Ecological Risk Assessment
for
Lead in Soil and Laysan Albatross Chicks
on
Sand Island

Midway Atoll National Wildlife Refuge

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(Sharon Taylor)

ABSTRACT

In April of 2008, studies were initiated to assess risks posed by lead paint contamination to ground nesting seabirds, specifically Laysan albatross (*Phoebastria immutabilis*), on Sand Island, Midway Atoll National Wildlife Refuge. Sand Island is approximately 1,100 acres in size and provides nesting and roosting habitat for 17 species of seabirds with an aggregate population of 1.8 million. The ground nesting Laysan albatross is among the species that nest on Sand Island. This colony of Laysan albatross nesting on Sand Island is the largest in the world for this species.

As part of the Midway Atoll, Sand Island has a long history of use for communications, commercial and military purposes. Midway was a base for military operations between 1941 and the early 1990's. As such, portions of Sand Island were, and continue to be occupied by an airfield, buildings and other structures to support operations and staff that live on the island. Paint used on those structures is known to have high levels of lead and chips that have peeled from the structures are a source of lead contamination, as paint chips and dust in adjacent soils. Studies conducted between the late 1980s and 2000, showed that albatross nestlings exhibited symptoms of lead toxicity, and their exposure could be related to ingestion of paint chips that they tended to pick up and place in their nests. Consequently, lead, and particularly lead-based paint was identified as a contaminant of concern on Sand Island.

This investigation was conducted to support efforts by Refuge managers, Environmental Contaminants Divisions and Region 1 Engineering Division for cleanup and management of soil contaminated with lead-based paint. Specifically, the goal of this assessment was to characterize concentrations of lead in soils around selected buildings (sources) at various distances and depths, and in reference areas which were selected based on distance (>15 meters) from any potential sources; and to compare levels measured in soil to blood lead levels from co-located Laysan albatross chicks. This assessment is specifically focused on lead paint and albatross chicks, as requested by the USFWS Region 1 Engineering Division. Results obtained with soil samples indicate that: (1) 67 parts per million (ppm) may be considered an upper limit on lead concentrations for soils from reference areas; (2) lead concentrations in soils around buildings with lead-based paint were into the thousands of ppm, but concentrations declined with distance from the building; (3) with few exceptions, lead concentrations in soil were highest at the very surface. Blood lead levels measured in albatross nestlings ranged from <3 ug/dL to >65 ug/dL. Blood lead levels for approximately 67% of the birds were below thresholds for sensitive clinical effects (<10 ug/dL). Conversely, approximately 33% of the birds had concentrations associated with toxicity, some of which were consistent with lethality (> 50 ug/dL) in sensitive avian species.

Results of this study suggest that maintaining soil lead concentrations below 100 ppm should be protective of albatross chicks, and subsequently that blood lead levels are not likely to exceed thresholds for sensitive clinical effects.

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ACRONYMS/ABBREVIATIONS

Ag	Silver
ALAD	delta-aminolevulinic acid dehydratase
As	Arsenic
ATSDR	Agency for Toxic Substances and Disease Registry
Ba	Barium
Cd	Cadmium
cm	centimeter
Co	Cobalt
Cr	Chromium
Cu	Copper
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
EDTA	Ethylene diamine tetraacetic acid
Fe	Iron
GFAAS	Graphite furnace atomic absorption spectroscopy
GPS	Global Positioning System
Hg	Mercury
HQ	Hazard Quotient
LOEC	Lowest observed effect concentration
Mn	Manganese
Mo	Molybdenum
Ni	Nickel
NOEC	No observed effect concentration
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	parts per million
Sb	Antimony
Se	Selenium
Sn	Tin
Ti	Titanium
ug/dL	micrograms per deciliter
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
XRF	X-Ray fluorescence
Zn	Zinc
Zr	Zirconium

1.0 INTRODUCTION

The objective of this study was to evaluate select ecological effects of lead paint contamination on Sand Island, Midway Atoll National Wildlife Refuge. This assessment was to focus on determining the background lead soil level for Sand Island and the soil level around select buildings at various distances and depths; and to correlate these soil levels to co-located blood lead levels from Laysan albatross chicks (*Phoebastria immutabilis*). Based on the results of this study, recommendations were developed for the cleanup of lead contaminated soil around buildings.

