Notes: * D.O. meter in error
Salinity: 1.78, 1.68, 1.66%, 1.64%

Type of Sample

☐ Low Concentration
☒ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX VOCs	HCl
App IX SVOCs	—

Dup #
MSMSD ☐

Air Bill # 9230386616
Date Shipped 2/1/96
Time Shipped 1630
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID 53MW-9
Source Location SWMU-3

Total Well Depth:	16.12' BTOC
Well Stickup:	2.37' Top pad to TOC
Well Casing Size:	2"
Static Water Level:	5.13' BTOC
One Casing Volume:	1.79 gal
Start Purge (hrs.):	0949
End Purge (hrs.):	1015
Total Purge Time (min.):	26
Total Amount Purged (gal.):	5.5
Monitoring Reading:	40 ppm Sensidyne
Purge Method:	Teflon bailer Δ
Sample Method:	Teflon bailer Δ
Depth Sampled:	5-8' BTOC
Sample Data & Time:	2/1/96 1125
Sampled By:	Rachel Layman
Signature(s):	Rachel M Layman

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/l D.O.
0	7.30	19.2	23.2	clear -10	-0.89
1	7.10	20.6	24.2	cloudy 999	-0.95
2	7.02	23.1	25.1	cloudy 999	-1.32
3	6.99	22.4	24.7	cloudy 999	-1.61
4	6.99	22.4	24.8	cloudy 999	-1.52
5.5	6.99	23.0	24.6	cloudy 999	-1.33

Sample Data 1125

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
7.32 ~~6.99~~ rf	21.1 ~~20.0~~ rf	24.0 ~~24.6~~ rf	433 ~~999~~ rf	-1.84 ~~-1.33~~ rf

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX VOCs	HCl
App IX SVOCs	—

Observations/Notes: * D.O. probe in error

Δ Peristaltic pump broke so had to use bailer. Used clean (new) bailer when sampled. Not possible to get a low turbidity with bailing. Let particulates settle some before sampling. All other parameters within required stabilization criteria.

Salinity: 1.15%, 1.23%, 1.41%, 1.36%, 1.36%, 1.40%, 1.27%

Dup #
MSMSD ☐

Air Bill # 9230386616
Date Shipped 2/1/96
Time Shipped 1630
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Page 1 of 1

By RL

Project Site Name: NAS Key West
Project Site Number: 7046
B&RE Sample ID: S3MW-7
Source Location: SWMU-3

Total Well Depth: 13.02' BTOC
Well Stickup: -0.36' topped to TOC
Well Casing Size: 2"
Static Water Level: 3.21' BTOC
One Casing Volume: 1.6 gal
Start Purge (hrs.): 1140
End Purge (hrs.): 1235
Total Purge Time (min.): 45
Total Amount Purged (gal.): 9.0
Monitoring Reading: 40 ppm Sensidyne
Purge Method: teflon bailer
Sample Method: bailer
Depth Sampled: 3-6' BTOC

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	*mg/l D.O.
0	7.45	11.1	25.5	cloudy 426	-1.06
1	7.13	24.5	26.6	cloudy 999	-1.20
2	7.06	27.4	26.7	cloudy 999	-1.10
3	7.03	28.1	26.9	cloudy 999	-1.28
4	6.98	30.6	27.1	cloudy 999	-1.09
5.5	6.91	34.8	27.3	cloudy 999	-1.05
6.5	6.95	31.9	27.5	cloudy 999	-1.17
7.0	6.87	37.9	27.6	cloudy 971	-0.89
8.0	6.92	32.5	27.4	cloudy 999	-1.15
9.0	6.87	37.3	27.7	cloudy 874	-0.70

Sample Data & Time: 2/1/96 1325
Sampled By: Rachel Layman
Signature(s): Rachel Layman

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
7.37	13.5	25.5	482	-0.14

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
Appix VOCs	HCl
Appix SVOCs	—

Observations/Notes: * D.O. probe in error
Salinity: 0.63%; 1.50%; 1.70%; 1.75%; 1.91%; 2.22%; 2.00%; 2.42%; 2.04%; 2.38%
Due to difficulty in stabilization, and the fact that 5 well volumes had been purged, sampling began after well water level recovered and particulates settled.

Dup # S3DPGW-01
MSMSD ☐
Air Bill # 9236386616
Date Shipped 2/1/96
Time Shipped 1630
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root
Environmental

☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID S3DPGW-01
Source Location SWMU-9/3

Total Well Depth:	
Well Stickup:	
Well Casing Size:	
Static Water Level:	
One Casing Volume:	
Start Purge (hrs.):	
End Purge (hrs.):	
Total Purge Time (min.):	
Total Amount Purged (gal.):	
Monitoring Reading:	
Purge Method:	
Sample Method:	
Depth Sampled:	

Purge Data

Volume	pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.

Sample Date & Time: 2/1/96 1325

Sampled By: Rachel Layman

Signature(s): Rachel Layman

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.

Type of Sample
- ☐ Low Concentration
- ☐ High Concentration
- ☐ Grab
- ☐ Composite
- ☐ Grab - Composite

Analysis:	Preservative:

Observations/Notes:

Duplicate to S3MW-7 sample
Refer to S3MW-7 Sample Log Sheet

Dup #
MSMSD ☐

Air Bill #
Date Shipped
Time Shipped
Lab
Other

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☒ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name S3SW-01 Sample Source or Location SWMU-3

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Elect. Conduct.(mS/cm)
7.51	22.8	2.10 mg/l	clear -10	12.6

Salinity 0.72%

Sample Date and Time: 1/25/96 1215

Sampled By (Print): Rachel Layman, Julia Bradley

Sampled By (Signatures): Rachel M Layman, Julia Bradley

Observations/Notes: Collected ~~S3SWDP-01~~ S3DPSW-01 RL 1/25
See S3SD-01 map
water depth 1'
sample depth 8'

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
TAL metals	HNO_3	✓	GEL	1/25/96 1730	9230385150
cyanide	NaOH	✓	ESI	1/25/96 1730	9230385146
Silverside toxicity					

COC # 11-4

Brown & Root Environmental

SAMPLE LOG SHEET

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name S3DPSW-01 Sample Source or Location SWMU-3

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Elect. Conduct.(mS/cm)

Sample Date and Time: 1/25/96 1215

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:

Duplicate of S3SW-01 sample.
Refer to S3SW-01 Sample Log Sheet.

