Pesticide Warehouse III

Manatí, Puerto Rico

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Executive Summary

The Pesticide Warehouse III site is in a mixed rural and residential area of Manatí, Puerto Rico. From 1954 to 1996, the Puerto Rico Land Authority manufactured and stored insecticides, herbicides, and fertilizers at the site. During operations, tanker trucks were parked near the loading docks while pesticides and water were mixed in their tanks. All excess pesticides and spills were allowed to go directly to the surrounding soil. Environmental investigations at the property show that soil and groundwater are contaminated with pesticides, PAHs, and metals. Groundwater is the primary pathway of contaminant migration from the site to NOAA trust resources in the Laguna Tortuguero. The freshwater habitat of the Laguna Tortuguero provides nursery and adult habitat for a variety of NOAA trust resources and is the habitat of primary concern to NOAA.

Site Background

The Pesticide Warehouse III (Pesticide Warehouse) site is in a mixed rural and residential area of Manatí, Puerto Rico. The Pesticide Warehouse property is approximately 0.8 hectare (2 acres) in area and is bordered to the west and north by pineapple fields, to the south by Road No. 670, and to the east by a church and retirement home. Laguna Tortuguero, a natural freshwater lagoon with an outlet channel connected to the Atlantic Ocean, is approximately 4 km (2.5 mi) northeast of the Pesticide Warehouse site. The Río Grande de Manatí is approximately 3 km (2 mi) west of the facility (Figure 1).

From 1954 to 1996, the Puerto Rico Land Authority, a division of the Puerto Rico Department of Agriculture, manufactured and stored insecticides, herbicides, and fertilizers at the site. The Puerto Rico Land Authority also used part of the site for processing and canning pineapple (Weston 1997). The site is currently privately owned and operated by Axel Gonzales Fruit Packers. A main warehouse, a smaller warehouse, and a small well shed are still present at the site (USEPA 2003). Sources of contamination that have been identified at the site are contaminated surface soil, a drainage ditch, and a leach-pit (Weston 2002). During operations, tanker trucks were parked near the loading docks while pesticides and water were mixed in their tanks. All excess pesticides and spills were allowed to go directly to the surrounding soil. There were no concrete pads, berms, or other secondary containments at the mixing and tanker truck loading area to collect spills (Weston 1997). Empty pesticide drums and bags were stored outside behind the main warehouse. The layout of the Pesticide Warehouse site is shown in Figure 2.

In 1989, the Puerto Rico Environmental Quality Board conducted an on-site preliminary assessment (PA) on behalf of the U.S. Environmental Protection Agency (USEPA). During the PA, drums and bags containing organochlorine pesticides and Toxaphene E8 were observed in the main warehouse, where there was a strong pesticide odor that made breathing difficult (Weston 2002).