Permits related to this study were issued to Matt D. Brown and John Klavitter, Midway National Wildlife Refuge, and Carlsbad Fish and Wildlife Service office through Region 1 (MB164274-0). All work related to this work plan was accomplished under the oversight of the Midway National Wildlife Refuge and complied with refuge research requirements.

1.1 Site Location

Midway Atoll is located at the northwest end of the Hawaiian Islands archipelago, at 28.208 degrees north latitude and -177.379 degrees west longitude (Figures 1 and 2). This is approximately 2,000 km (1,300 miles) from Honolulu, Hawaii and 4900 km (3,000 miles) from Portland, Oregon. The atoll is comprised of two main islands, Sand and Eastern, and one smaller islet, enclosed within a reef approximately 8 km (5 miles).

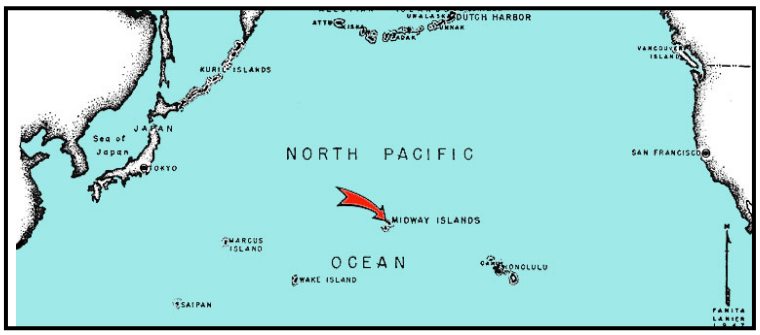


Figure 1. Location of Midway Atoll in Pacific Ocean.

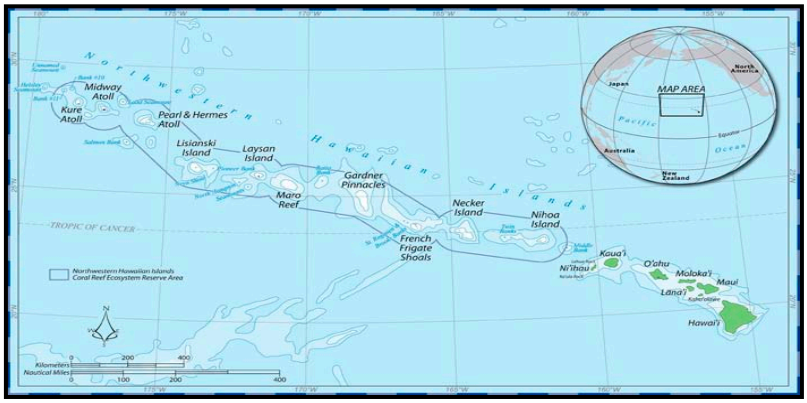


Figure 2. Location of Midway Atoll in relation to Hawaiian Islands

1.2 Ecological Setting

Midway Atoll is a small (8 km, 5 miles in diameter) coral reef in the Pacific Ocean comprised of coral and algal debris, with little soil development (Figure 3). Sand Island, the focus of this investigation, is about 3 km (1.8 miles) by 2 km (1.2 miles) across with a total land area of about 4.45 km^2 (1,100 acres). The atoll is only an average 3 meters (10 feet) above average ocean levels, and has infrequently been historically inundated due to storm events (Earth Tech 2003).

Figure 3. Midway Atoll - Aerial photo, 2008. (NASA)

Soil has been augmented on Sand Island using naturally occurring guano from seabirds, as well as a shipment of 9,000 tons of soil in the early 1900's from Oahu and Guam. The latter soil augmentation was done to facilitate growing vegetables on the island, and to extend the runway. No streams or freshwater sources are available on the atoll, except for natural precipitation.

A comprehensive list of birds and estimated populations can be found on the Midway Atoll National Wildlife Refuge website (USFWS 2009a).