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #

COC #

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☒ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West
Project Site Number 7046
HNUS Sample Name S35W-02
Sample Source or Location SWMU-3

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Turbidity	Elect. Conduct.(mS/cm)
7.58	24.9	3.33 mg/l	clear	-10	12.6

Salinity 0.72%

Sample Date and Time: 1/25/96 1240

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel Layman, Julea Bradley

Observations/Notes: See S35D-02 map

water depth 8-10"
sample depth 6"

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
TAL metals	HNO_3	✓	GEL	1/25/96 1730	9230385150
cyanide	NaOH	✓	ESI	1/25/96 1730	9230385146
silverside toxicity					

COC # 11; 4

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☒ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West
Project Site Number 7046
HNUS Sample Name S35W-03
Sample Source or Location SWMU-3

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Turbidity	Elect. Conduct.(mS/cm)	Salinity
8.16	32.7	7.58 mg/l	clear	-10	14.6	0.84%

Sample Date and Time: 1/25/96 1420

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel Layman, Julea Bradley

Observations/Notes: See S35D-03 map

water depth 3-4"
sample depth 2-3"

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
TAL metals	HNO_3	✓	GEL	1/25/96 1730	9230385150
cyanide	NaOH	✓	ESI	1/25/96 1730	9230385146
Silverside toxicity					

COC # 11,4

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name S3SW-04 Sample Source or Location SWMU-3

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)	Salinity
7.56	24.3	3.32 mg/l	clear -10	12.7	0.73%

Sample Date and Time: 1/25/96 1430

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel Layman, Julea Bradley

Observations/Notes: See S3SD-04 map.

water depth 3"
sample depth 2"

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
TAL metals	HNO_3	✓	GEL	1/25/96 1730	9230385150
cyanide	HCl	✓	ESI	1/25/96 1730	9230385146
silverside toxicity					

COC # 11;4

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name S3SW-05

Sample Source or Location SWMU-3

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)	Salinity
7.21	23.2	2.41 mg/l	clear -10	~~0.71~~ 12.4 RZ	0.71%

Sample Date and Time: 1/25/96 1515

Sampled By (Print): Rachel Layman, Julea Bradley

Sampled By (Signatures): Rachel Layman, Julea Bradley

Observations/Notes: See S3SD-05 map.

Water depth 4"
Sample depth 3"

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
TAL metals	HNO_3	✓	GEL	1/25/96 1730	9230385150
cyanide	NaOH	✓	ESI	1/25/96 1730	9230385146
Silverside toxicity					

COC # 11,4

SUMMARY OF SWMU-9 MONITORING WELL WATER QUALITY DATA
January 18-19, 1996

Monitoring Well	Temperature (°C)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
S9MW-3	23.6	6.95	1.37	1.47	24
S9MW-6	25.8	6.73	1.07	2.04	2
S9MW-9	24.5	6.95	2.47	1.85	44
S9MW-15	23.4	6.86	o.807	2.01	32
S9MW-17	28.5	6.92	0.562	2.01	2
S9MW-19D	27.7	7.16	5.67	2.57	7
S9MW-21	25.3	6.54	14.4	2.07	2
S9MW-24	24.8	7.00	6.98	3.11	97

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name Naval Air Station, Key West
Project Site Number 7046
B&RE Sample ID 59MW-3
Source Location SWMU-9 (Jet Engine Test Cell)

Total Well Depth:	10.31 ft
Well Stickup:	flush
Well Casing Size:	2"
Static Water Level:	1.55 ft
One Casing Volume:	1.43 g
Start Purge (hrs.):	1345
End Purge (hrs.):	1445
Total Purge Time (min.):	60
Total Amount Purged (gal.):	6
Monitoring Reading:	0ppm 11.7ev HNU
Purge Method:	peristaltic pump
Sample Method:	bailer and peristaltic 0.1l/min
Depth Sampled:	3-4', 7'
Sample Data & Time:	1/18/96 0915
Sampled By:	Rachel Layman, Julea Bradley
Signature(s):	Rachel Layman, Julea Bradley

Purge Data

1-17-95 (gallons) Volume	** pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/l D.O.
0	~~6.69~~	1.65	25.8	clear -10	* -1.21
1.5	~~7.09~~	1.66	25.1	clear -10	* -1.55
3.0	~~7.09~~	1.66	25.2	clear -10	* 1.76
4.5	~~7.04~~	1.64	25.1	clear -10	* 1.68
1/18/96					
0	6.81	1.38	24.5	clear 73	1.96
1	6.98	1.37	24.0	clear 12	1.94
1.5	NA	NA	NA	clear 6	NA

Sample Data

1-18-96 pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.95	1.37	23.6	clear 24 sec above	1.47

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	–
pesticides / PCBs	–
herbicides	–
TAL metals	HNO_3
cyanide	NaOH

Observations/Notes:
* Negative DO reading on meter. Purged at rate of ~0.5l/min.
** RL left cap on pH probe. Will obtain several readings before sampling to verify stabilization.
*
Water levels at 1.54' BTOC prior to sampling

Dup #	
MSMSD	☐
Air Bill #	9230386642
Date Shipped	1/18/96
Time Shipped	1315
Lab	GEL
Other	

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name Naval Air Station, Key West
Project Site Number 7046
B&RE Sample ID 9MW-9
Source Location SWMU-9 (Jet Engine Test Cell)

Total Well Depth:	10.62' BTOC
Well Stickup:	flush
Well Casing Size:	2"
Static Water Level:	1.27' BTOC
One Casing Volume:	1.52 g
Start Purge (hrs.):	15:05
End Purge (hrs.):	15:45
Total Purge Time (min.):	40
Total Amount Purged (gal.):	5 g
Monitoring Reading:	0 ppm 11.7 ev HNu
Purge Method:	Peristaltic pump
Sample Method:	Teflon bailer / peristaltic pump
Depth Sampled:	3-4'
Sample Data & Time:	1-18-96 1050
Sampled By:	Rachel Layman, Julea Bradley
Signature(s):	Rachel M Layman, Julea Bradley

Purge Data

(1-17-96) Gallons Volume	** pH	(mS/cm) S.C.	Temp. (°C)	Color & Turbidity	(mg/l) * D.O.
0	~~7.18~~	1.99	24.2	clear ~~10~~	-1.36
1	~~7.14~~	2.68	24.5	clear -10	-0.52
2	~~7.10~~	2.78	24.5	clear -10	+1.070
3	~~7.06~~	2.80	24.5	clear -10	-1.040
4	~~7.04~~	2.77	24.5	clear -10	-1.43
1-18-96,	1010				
0	6.91	1.70	23.5	cloudy 25	2.14
1	6.87	2.41	23.7	7	2.00
2	6.83	2.45	23.8	31	2.51
3	6.87	2.40	24.2	30	

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.95	2.47	24.5	cloudy 44 See below	1.85

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	—
pesticides/PCBs	—
herbicides	—
TAL metals	HNO_3
cyanide	NaOH

Observations/Notes:

* DO meter reading negative readings

** RL left cap on pH probe. Will obtain several readings before sampling to verify stabilization

Turbidity would not drop below 30 while completing purging.