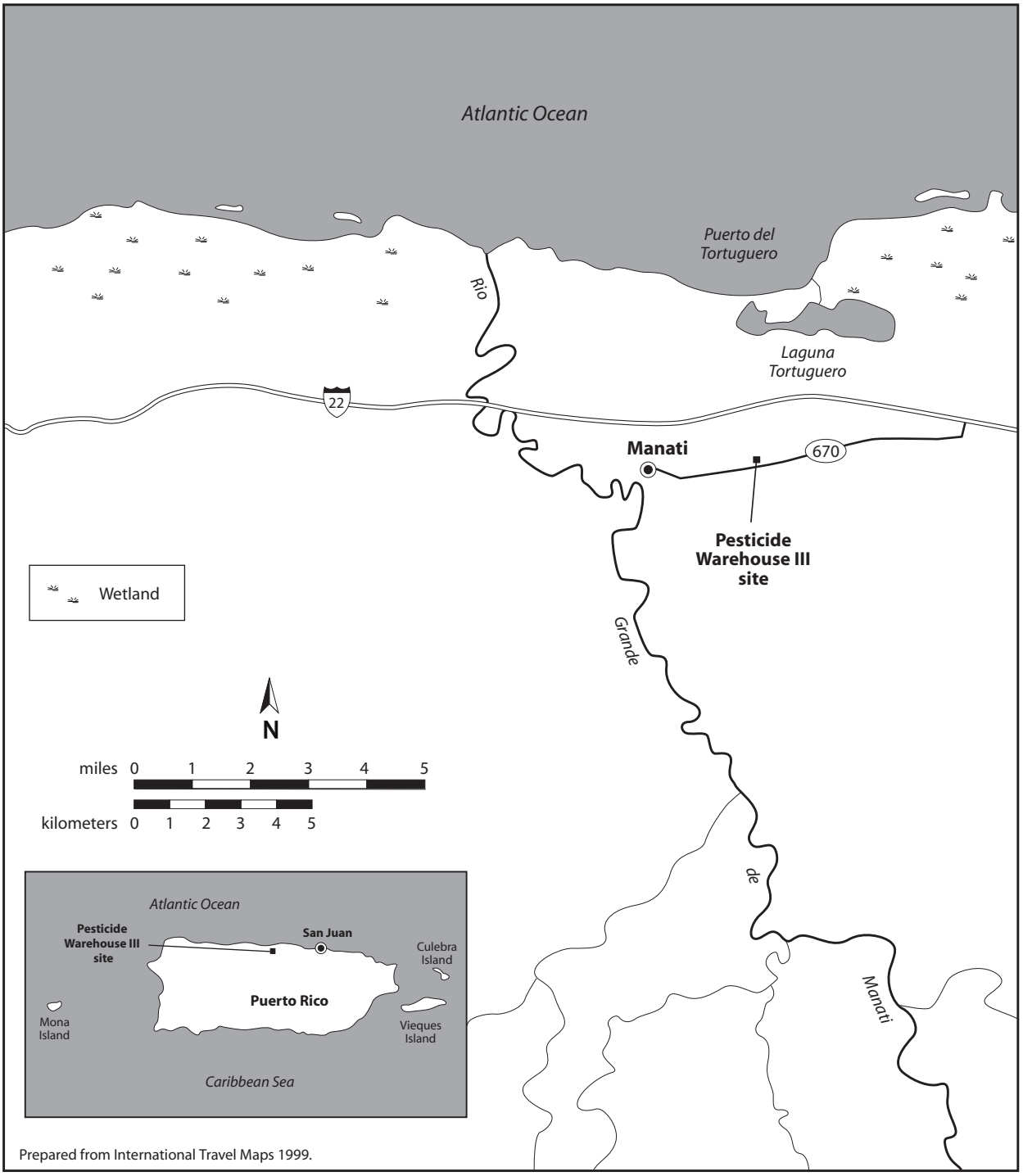

Figure 1. Location of the Pesticide Warehouse III site, Manatí, Puerto Rico.

During a site inspection (SI) conducted by the USEPA in 1996, stained soils were documented throughout the site and spilled materials were observed throughout the warehouse (USEPA 2003). At the time the SI was conducted, pesticides were still being mixed at the loading platform and evidence of spilled pesticides was observed. Also during the SI, stressed vegetation was observed along the surface water runoff pathway from the loading platform to a drainage ditch (Weston 1997; 2002).