This study focused on ground nesting birds, and the atoll provides suitable nesting and roosting habitat for 17 species of seabirds, with an aggregate average population of 1.8 million birds (USFWS 2009a). Resident and migratory birds nesting and breeding on Midway Atoll include Laysan albatross (*Phoebastria immutabilis*), black-footed albatross (*Phoebastria nigripes*), short-tailed albatross (*Phoebastria albatrus*), bonin petrel (*Pterodroma hypoleuca*), wedge-tailed shearwater (*Puffinus pacificus chlororhynchus*), white-tailed tropic bird (*Phaethon lepturus dorotheae*), red-tailed tropic bird (*Phaethon rubricauda rothschildi*), masked booby (*Sula dactlyatra*), brown booby (*Sula leucogaster*), red-footed booby (*Sula sula rubripes*), great frigate bird (*Fregata minor palmerstoni*), gray-backed tern (*Sterna lunata*), sooty tern (*Sterna fuscata oahuensis*), little tern (*Sterna albifrons*), brown noddy (*Anous stolidus pileatus*), black noddy (*Anous minutus melanogenys*), white tern (*Gygis alba rothschildi*), and Laysan duck (*Anas laysanensis*). (USFWS 2009a)

The atoll includes the largest colony of albatross in the world (Figure 4)

Figure 4. Laysan albatross with chicks on Sand Island, Midway Atoll National Wildlife Refuge, 2008. (Sharon Taylor)

A variety of marine fauna use the beaches, shores and near shore waters as habitat on Midway Atoll. The endangered Hawaiian monk seals (*Monachus schauinslandi*), threatened Hawaiian green turtles (*Chelonia mydas*), and the Hawaiian spinner dolphins (*Stenella longirostris*) that frequent the Sand Island lagoon (USFWS 2009b).

There is a complex ecosystem of coral reef fishes and marine invertebrates inhabiting the near shore waters of Midway Atoll with over 300 species representing 68 families of reef fishes. Many of these species are endemic, indigenous, and rare (USFWS 2009b).

Five non-native reptiles reside on Midway Atoll. They include the penny skink (*Lampropholis delicate*), Indo-Pacific gecko (*Hemidactylus garnotii*), house gecko (*Hemidactylus frenatus*), mourning gecko (*Lepidodactuylus lugubris*), and blind snake (*Ramphotyphlops braminus*).

Historically, there were 37 native plant species recorded on Midway Atoll; however, some species have been extirpated and at least two are believed extinct. Currently, there are 20 native plant species of which six are endemic and one is a species of concern. The invasive species are the most common taxa (USFWS 2009c).

1.3 Site History

Like on many of the low islands and atolls in the Northwestern Hawaiian Islands, the first visitors to what is now called Midway Atoll may have been Polynesians/Hawaiians exploring the Pacific Ocean in voyaging canoes. Native Hawaiians named the atoll “Pihemanu,” which means “the loud din of birds” (Kimura 1998).

Midway Atoll’s central location in the midst of the Pacific Ocean has made it a vital link in modern-day communication, transportation, and military history. The first recorded landing at Midway Atoll was made in 1859 by Captain N. C. Brooks who then claimed Midway Atoll for the United States under the Guano Act of 1856. In 1867, the Secretary of the Navy sent Captain Reynolds to take possession of the islands for the United States.

Efforts in the 1870s to open a channel in the reef were unsuccessful, and for the next 30 years visits to the atoll were limited to shipwreck survivors and bird feather collectors, who sought to satisfy the significant demand for feathers in the millinery trade. In January 1903, President Theodore Roosevelt signed Executive Order 199-A to stop the destruction of birds on the island by hunters, feather collectors, and squatters. His order also placed the Midway Islands and area surrounding the islands under the jurisdiction and control of the Navy Department.

Midway's role as an important communications link was established in 1903, when the Commercial Pacific Cable Company used Sand Island for a cable link between Honolulu and Guam. As shipping via Midway became more popular; the U.S. Lighthouse Service established a lighthouse on Sand Island in 1905. By 1935, Midway's role as a refueling depot became important for Pan American World Airways for their trans-pacific seaplane route. Because of the usefulness of the island for refueling aircraft, military interest in Midway increased, as conflict occurred in Europe.

By 1941, Midway Naval Air Station was under construction (Figure 5), and in December of that year, Midway was attacked simultaneously with Pearl Harbor. Throughout the war, Midway was an important location for the massing of troops and munitions. One of the most important naval battles of World War II, the Battle of Midway, is credited with achieving the victory that turned the war in the Pacific in favor of the Allies (USFWS 2009d).