* a lot of fine particulates were observed in samples that were taken by bailer

Dup #
MSMSD ☐

Air Bill # 9230386642
Date Shipped 1/18/96
Time Shipped 1315
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Page 1 of 1

By RL, JB

Project Site Name NAS Key West
Project Site Number 7046
B&RE Sample ID S9MW-6
Source Location SWMU-9

Total Well Depth:	10.65' BTOC
Well Stickup:	flush mount
Well Casing Size:	2"
Static Water Level:	1.88' BTOC
One Casing Volume:	1.42 gallons
Start Purge (hrs.):	1605
End Purge (hrs.):	1650
Total Purge Time (min.):	45'
Total Amount Purged (gal.):	5
Monitoring Reading:	70 ppm 11.7ev HNu
Purge Method:	peristaltic pump
Sample Method:	Teflon bailer & peristaltic pump
Depth Sampled:	3-4'
Sample Data & Time:	1-18-96 1145
Sampled By:	Rachel Layman, Julia Bradley
Signature(s):	Rachel M Layman, Julia Bradley

Purge Data (1-18-96)

(gallons) Volume	pH 7.75 JPB	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.*
0	~~6.49~~ 7.77 JPB	1.28	26.7	white + turbid 999	-1.19
1	7.88	1.25	26.7	clear -10	-0.80
2	7.87	1.23	26.8	clear -10	~~-1.23~~
3	7.92	1.22	26.7	clear -10	-1.54
4	7.91	1.23	26.8	clear -10	-1.20
5	7.91	1.23	26.7	clear -10	-1.25
✓ JPB					

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.73	1.07	25.8	clear 2	2.04

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
Appix volatiles	HCl
App IX semivolatiles	—
pesticides / PCBs	—
herbicides	—
TAL metals	HNO_3
cyanide	NaOH

Observations/Notes:
* DO meter reading negative readings
* water level 1.9' prior to sampling

Dup #
MSMSD ☐

Air Bill # 9230386642
Date Shipped 1/18/96
Time Shipped 1315
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name Naval Air Station, Key West
Project Site Number 7046
B&RE Sample ID 59MW-17
Source Location SWMU-9 (Jet Engine Test

Total Well Depth:	10.48' BTOC
Well Stickup:	Flush mount
Well Casing Size:	2"
Static Water Level:	1.94'
One Casing Volume:	1.39 gal
Start Purge (hrs.):	1700
End Purge (hrs.):	1743
Total Purge Time (min.):	43
Total Amount Purged (gal.):	5
Monitoring Reading:	6.5 ppm 11.7ev HNu
Purge Method:	peristaltic pump
Sample Method:	teflon bailer peristaltic pump
Depth Sampled:	3-9' / 9' metals
Sample Data & Time:	1-18-96 1235
Sampled By:	Rachel Layman, Julee Bradley
Signature(s):	Rachel Layman, Julee Bradley

Type of Sample

☑ Low Concentration
☐ High Concentration
☑ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	–
Pesticides / PCBs	–
Herbicides	–
TAL metals	HNO_3
cyanide	NaOH

(1-17-96)

Purge Data

(gallons) Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.*
0	7.94	0.653	28.8	white 999	-1.38
1	7.99	0.643	28.3	cloudy 185 ~~185~~	-1.49
2	8.02	0.639	28.0	clear -10	-0.40
3	8.03	0.647	27.8	clear 44	-0.53
4	8.05	0.642	26.7	clear -10	-0.68
5	8.01	0.650	27.7	clear -10	-0.69

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/L
6.92	0.562	28.5	clear, suspension 2	2.01

Observations/Notes:

* DO meter reading negative readings
* initial sample had several large clear thick clumps ~~of product~~ floating on sample. RL 1/17/96
* 1-18-96, water level 1.95'
* Sample was clear but had suspended material suspended throughout.

Dup #	59DPGW-01
MSMSD	☐
Air Bill #	9230386642
Date Shipped	1/18/96
Time Shipped	1315
Lab	GEL
Other	

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name Naval Air Station Key West
Project Site Number 7046
B&RE Sample ID S9DPGW-01
Source Location SWMU-9

Total Well Depth:	
Well Stickup:	
Well Casing Size:	
Static Water Level:	
One Casing Volume:	
Start Purge (hrs.):	
End Purge (hrs.):	
Total Purge Time (min.):	
Total Amount Purged (gal.):	
Monitoring Reading:	
Purge Method:	
Sample Method:	
Depth Sampled:	
Sample Date & Time: 1-18-96 1235	
Sampled By: Rachel Layma	
Signature(s): Rachel Layma	

Purge Data

Volume	pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.

Type of Sample

- ☐ Low Concentration
- ☐ High Concentration
- ☐ Grab
- ☐ Composite
- ☐ Grab - Composite

Analysis:	Preservative:

Observations/Notes:

Duplicate to S9MW-17 sample. Refer to S9MW-17 Sample Log Sheet.

Dup #
MSMSD ☐

Air Bill #
Date Shipped
Time Shipped
Lab
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name: Naval Air Station
Project Site Number: 7046
B&RE Sample ID: S9MW-21
Source Location: SWMU-9 (Jet Engine Test Cell)

Total Well Depth: 9.76' BTOC
Well Stickup: flush mount
Well Casing Size: 2"
Static Water Level: 1.24' BTOC
One Casing Volume: 1.38 gal
Start Purge (hrs.): 1428
End Purge (hrs.): 1455
Total Purge Time (min.): ~~27~~ 27'
Total Amount Purged (gal.): 3.25 gal
Monitoring Reading: 0 ppm 11.7 ev HNU
Purge Method: Peristaltic pump
Sample Method: Teflon Bailer & Peristaltic pump
Depth Sampled: 3-4', 6'
Sample Data & Time: 1-18-96 1515
Sampled By: Rachel Layman, Julea Bradley
Signature(s): Rachel Layman, Julea Bradley

1/18/96 — Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/l D.O.
0	6.54	14.2	26.4	cloudy 39	3.76
1	6.63	14.3	25.8	clear 2	3.40
2	6.56	14.5	25.4	clear 2	3.29
3	6.53	14.8	25.6	clear 3	2.87

Sample Data

pH	S.C.	Temp. (°C) ~~25.3~~	Color & Turbidity	D.O.
6.54	14.4	25.3	clear -2	2.07

Observations/Notes:
* New lock placed on well.