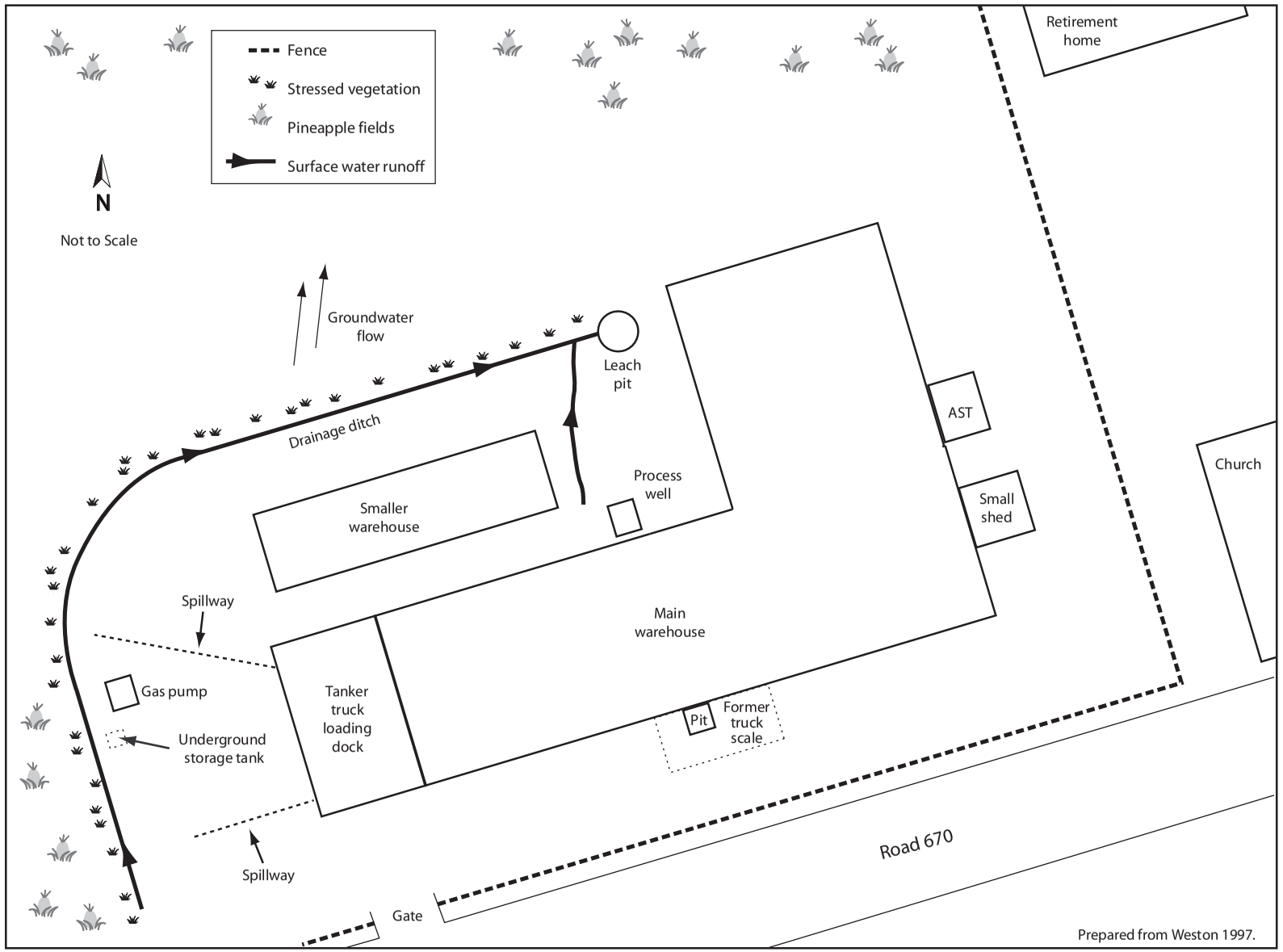

Figure 2. Detail of the Pesticide Warehouse III property, Manatí, Puerto Rico.

In 2001, the USEPA conducted an on-site reconnaissance. Observations made during the reconnaissance indicated that conditions had not changed at the facility since the 1996 SI (Weston 2002). The Pesticide Warehouse site was proposed to the National Priorities List (NPL) on September 5, 2002, and placed on the NPL on April 30, 2003 (USEPA 2003).

Groundwater is the primary pathway for the migration of contaminants from the site to NOAA trust resources. Surface water runoff flows to the west to a drainage ditch that runs along the western and northern boundaries of the site and empties into an unlined leach-pit, which appears to be a natural sinkhole, on the north side of the warehouses (USEPA 2003). The upper groundwater aquifer beneath the site is a karst aquifer, and numerous karst features, including sinkholes and limestone hills, characterize the area under and surrounding the Pesticide Warehouse site. The aquifer is an important source of groundwater and the principal source of water supply in the Manatí area (Weston 2002). Sinkholes are the primary mode of aquifer recharge in this area. The depth to groundwater beneath the site is approximately 79 m (260 ft) below ground surface; the groundwater generally flows north. The primary point of natural groundwater discharge from the upper groundwater aquifer is into the Laguna Tortuguero (AWRA 1998).

NOAA Trust Resources

The habitat of primary concern to NOAA in the vicinity of the site is the Laguna Tortuguero. Laguna Tortuguero is a freshwater lagoon connected to the Atlantic Ocean by an outlet channel and contains approximately 19 species of fish, several of which are NOAA trust resources. The endangered hawksbill turtle nests regularly at the beach north of Laguna Tortuguero. The Río Grande de Manatí is a habitat that is also of concern to NOAA because it could not be confirmed whether or not contaminants were migrating from the site to the river (Modica 2004). The Río Grande de Manatí is one of the largest rivers in Puerto Rico and it also has the fewest number of dams. This river provides habitat to a variety of NOAA trust resources.

Freshwater lagoons such as Laguna Tortuguero are a rare type of wildlife habitat in Puerto Rico, and Laguna Tortuguero has been classified as a natural reserve by the Department of Natural Resources (Lilyestrom 2004). Laguna Tortuguero provides adult and juvenile rearing habitat for several NOAA trust species (Table 1). Amphidromous fish species, including the jurel ojon (horse-eye jack), snook, and dog snapper, have been observed in the outlet channel to the Atlantic Ocean (Lilyestrom 2004). Other species present in the lake include the white mullet, fat sleeper, and yellowfin mojarra. The beach north of the lagoon is prime nesting habitat for three federally protected species of sea turtle: green, hawksbill, and loggerhead (Lilyestrom 2004).