Figure 5. Aerial photograph of Midway Naval Air Facility at Sand Island under construction in 1941. (Navy)

In July 1942, the Midway Submarine Advanced Base was formally established and operated until the end of World War II. Midway's importance returned in 1953 with the Cold War and the construction of the Distant Early Warning Line. By 1958, Midway was an important part of the "Pacific Barrier," which extended North America's early warning system from Alaska to the mid-Pacific. During the Vietnam War, Midway was one of the main aircraft and ship refueling stations, and it also hosted classified missile and submarine monitoring missions.

U.S. Fish and Wildlife Service staff have been conducting research and/or assisting the Navy with wildlife management issues on Midway Atoll for almost 50 years. In the 1970s, cooperative projects included rodent control and studies of lead toxicity in seabirds. A cooperative management plan developed by the Navy and FWS in the early 1980s further defined responsibilities and eventually led to establishment of an "overlay" national wildlife refuge on Midway in 1988 (USFWS 1991).

By the early 1990's due to increased range of aircraft and new technologies, Midway's importance as a base of military operations lessened. On October 1, 1993, Naval Air Facility Midway was operationally closed under the Base Realignment and Closure Act of 1990. Prior to the Navy's departure in 1997, a significant effort was made to remove the environmental contaminants and hazards left by more than 90 years of military operations (Ogden Environmental and Energy Services Co., Inc. 2001, Department of Navy 1995, Earth Tech 2003).

Midway Atoll's Naval Air Facility Midway was transferred to the U.S. Fish and Wildlife Service in 1996, per Executive Order 13022. The purposes of Midway Atoll National Wildlife Refuge, as defined in this Executive order, are to maintain natural biological diversity; conserve fish and wildlife and their habitats; fulfill international wildlife treaty obligations; provide opportunities for research, education, and compatible wildlife-dependent recreation; and recognize and maintain the atoll's historic significance.

On September 13, 2000, Secretary of the Interior Bruce Babbitt signed Secretary's Order 3217 designating the lands and waters of Midway Atoll National Wildlife Refuge as the Battle of Midway National Memorial.

On June 15, 2006, Papahānaumokuākea Marine National Monument (Monument) was established through Presidential Proclamation 8031. The Monument provides immediate and permanent protection for the lands and waters associated with the Northwestern Hawaiian Islands, including Midway Atoll National Wildlife Refuge. The National Oceanic and Atmospheric Administration has the primary responsibility regarding management of the marine areas. The U.S. Fish and Wildlife Service has sole responsibility for management of the areas of the Monument that overlay the Midway Atoll National Wildlife Refuge, the Battle of Midway National Memorial, and the Hawaiian Islands National Wildlife Refuge (USFWS 2007a, 2008b).

Midway Atoll is a U.S possession, and therefore, is governed only by federal laws and regulations.

1.4 Current Operations

Sand Island Structures

Currently, there are over 100 buildings and structures on Sand Island (Figure 6). Although some of the buildings on Sand Island have been designated for re-use from their former military needs to the current refuge needs, other have been classified as secure in place, leave as is, abandoned, and demolished. For some buildings, remediation efforts have been undertaken to stabilize them or remove exterior lead paint. Other buildings are being actively demolished and removed or passively managed and thus subject to deterioration. Nine structures were designated as National Historic landmarks in 1986 due to their importance with the June 1942 Battle of Midway (USFWS 1999).

As of April 2008, there are at least 95 buildings and structures that contain multiple layers of lead-based paint on interior or exterior walls. Deterioration of these buildings over time has resulted in lead-based paint chips and residues throughout Sand Island with high concentrations of chips and residues immediately surrounding certain buildings. In addition, numerous buildings and structures that were previously demolished by the Navy prior to FWS management also contained lead-based paint (USFWS 2007b).