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	–
Pesticides / PCBs	–
Herbicides	–
TAL metals	HNO_3
Cyanide	NaOH

Dup #
MSMSD ☑
Air Bill # 9230385054
Date Shipped 1/19/96
Time Shipped 330
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL and JP

Project Site Name: Naval Air Station, Key West
Project Site Number: 7046
B&RE Sample ID: S9 MW-4
Source Location: SWMU-9 (Jet Engine Test Cell)

Total Well Depth:	10.81'
Well Stickup:	flush
Well Casing Size:	2"
Static Water Level:	1.80'
One Casing Volume:	1.47 gal
Start Purge (hrs.):	1520
End Purge (hrs.):	1633
Total Purge Time (min.):	73'
Total Amount Purged (gal.):	4.5 gal
Monitoring Reading:	200ppm 11.7ev HNu
Purge Method:	peristaltic pump
Sample Method:	teflon bailer / peristaltic pump
Depth Sampled:	3-4'

Purge Data

(gallons) Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.
0	6.57	1.03	26.5	clear *sheen/21	1.65
1	6.43	0.848	26.2	clear * " 25	2.45
2	6.56	0.856	25.6	clear * " 30	2.37
3	6.53	0.855	25.4	clear * " 26	2.42
4	6.45	0.860	25.4	clear * " 19	2.57

Sample Data & Time: 1-18-96 **

Sampled By: Rachel Layman, Julea Bradley

Signature(s): Julea Bradley

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	–
Pesticides / PCBs	–
Herbicides	–
AL metals	HNO_3
Cyanide	NaOH

Observations/Notes:

well cap loose. Obvious contamination on water level tape. strong odor.

* Purge water clear with black particulates suspended throughout.
* Sheen observed on surface of purge water in container.
* Free product observed at top of first sample volume
* After 25 minute 0.04 ft of free product had collected at top of bailer.
* new lock and cap placed on well

Dup #
MSMSD ☐
Air Bill #
Date Shipped
Time Shipped
Lab
Other

** Not sampled due to presence of free product AL 1/18/96

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL and JB

Project Site Name Naval Air Station Key West
Project Site Number 7046
B&RE Sample ID S9MW-15
Source Location SWMU-9 (Jet Engine Test Cell)

Total Well Depth:	10.65'
Well Stickup:	flush
Well Casing Size:	2"
Static Water Level:	2.7'
One Casing Volume:	1.30 gallons
Start Purge (hrs.):	1655
End Purge (hrs.):	1735
Total Purge Time (min.):	40'
Total Amount Purged (gal.):	4 gal
Monitoring Reading:	5 ppm 11.7 ev HNU
Purge Method:	peristaltic pump
Sample Method:	Teflon bailer / peristaltic pump
Depth Sampled:	3-4'
Sample Data & Time:	1-18-96 1738
Sampled By:	Rachel Layman, Julea Bradley
Signature(s):	Rachel Layman, Julea Bradley

Purge Data

(gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.
0	6.89	0.848	23.6	clear 29	2.05
1	6.87	0.99	24.1	clear 16	2.52
2	6.91	1.04	24.1	clear 10	2.88
3	6.87	1.06	24.1	clear 12	2.52
4	6.85	1.09	24.0	clear 12	2.90
			~~23.4~~		~~2.0~~

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
6.86	0.807	23.4	clear 32	2.01

Observations/Notes:

*sample bottle labels were changed from MW-4 to MW15.
*new lock place on well

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	–
Pesticides / PCB	–
Herbicides	–
TAL metals	HNO_3
Cyanide	NaOH

Dup #
MSMSD ☐

Air Bill # 9230385054
Date Shipped 1/19/96
Time Shipped 1330
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name Naval Air Station, Key West
Project Site Number 7046
B&RE Sample ID S9MW-24
Source Location SWMU-9 (Jet Engine Test Cell)

Total Well Depth:	9.70'
Well Stickup:	flush
Well Casing Size:	2"
Static Water Level:	1.15'
One Casing Volume:	1.39
Start Purge (hrs.):	0825
End Purge (hrs.):	0905
Total Purge Time (min.):	40'
Total Amount Purged (gal.):	4.5g
Monitoring Reading:	80ppm 11.7ev HNu
Purge Method:	peristaltic pump
Sample Method:	teflon bailer & peristaltic pump
Depth Sampled:	3-5'

Purge Data

(gallons) Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/L D.O.
0	6.79	6.92	23.6	clear 17	2.37
1	7.00	6.97	23.9	clear 15	2.43
2	7.01	6.98	24.2	clear 15	2.31
3	7.00	6.98	24.3	clear 13	2.76
4	7.01	6.97	24.0	clear 11	3.22

Sample Data & Time: 1-19-96 0920

Sampled By: Rachel Layman, Julea Bradley

Signature(s): Rachel Layman, Julea Bradley

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.
7.00	6.98	24.8	JFB 1-19-96 ~~24.8~~ see below 97	3.11

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Observations/Notes:
slight odor when purging began.
* 1 additional gallon was purged at 0.1 liter per minute the turbidity would not come down
* It was observed that the top of the water column was cloudy white when sampling with bailer

Analysis:	Preservative:
App IX volatiles	HCl
App IX semivolatiles	–
Pesticides/PCBs	–
Herbicides	–
Metals	HNO_3
Cyanide	NaOH

Dup #
MSMSD ☐

Air Bill # 9230385054
Date Shipped 1/19/96
Time Shipped 1330
Lab GEL
Other

SAMPLE LOG SHEET

Brown & Root Environmental

☑ Monitoring Well Data
☐ Domestic Well Data
☐ Other_____

Page 1 of 1

By RL, JB

Project Site Name: Naval Air Station, Key West
Project Site Number: 7046
B&RE Sample ID: 59mw-19D
Source Location: SWMU-9 (Jet Engine Test Cell)

Total Well Depth:	25.5' BTOC
Well Stickup:	
Well Casing Size:	2"
Static Water Level:	1.95' BTOC
One Casing Volume:	3.8 gallons
Start Purge (hrs.):	1030
End Purge (hrs.):	1125
Total Purge Time (min.):	55
Total Amount Purged (gal.):	11
Monitoring Reading:	0 ppm 11.7 ev HNu
Purge Method:	peristaltic pump
Sample Method:	teflon bailer, peristaltic pump
Depth Sampled:	~16'
Sample Data & Time:	1-19-96 1130
Sampled By:	Rachel Layman, Julea Bradley
Signature(s):	Rachel Layman, Julea Bradley

Purge Data

gallons Volume	pH	mS/cm S.C.	Temp. (°C)	Color & Turbidity	mg/l D.O.
0	7.16	5.57	27.7	cloudy 374	2.50
1	7.11	5.58	28.0	63	1.88
2	7.13	5.57	27.5	clear 24	2.73
3	7.18	5.58	27.9	clear 23	3.11
4	7.14	5.61	27.8	clear 17	2.51
5	7.15	5.55	28.0	clear 12	2.52
6	7.16	5.62	27.8	clear 9	2.30
7	7.16	5.63	28.0	clear 8	2.23
8	7.13	5.68	28.1	clear 7	2.11
9	7.14	5.69	27.8	clear 7	2.47
10	7.12	5.72	27.4	clear 5	2.40
11	7.13	5.74	28.1	clear 5	2.50

Sample Data

pH	S.C. mS/cm	Temp. (°C)	Color & Turbidity	D.O. mg/l
7.16	5.67	27.7	clear 7	2.57

Type of Sample

☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:
Appix VOC	HCl
Appix SVOC	—
Pesticides/PCBs	—
herbicides	—
TAL metals	HNO_3
cyanide	NaOH