The native freshwater fish and invertebrate species found in Puerto Rico are compulsory migrators that must spend a portion of their life cycle in estuarine or marine waters (Yoshioka 2002). Puerto Rican native freshwater fish and invertebrates are best described as amphidromous and iteroparous. The term amphidromous refers to predominately freshwater species that require estuarine or marine waters for completion of larval phases; iteroparous means they do not die after spawning. Following fertilization in fresh water, eggs and larvae are carried downstream to estuaries, and fish and shrimp larvae spend several months maturing in marine or estuarine waters. Shrimp larvae enter marine and estuarine waters as non-feeders; when salinities reach 12 parts per thousand and above, the larvae molt and begin feeding before re-entering freshwater systems as juveniles. These fish and shrimp spend the majority of their life cycles in the middle to upper reaches of natural freshwater rivers and lagoons (Yoshioka 2002).

Table 1. NOAA trust resources in the Rio Grande de Manati and Laguna Tortuguero, Puerto Rico (Lilyestrom 2004; Yoshioka 2002).

Species		**Habitat Use**			**Fisheries**	
Common Name	Scientific Name	Spawning Area	Nursery Area	Adult Habitat	Comm.	Rec.
CATADROMOUS FISH						
American eel	*Anguilla rostrata*		◆	◆		◆
AMPHIDROMOUS FISH						
Atlanitc tarpon	*Megalops atlanticus*	◆	◆	◆		
Bigmouth sleeper	*Gobiomorus dormitor*	◆	◆	◆		◆
Dog snapper	*Lutjanus jocu*		◆	◆		◆
Fat sleeper	*Dormitator maculatus*	◆	◆	◆		◆
Horse-eye jack	*Caranx latus*		◆	◆		◆
Western mosquitofish	*Gambusia affinis*	◆	◆	◆		
Mountain mullet	*Agonostomus monticola*	◆	◆	◆		◆
River goby	*Awaous tajasica*	◆	◆	◆		◆
Sirajo goby[b]	*Sicydium plumieri*	◆	◆	◆		◆
Snook[a]	*Centropomus undecimalis*		◆	◆		◆
Spinycheek sleeper	*Eleotris pisonis*	◆	◆	◆		◆
Tilapia[a]	*Tilapia mossambica*	◆	◆	◆		◆
White mullet	*Mugil curema*		◆	◆		◆
Yellowfin mojarra	*Gerres cinereus*		◆	◆		◆
AMPHIDROMOUS INVERTEBRATES						
Cascade river prawn	*Macrobrachium heterochirus*	◆	◆	◆		◆
Unamed river prawn[c]	*Macrobrachium crenulatum*	◆	◆	◆		
Unamed river prawn[c]	*Macrobrachium faustinum*	◆	◆	◆		
Bigclaw river shrimp	*Macrobrachium carcinus*	◆	◆	◆		
Cinnamon river shrimp	*Macrobrachium acanthurus*	◆	◆	◆		
Unnamed river shrimp[b,c]	*Atya innocous*	◆	◆	◆		◆
Unnamed river shrimp[b,c]	*Atya lanipes*	◆	◆	◆		◆
Unnamed river shrimp[b,c]	*Atya scabra*	◆	◆	◆		◆
Unnamed river shrimp[b,c]	*Jonga serrei*	◆	◆	◆		
Unnamed river shrimp[b,c]	*Micratya poeyi*	◆	◆	◆		
Unnamed river shrimp[b,c]	*Potimirrim americana*	◆	◆	◆		
Unnamed river shrimp[b,c]	*Potimirrim mexican*	◆	◆	◆		
Unnamed river shrimp[b,c]	*Xiphocaris elongata*	◆	◆	◆		
SEA TURTLES						
Green turtle	*Chelonia mydas*	◆	◆			
Hawksbill turtle	*Eretmochelys imbricata*	◆	◆			
Loggerhead turtle	*Caretta caretta*	◆	◆			

a: Common names are from Lilyestrom 2004.

b: Scientific names are from Yoshioka 2002.

c: No common names were available.