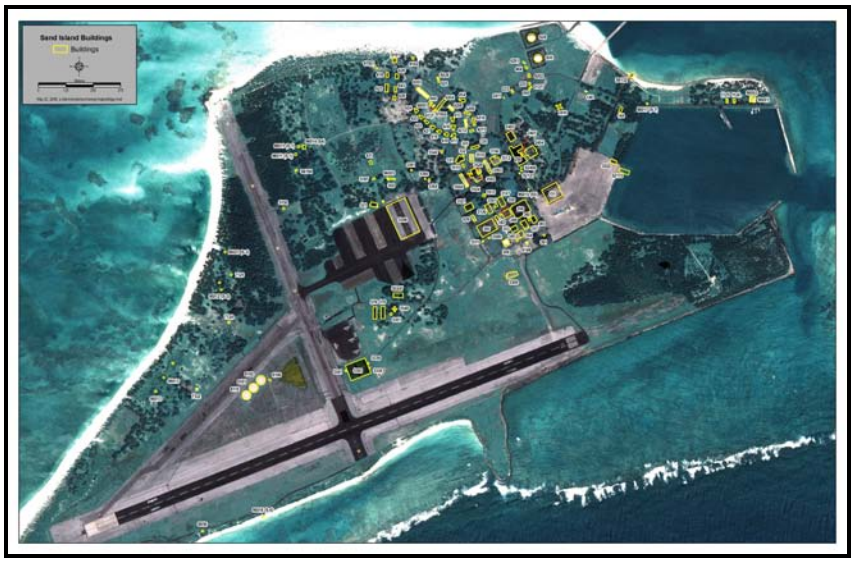


Figure 6. Current structures on Sand Island, Midway Atoll National Wildlife Refuge, 2008. (NASA)

Refuge operations

Midway Atoll National Wildlife Refuge is managed to maintain and restore its natural biological diversity; to provide for the conservation and management of fish and wildlife and their habitats within refuge boundaries; to fulfill international fish and wildlife treaty obligations; to provide opportunities for scientific research, environmental education, and compatible wildlife-dependent recreational activities; and to recognize and maintain the historical significance.

Midway Atoll is so remote (about 1,250 miles from Honolulu, its nearest major city) that it must operate independently as its own small town. It provides its own power system, water treatment and distribution, facilities maintenance, sewage treatment, waste management systems, communications systems, and all the other operational necessities.

The refuge is staffed by approximately eight full-time employees and a few volunteers to assist in biological and habitat management activities. It also hosts researchers, U.S. Coast Guard personnel, and other visitors on occasional basis. The refuge has contracted with a Chugach Industries to operate the infrastructure and currently has from 30 to 40 employees on the island (USFWS 2009).

Island residents live in renovated Navy housing, including single family homes, duplexes, and Bachelor Officers Quarters or Barracks. Almost all of the residents and visitors eat buffet style at the "Clipper House." Most supplies, particularly foodstuffs, are flown to the island on chartered aircraft. Approximately once a year, a barge brings in equipment, food, fuel for generators, vehicles, and aircraft, and supplies too large or heavy for the aircraft. All fuel deliveries operate in compliance with USFWS regulations and the Midway Atoll Spill Prevention Control and Counter Measure Plan.

2.0 TECHNICAL APPROACH

2.1 Identification of Contaminants of Potential Concern

At the request of USFWS, Region 1 Division of Engineering, this project was to focus exclusively on determining a background soil level of lead on Sand Island and the level around select buildings; and to correlate these soil levels to blood lead levels in Laysan albatross chicks.

While there are multiple historic sources of lead on the island, the scope of this project was to focus on building areas where the soil lead was believed to be derived from lead-based paint. The USFWS accepted responsibility for lead paint remaining on buildings that were not demolished prior to the transfer of the site from the Navy. This lead-based paint has chipped off the old buildings that remain and are now in need of repair and lead paint abatement (Earth Tech, Inc., 2004; Finklestein et al. 2003). It is this lead paint that has been shown through isotope analysis (Finkelstein et al. 2003) and other studies, to be toxic to Laysan albatross chicks when ingested (Sileo and Fefer 1987; Burger and Gochfeld 2000a, b, c).

It is known that contamination from other lead sources has occurred on Sand Island through military uses, and attempts were made to remediate these (Table 1 and 2). Historically, there was extensive use and storage (above and below ground tanks) of leaded fuels on the island. As a military facility, there was also extensive us of lead in ammunitions and munitions, as well as in batteries. Pesticides, such as lead arsenate may also have been historically used on the island.