Observations/Notes:
Salinity 0.29%, 0.29%, 0.28%, 0.29%, 0.29%, 0.30%

Dup #
MSMSD ☐

Air Bill # 9230385054
Date Shipped 1/19/96
Time Shipped 1330
Lab GEL
Other

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 70416

HNUS Sample Name 595W-01

Sample Source or Location SWMU-9

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Turbidity	Elect. Conduct.(mS/cm)
~~7.5~~ 6.8	21	4.1 mg/L	clear	0	41

salinity 2.6%

Sample Date and Time:	Observations/Notes:
1/23/96 1030	Sampled ~ 15' offshore. Water depth ~ 3'
Sampled By (Print): Rachel Layman	See 595D-01 map
Sampled By (Signatures): Rachel Layman	

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOCs	HCl	✓	GEL	1/23/96 1800	9230386620
App IX SVOCs	–	✓	ESI	1/23/96 1750	9230385135
pesticide/PCBs	–	✓			
herbicides	–	✓			
TAL metals	HNO_3	✓			
cyanide	NaOH	✓			
Silverside toxicity					
Oyster toxicity					
urchin toxicity					

COC # 9;2

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☑ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West
Project Site Number 7046
HNUS Sample Name S9SW-02
Sample Source or Location SWMU-9

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Turbidity	Elect. Conduct.(mS/cm)
7.5	21°C	4.1 mg/L	clear	0	41

Salinity 2.6%

Sample Date and Time: 1/23/96 1100

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:
Sampled ~ 15' offshore
Water depth ~ 3.0'
See S9SD-02 map

Analysis	Preserv.	Bottle Lot #s
App IX VOCs	HCl	✓
App IX SVOCs	—	✓
Pesticide/PCBs	—	✓
herbicide	—	✓
TAL metals	HNO_3	✓
Cyanide	NaOH	✓
Silverside toxicity		
Oyster toxicity		
Sea urchin toxicity		

Laboratory	Ship Date/Time	Airbill #
GEL	1/23/96 1800	9230386620
ESI	1/23/96 1750	9230385135

COC # 9,2

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name NAS Key West

Project Site Number 7046

HNUS Sample Name 59SW-03

Sample Source or Location SWMU-9

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)	Salinity
7.6	22	4.8 mg/l	clear -10	41	2.6%

Sample Date and Time:	Observations/Notes:
1/23/96 1430	Collected 59DPSW-01. Water depth ~4'
Sampled By (Print): Rachel Layman	See 59SD-03 map
Sampled By (Signatures): Rachel Layman	

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOCs	HCl	✓	GEL	1/23/96 1800	9230386620
App IX SVOCs	—	✓	ESI	1/23/96 1750	9230385135
pesticide/PCBs	—	✓			
herbicide	—	✓			
TAL metals	HNO_3	✓			
cyanide	NaOH	✓			
Silverside toxicity					
Oyster toxicity					
sea urchin toxicity					

COC # 9; 2

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- [x] Surface Water
- [ ] Water QA/QC Blank Sample
  - [ ] Trip Blank
  - [ ] Rinsate Blank
  - [ ] Field Blank
  - [ ] Ambient Condition Blank

Project Site Name: NAS Key West

Project Site Number: 7046

HNUS Sample Name: _____

Sample Source or Location: SWMU-9

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Elect. Conduct.(mS/cm)

Sample Date and Time: 1-23-96 1430

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes:

Duplicate to S9SW-03 sample.
Refer to S9SW-03 Sample Log Sheet.

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #

COC #

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☑ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West
Project Site Number 7046
HNUS Sample Name S9SW-04
Sample Source or Location SWMU-9

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)	Salinity
7.4	22	4.5 mg/l	clear -10	41	2.6%

Sample Date and Time: 1/23/96 1245

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes: Sampled ~~~15'~~ 15' offshore. Water depth ~4.5'
RL 1/24/96

See S9SD-04 map

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOCs	HCl	✓	GEL	1/23/96 1500	9230386620
App IX SVOCs	—	✓	ESI	1/23/96 1750	9230385135
pesticides/PCBs	—	✓			
herbicides	—	✓			
TAL metals	HNO_3	✓			
cyanide	NaOH	✓			
Silverside toxicity					
oyster toxicity					
sea urchin toxicity					

COC # 9;2

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☒ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West
Project Site Number 7046
HNUS Sample Name S9SW-05
Sample Source or Location SWMU-9

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color Turbidity	Elect. Conduct.(mS/cm)
7.5	21	4.9 mg/l	clear -10	41

Salinity 2.6%

Sample Date and Time: 1/23/96 1320

Sampled By (Print): Rachel Layman

Sampled By (Signatures): Rachel Layman

Observations/Notes: ~~Sampled at edge of wetland area~~. RL 1/24/96 Water depth ~3'. Sampled at ~20' offshore
See S9SD-05 map

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOC	HCl	✓	GEL	1/23/96 1800	9230386620
App IX SVOCs	–	✓	ESI	1/23/96 1750	9230385135
pesticide/PCBs	–	✓			
herbicides	–	✓			
TAL metals	HNO_3	✓			
Cyanide	NaOH	✓			
Silverside toxicity					
Oyster toxicity					
sea urchin toxicity					

COC # 9;2

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 c

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West

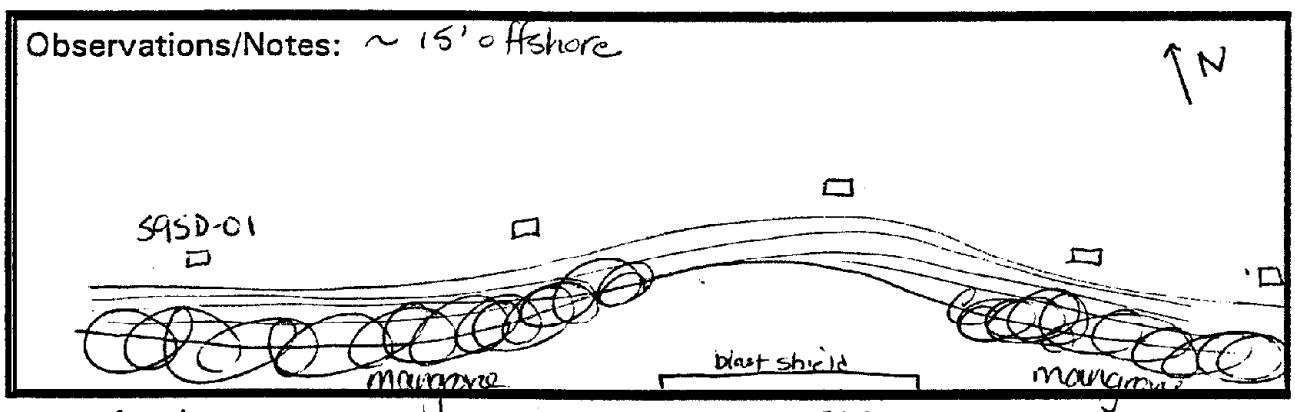
Project Site Number 7041

HNUS Sample Name 595D-01

Sample Source or Location SWMU-9

Sample Method: petite ponar	Sample Date and Time: 1/23/96 1030
Sample Depth: 3'	Color: grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: fine to medium sand and ~~some~~ RL 1/23/96 organic matter and crushed shells
Sampled By (Signatures): Rachel Layman, Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes: ~ 15' offshore