Two large dams are present on the Río Grande de Manatí; however, both dams are upstream of the site. The lower portion of the river contains several small impediments, none greater than 3 m (10 ft) in height, which allows most migratory species to pass upstream. Table 1 lists the NOAA trust resources commonly found in the Río Grande de Manatí. Mountain mullet, sirajo and river goby, three species of sleepers, and several shrimp species are the primary NOAA trust resources that use the Río Grande de Manatí (Yoshioka 2002). American eel is also found in the river. The amphidromous and catadromous species listed in Table 1 are found throughout the Río Grande de Manatí system, from the mouth to the headwaters. Many of the NOAA trust resources use the river system for adult and juvenile habitat, and as a spawning area.

No commercial fishing occurs in Laguna Tortuguero or Río Grande de Manatí. Recreational fishing for most of the fish listed in Table 1 occurs in Laguna Tortuguero (Lilyestrom 2004), and recreational and subsistence fishing occurs throughout the Río Grande de Manatí. Sirajo goby, considered a delicacy, are fished in their larval stage as they migrate upstream. The larger Macrobrachium prawns, Atya shrimp, eel, mountain mullet, and bigmouth sleeper are also fished recreationally (Yoshioka 2002). Many of the larger shrimp species are important for native celebrations. No fish-consumption advisories were in effect for the Río Grande de Manatí or Laguna Tortuguero at the time of this report (Lilyestrom 2004).

Site-Related Contamination

Several surface-soil samples and groundwater samples were collected from the Pesticide Warehouse III site during multiple sampling events between 1989 and 1997. All samples were analyzed for metals (including selenium), polycyclic aromatic hydrocarbons (PAHs), phenols, pesticides, and polychlorinated biphenyls (PCBs). Soil samples were collected from throughout the site, including the spillways and the leach-pit. Groundwater samples were collected from the Pesticide Warehouse process well, public supply wells, and monitoring wells.

The primary contaminants of concern to NOAA are zinc and pesticides. Table 2 summarizes maximum contaminant concentrations detected during the site investigations and compares them to appropriate screening guidelines. Only maximum concentrations that exceeded relevant screening guidelines are discussed below. The screening guidelines for soil are from the Oak Ridge National Laboratory final preliminary remediation goals (ORNL-PRGs; Efroymson et al. 1997) and screening guidelines for water are from the ambient water quality criteria (AWQC; USEPA 2002), with exceptions as noted on Table 2.

Groundwater

During a 1992 groundwater quality survey conducted by the U.S. Geological Survey, groundwater samples were collected from public supply wells and monitoring wells within the Manatí area, including the Pesticide Warehouse process well, approximately 9 m (30 ft) north of the main warehouse (Figure 2). The process well was also sampled during the 1996 SI. The process well provided water for operations conducted at the facility. Chromium, toxaphene, and dieldrin were detected in samples from the process well. Although the maximum concentration of chromium was less than the ambient water quality criteria (AWQC), toxaphene concentrations exceeded the AWQC by four orders of magnitude, and dieldrin concentrations were six times the AWQC (Table 2).

Soil

During the 1996 SI, fifteen surface soil samples were collected at the Pesticide Warehouse site from the area surrounding the loading dock, the spillways, the drainage ditch west and north of the main warehouse, and the area adjacent to the above-ground-storage tank (AST) east of the

Table 2. Maximum concentrations of contaminants of concern to NOAA detected at the Pesticide Warehouse III site (Weston 1997; 2002). Contaminant values in bold exceeded screening guidelines.

	Soil (mg/kg)		Water (µg/L)	
Contaminant	Soil	ORNL-PRG[a]	Groundwater	AWQC[b]
METALS/INORGANICS				
Arsenic	**42**	9.9	ND	150
Cadmium	**6.8**	0.38[c]	ND	0.25[d]
Chromium[e]	**90**	0.4	6.1	11
Copper	**99**	60	ND	9[d]
Lead	**180**	40.5	ND	2.5[d]
Mercury	**0.34**	0.00051	ND	0.77[f]
Nickel	21	30	ND	52[d]
Selenium	**1.3**	0.21	ND	5.0[g]
Silver	1	2	ND	3.2[d,h]
Zinc	**3,700**	8.5	ND	120[d]
PAHs				
Benz(a)anthracene	0.067	0.1[i]	N/A	NA
Chrysene	0.096	NA	N/A	NA
Fluoranthene	0.21	NA	N/A	NA
2-Methylnaphthalene	0.096	NA	N/A	NA
Naphthalene	0.096	0.1[i]	N/A	620[j]
Phenanthrene	**0.14**	0.1[i]	N/A	NA
Pyrene	**0.25**	0.1[i]	N/A	NA
PHENOLS				
Pentachlorophenol (PCP)	0.091	3	N/A	15[k]
PESTICIDES				
Aldrin	1.7	NA	ND	3[h]
Chlordane	3.4	NA	ND	0.0043
4,4'-DDE	0.33	NA	ND	1050[h,j]
Diazinon	0.98	NA	ND	NA
Dieldrin	**3.6**	0.00028[c]	**0.35**	0.056
Diuron	35	NA	ND	NA
Endosulfan (alpha and beta)	0.1	NA	ND	0.056
Endrin	0.19	NA	ND	0.036
Heptachlor	1	NA	ND	0.0038
Heptachlor Epoxide	0.17	NA	ND	0.0038
Malathion	0.075	NA	ND	NA
Toxaphene	200	NA	**6**	0.0002