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Mysid toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/23/96 1800	9230386620
ESI	1/23/96 1750	9230385135

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

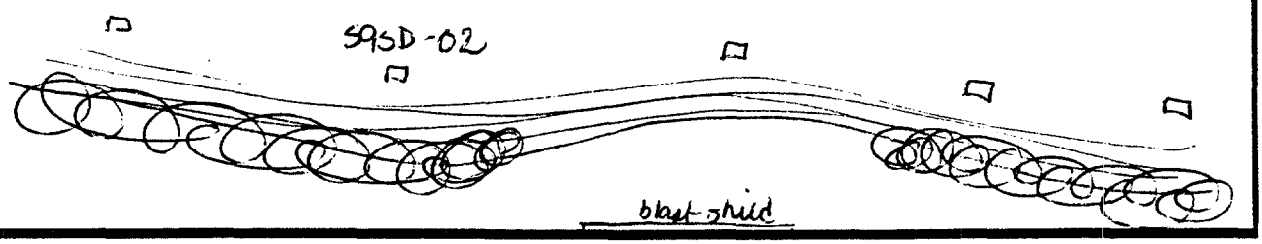
- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name S9SD-02 Sample Source or Location SWMU-9

Sample Method: Petite ponar	Sample Date and Time: 1/23/96 1100
Sample Depth: ~3'	Color: grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: fine to medium sand and organic silt, some crushed shell, org. matter
Sampled By (Signatures): Rachel Layman, Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes: Very deep silt/sediment at SWMU-9 (>2') Collected ~ 15-20' off shore



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Mysid toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/23/96 1800	9230386620
ESI	1/23/96 1750	9230385135

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West

Project Site Number 7046

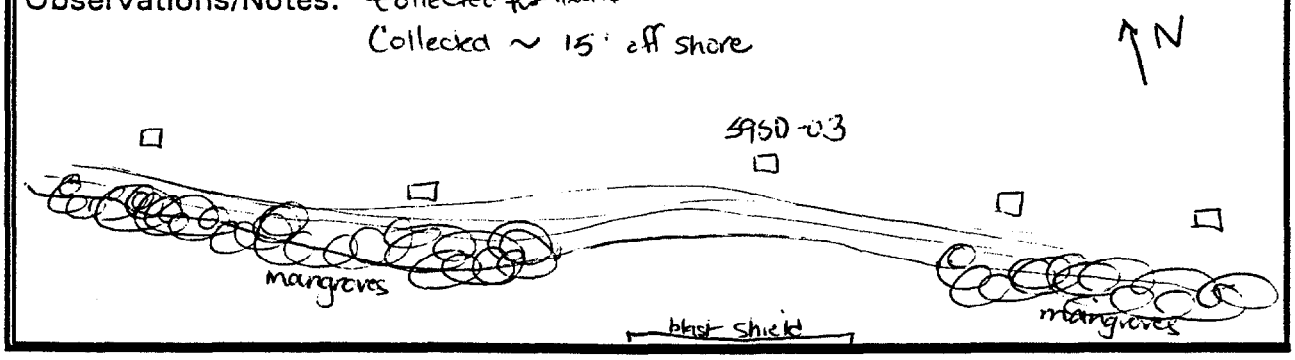
HNUS Sample Name SPSD-03

Sample Source or Location SWMU-9

Sample Method: Petit Ponar	Sample Date and Time: 1/23/96 1430
Sample Depth: 0-4'	Color: grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: silt, no shells, some organic matter
Sampled By (Signatures): Rachel Layman, Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes: ~~Collected~~ 1/23/96

Collected ~ 15' off shore



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
mysid toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/23/96 1800	9230386620
ESI	1/23/96 1750	9230385135

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name: NAS Key West

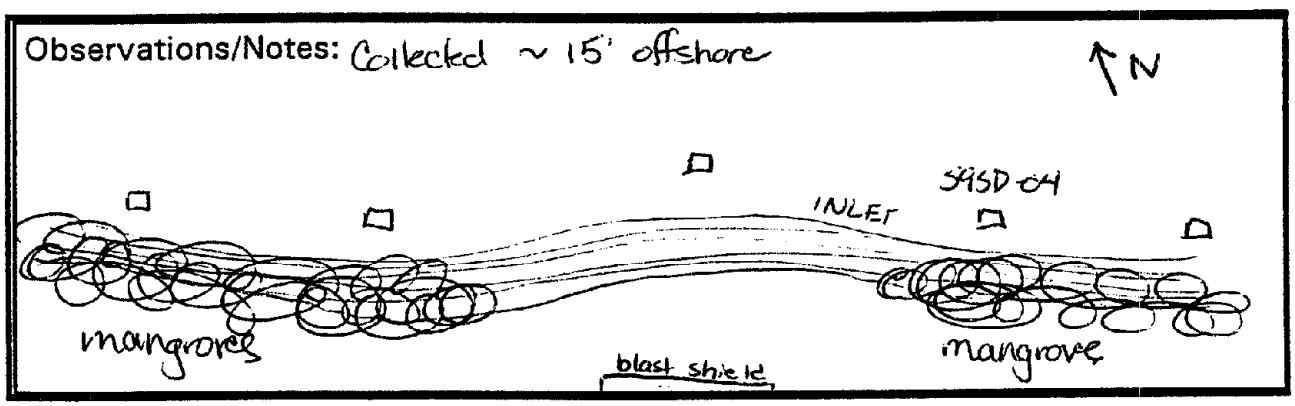
Project Site Number: 7046

HNUS Sample Name: 595D-04

Sample Source or Location: SWMU-9

Sample Method: petite ponar	Sample Date and Time: 1/23/96 1245
Sample Depth: ~3-4'	Color: grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: fine to medium sand with crushed shells and organic matter
Sampled By (Signatures): Rachel Layman, Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes: Collected ~15' offshore



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide / PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
mysid toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/23/96 1800	9230386620
ESI	1/23/96 1750	9230385135

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name NAS Key West

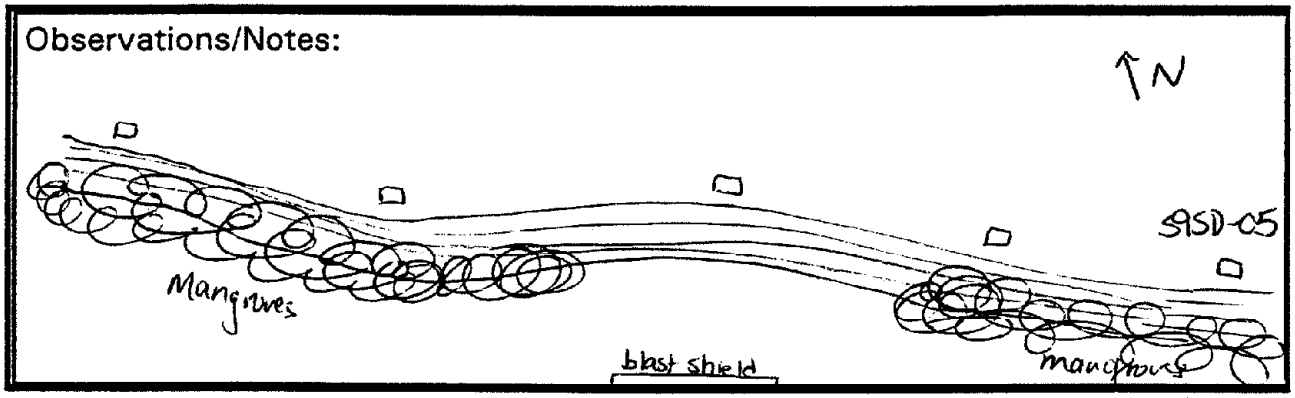
Project Site Number 7046

HNUS Sample Name 595D-05

Sample Source or Location SWMU-9

Sample Method: Petite ponar	Sample Date and Time: 1/23/96 1320
Sample Depth: 3'	Color: grey
Sampled By (Print): Rachel Layman, Julea Bradley	Sample Description: silt; few crushed shells
Sampled By (Signatures): Rachel Layman, Julea Bradley	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
mysid toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/23/96 1800	9230386620
ESI	1/23/96 1750	9230385135

SAMPLE LOG SHEET

Page 1 of 1

Brown & Root Environmental

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other _____

Case # _____

By RL, GB

CoFC # 2

Project Site Name NAS Key West Project Site Number 7046

Source No. SS55-1 Source Location SWMU-9

Sample Method: stainless steel trowel

Depth Sampled: ~~6-12"~~ 0-2" RB 1/15/96

Sample Date & Time: 1/15/96 1400

Sampled By: Rachel Laymar

Signature(s): Rachel Laymar

Composite Sample Data

Sample	Time	Color / Description
	NA	1/15/96
	EMG	

Type of Sample

- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Sample Data

Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)
brown	silty sandy some organic matter

Analysis:	✓ If Collected
App IX VOCs	✓
App IX SVOCs	✓
pesticides / PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Observations / Notes RL 1/15/96

1/2 inch top soil; grass roots in sample

DUP #	
MS/MSD	

SAMPLE LOG SHEET

Page 1 of 1

Brown & Root Environmental

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other _____

Case # _____

By RL, GB

CoFC # 2

Project Site Name NAS Key West Project Site Number 7046

Source No. SYSS-2 Source Location SWMU-9

Sample Method: stainless steel trowel	Composite Sample Data		
	Sample	Time	Color / Description
Depth Sampled: RL 0-6"			
Sample Date & Time: 1/15/96 1430			
Sampled By: Rachel Layman, Gary Braganza		RML 1/15/96	
Signature(s): Rachel M Layman, RL for GB			

Type of Sample	✓ If Collected
[x] Low Concentration	
[ ] High Concentration	
[x] Grab	
[ ] Composite	
[ ] Grab - Composite	

Sample Data	
Color: brown and white	Description: (Sand, Clay, Dry, Moist, Wet, etc.) Moist, humus and limestone with some ~~dry~~ clay

Analysis:	
App IX VOCs	✓
App IX SVOCs	✓
Pesticides / PCBs	✓
Herbicides	✓
TAL metals	✓
cyanide	✓

Observations / Notes

4" top soil (2" of which was limestone) over cap rock. Vegetation cover.

DUP#	
MS/MSD	

SAMPLE LOG SHEET

Page 1 of 1

Brown & Root Environmental

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other _____

Case # _____

By GB

CoFC #2

Project Site Name NAS Key West Project Site Number 7C46

Source No. SS55-4 Source Location SWMU 91

Sample Method:	Composite Sample Data		
stainless steel spoon	Sample	Time	Color / Description
Depth Sampled: 0-2"			
Sample Date & Time: 1/15/96 1430			
Sampled By: Gary Braganza		NA	1/15/96
Signature(s): Rachel Layma for GB		RMT	

Type of Sample	✓ If Collected
[x] Low Concentration	
[ ] High Concentration	
[x] Grab	
[ ] Composite	
[ ] Grab - Composite	

Sample Data

Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)
brown	sandy silt, some organic

Analysis:	
App IX VOCs	✓
App IX SVOCs	✓
Pesticide PCBs	✓
Herbicides	✓
TAL metals	✓
cyanide	✓

Observations / Notes

1" top soil, organic material abundant over limestone cap rock.

DUP#	
MS/MSD	

SAMPLE LOG SHEET

Page 1 of 1

Brown & Root Environmental

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other _____

Case # _____

By RL

CoFC # 2

Project Site Name NAS KeyWest Project Site Number 7046

Source No. SPSS-3 Source Location SWMU-9

Sample Method: stainless steel trowel

Depth Sampled: ~~0-6~~ RL 1/15/98 0-3"

Sample Date & Time: 1/15/98 1445

Sampled By: Rachel Layman

Signature(s): Rachel Layman

Composite Sample Data		
Sample	Time	Color / Description

RML

Type of Sample

- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Sample Data	
Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)
brown	sandy topsoil, some organic matter

Analysis:	✓ If Collected
Appix VOCs	✓
Appix SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Observations / Notes

3-2" top soil over cap rock.