a: Oak Ridge National Laboratory final preliminary remediation goals (ORNL-PRG) for ecological endpoints (Efroymson et al. 1997).

b: Ambient water quality criteria for the protection of aquatic organisms (USEPA 2002). Freshwater chronic criteria presented.

c: Ecological soil screening guidelines (USEPA 2004).

d: Criterion expressed as a function of total hardness; concentrations shown correspond to hardness of 100 mg/L $CaCO_3$.

e: Screening guidelines represent concentrations for $Cr.^{+6}$

f: Derived from inorganic, but applied to total mercury.

g: Criterion expressed as total recoverable metal.

h: Chronic criterion not available; acute criterion presented.

i: Canadian Council of Ministers of the Environment (CCME) soil screening guidelines for protection of agricultural land uses.

j: Lowest observable effects level (LOEL) (USEPA 1986).

k: Chronic value is pH dependent; concentration shown above corresponds to pH of 7.8.

NA: Screening guidelines not available.

N/A: Contmaminant was not analyzed for.

ND: Not detected.

main warehouse (Figure 2). Dieldrin, a pesticide, was detected in on-site soils and the leach-pit at concentrations substantially greater than concentrations detected in background soil samples collected during the same event. Several other pesticides were also detected in the soil samples, including diuron (Table 2). The maximum concentration of dieldrin exceeded the soil screening guidelines by four orders of magnitude (Table 2). Currently, there is no screening guideline available for comparison to the maximum concentration of diuron found in the soil samples (Table 2).

PAHs were detected in soil samples collected approximately 18 m (60 ft) west and 9 m (30 ft) east of the main warehouse and approximately 6 m (20 ft) north of the Pesticide Warehouse process well (Figure 2). Concentrations of PAHs ranged between 0.067 mg/kg and 0.25 mg/kg. The maximum concentration of the PAH pyrene, exceeded the screening guideline by a factor of two, while the PAH phenanthrene, was just above the screening guideline (Table 2). Currently, there are no screening guidelines available for comparison to the maximum concentrations of three of the seven PAHs found in the soil samples (Table 2).

Metals, including selenium, were detected in soil samples collected throughout the site at concentrations above the screening guidelines. The maximum concentration of cadmium was found in a sample collected from a spillway approximately 15 m (50 ft) northwest of the main warehouse (Figure 2), and exceeded soil screening guidelines by one order of magnitude (Table 2). Zinc was detected at concentrations substantially above background levels both in on-site soils and in soils collected at the retirement home adjacent to the Pesticide Warehouse site. Zinc was detected in soil samples taken approximately 18 m (60 ft) west of the main warehouse (Figure 2); maximum concentrations exceeded the screening guidelines by two orders of magnitude (Table 2). The maximum concentration of lead, detected in a sample taken approximately 3 m (10 ft) south of the main warehouse (Figure 2), also exceeded the screening guidelines by a factor of four (Table 2). The maximum concentration of arsenic, detected in a sample taken approximately 6 m (20 ft) north of the process well (Figure 2), was four times the screening guidelines (Table 2). Copper, mercury, and selenium were detected in soil samples taken approximately 6 m (20 ft) north of the process well, at the leach-pit approximately 16 m (55 ft) north of the process well, and 9 m (30 ft) east of the process well, respectively (Figure 2). The maximum concentration of mercury exceeded the screening guidelines by two orders of magnitude; concentrations of selenium were six times the screening guidelines, and concentrations of copper just exceeded the screening guidelines (Table 2). The maximum concentration of chromium, detected in a soil sample taken from the leach-pit (Figure 2), exceeded the screening guidelines by two orders of magnitude (Table 2).

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