DUP#	✓ SYDPSS-1
MS/MSD	

SAMPLE LOG SHEET

Page 1 of 1

Brown & Root Environmental

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other _____

Case # _____

By RL GB

CoFC # 2

Project Site Name NAS Key West Project Site Number 7046

Source No. SS55-5 Source Location SWMU-9

Sample Method:	Composite Sample Data		
-Tumion steel trowel	Sample	Time	Color / Description
Depth Sampled: 0-6" RL			
Sample Date & Time: 1/15/96 1450			
Sampled By: Gary Braganza		NA	
Signature(s): Gary Braganza		1/15/96	

Type of Sample	✓ If Collected
[x] Low Concentration	
[ ] High Concentration	
[x] Grab	
[ ] Composite	
[ ] Grab - Composite	

Sample Data	
Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)
grayish brown	* See below

Analysis:	
App IX VOCs	✓
App IX SVOCs	✓
pesticide / PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓

Observations / Notes

* <1" sandy top soil with abundant organic material, minor clay and limestone pebbles

DUP#	
MS/MSD	

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

☒ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name NAS Key West Project Site Number 7046

HNUS Sample Name BG1SW-01 Sample Source or Location Background 1 (between runways 21 and 25)

Surface Water Data

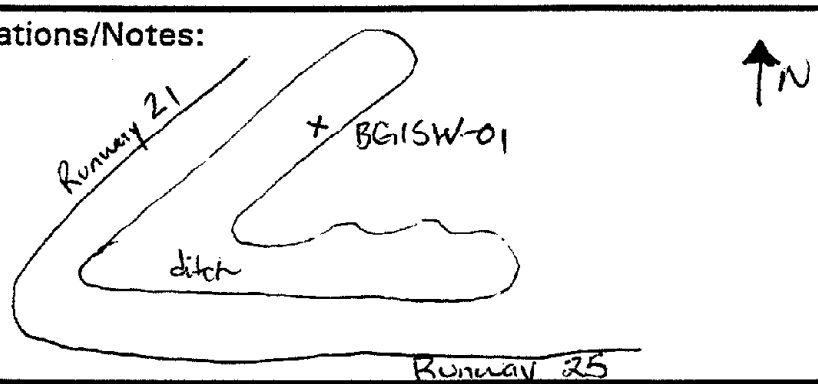
pH	Temp. (°C)	Dissolv. O_2	Color Turb	Elect. Conduct.(mS/cm)	Salinity
6.87	22.3°C	4.63 mg/l	clear 27	7.99	0.43%

Sample Date and Time: 1/26/96 0945

Sampled By (Print): Rachel Layman

Sampled By (Signature): Rachel M Layman

Observations/Notes:



Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #
App IX VOCs	HCl	✓	GEL	9230388516 1	1/26/96 1730
App IX SVOCs	—	✓	ESI	1/26/96 1730	9230385172
pesticides/PCBs	—	✓			
herbicides	—	✓			
TAL metals	HNO_3	✓			
cyanide	NaOH	✓			
Silverside toxicity		✓			

COC # 12;6

SAMPLE LOG SHEET

Page 1 of 1

Brown & Root Environmental

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other _____

Case # NA

By RL

CoFC # 2

Project Site Name NAS Key West

Project Site Number 7046

NUS Source No. S9DPSS-1

Source Location SWMU-9

Sample Method:	Composite Sample Data		
	Sample	Time	Color / Description
Depth Sampled:			
Sample Date & Time: 1/15/95 1445			
Sampled By: Rachel Layman			
Signature(s): Rachel Layman			

Type of Sample	✓ If Collected
[ ] Low Concentration	
[ ] High Concentration	
[x] Grab	
[ ] Composite	
[ ] Grab - Composite	

Sample Data	
Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)

Analysis:	

Observations / Notes

Duplicate to S9SS-3 sample

Refer to S9SS-3 Sample Log Sheet.

DUP #	
MS/MSD	

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of 1

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☒ Sediment
- ☐ Other

Project Site Name: NAS Key West

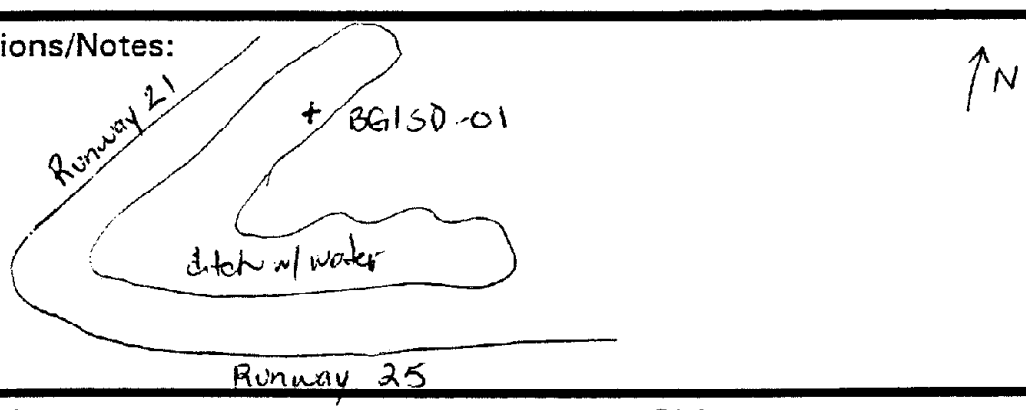
Project Site Number: 7046

HNUS Sample Name: BG1SD-01

Sample Source or Location: Background 1 (between runways 21 and 25)

Sample Method: petite ponar	Sample Date and Time: 1/26/96 0945
Sample Depth: ~5'	Color: Grey / lt grey
Sampled By (Print): Rachel Layman	Sample Description: Silt, some fine to med sand; some lt grey clay
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: ☒ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☒ Grab

Observations/Notes:



Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide/PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Amphipod toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/26/96 1730	9230385161
ESI	1/26/96 1730	9230385172

Brown & Root Environmental

SAMPLE LOG SHEET

Page 1 of ___

- [x] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Other

Project Site Name: NAS Key West

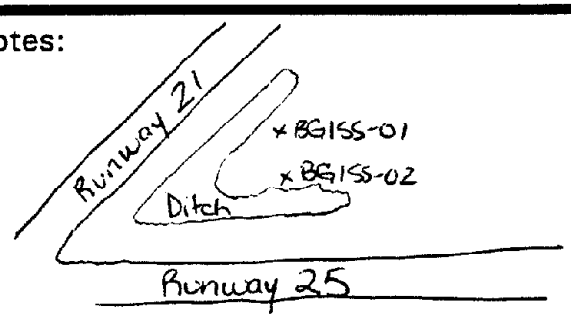
Project Site Number: 7046

HNUS Sample Name: BG15S-01

Sample Source or Location: Background 1 (between runways 21 and 25)

Sample Method: stainless steel trowel	Sample Date and Time: 1/26/96 0945
Sample Depth: 0-2"	Color: grey
Sampled By (Print): Rachel Layman	Sample Description: Fine to medium sand; some silt (organic)
Sampled By (Signatures): Rachel M Layman	FID Reading of Sample (if appropriate): NA
Concentration of Sample: [x] Low [ ] Medium [ ] High	Type of Sample: [ ] Composite [x] Grab

Observations/Notes:



↑N

Rockland
Some veg (grass) cover

Analyses

Analysis	Bottle Lot #
App IX VOCs	✓
App IX SVOCs	✓
pesticide / PCBs	✓
herbicides	✓
TAL metals	✓
cyanide	✓
Earthworm toxicity	

Shipment

Laboratory	Ship Date/Time	Airbill #
GEL	1/26/96 1730	9230388516 1
ESI	1/26/96 1730	9230385172