Table 1. Superfund Site Identification Information for Midway Island Naval Air Station.

Site Name: Midway Island National Air Station
Street: US Navy Naval Air Station Midway
City / State / ZIP: Midway Islands, UM 96614
National Priority List Status: Not on the National Priority List
Non-National Priority List Status: Federal Facility-Lead Cleanup
Environmental Protection Agency (EPA) ID: UM6170027332
Base Closure and Realignment Commission ID: UM6170027332
EPA Region: 09
County: Midway Islands
Federal Facility Flag: Federal Facility

Table 2. Superfund Site Past Actions at Sand Island, Midway Atoll.

OU*	Action Name	Qualifier*	Lead*	Actual Start	Actual Completion
00	DISCOVERY		FF		05/01/1981
00	SITE INSPECTION	H	FF		10/16/1991
00	PRELIMINARY ASSESSMENT	H	FF		10/16/1991
00	FEDERAL FACILITY REMOVAL	C	FF	08/09/1996	04/30/1997
00	FEDERAL FACILITY REMOVAL	P	FF	07/26/1996	06/30/1997
00	FEDERAL FACILITY REMOVAL	P	FF	07/26/1996	06/30/1997
00	FEDERAL FACILITY REMOVAL		FF	06/06/1997	01/31/1998
00	RECORD OF DECISION		FF		07/31/2004
00	SITE REASSESSMENT	L	F		08/09/2006

*OU-Operable Unit; H-High; C-Cleaned up; P-Partially Cleaned up; L-Low; F-EPA Fund-Financed; F-Federal Facilities. (http://cfpub.epa.gov/supercpad/cursites/cactinfo.cfm?id=0902928)

On a global scale, deposition of atmospheric lead has been documented in coral reefs within undeveloped areas of the northern Hawaiian Islands, specifically Lisianski Island (Shen and Boyle 1987) and French Frigate Shoals (Miao et al. 2000). Atmospheric releases of lead have been reduced dramatically, first with the phased reduction in lead in gasoline from 1973-1986, and complete elimination of leaded gasoline for highway use in the U.S. in 1996 (USEPA 2000, 2008). However, it is likely that some background level of lead exists throughout Sand Island that is unrelated to lead paint.

During this study, XRF analytical data were simultaneously collected on numerous metals other than lead at all soil sample locations, however at the request of Region 1 Division of Engineering. These data were not included this report. These metals included Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Zr, Mo, Ag, Cd, Sn, Sb, Ba, and Hg. These data should be reviewed and if applicable provided to the Navy if any areas exceed cleanup levels or reveal previously undocumented contaminated areas.

Through the Baseline Realignment and Closure process, the Navy undertook a cleanup operation to remove many environmental contaminants that resulted from 90 years of military operations. Contaminants included polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), petroleum hydrocarbons, asbestos, pesticides such as dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE), and numerous metals. In order to limit exposure by ecological receptors to the contaminants of concern, remedies have been implemented, consisting of soil removal, placement of soil covers, and land use controls. At some sites contaminants of concern were left in place four feet below ground surface. Several areas require continued monitoring for possible further remediation (Ogden Environmental and Energy Services Co., Inc. 2001, Earth Tech 2003, 2004, 2008).

2.2 Exposure Characterization

The objective of the exposure characterization was to identify the media and the pathways through which assessment endpoints may be exposed and affected by site contaminants. Potential exposure pathways are dependent on the extent and magnitude of contamination, the site habitat, the receptor species present at the site, and the environmental fate and transport of lead.

Region 1 Engineering Division requested that this project focus on the incidental ingestion of lead paint as the sole lead exposure pathway documented for Laysan albatross chicks on Sand Island.

Previous reports have documented clinical lead toxicity in albatross chicks on Sand Island (Sileo and Fefer 1987, Sileo et al. 1990, Work and Smith 1996, Burger and Gochfeld 2000a, b, c), Finkelstein et al. 2003). This occurs through incidental ingestion as chicks pick up contaminated material such as leaded paint chips in their mouths to put in their soil cup nests. In addition, Finkelstein et al. (2003) looked at the relationship between lead in the soil, lead paint chips and albatross exposure. Through isotope analysis it was concluded that lead paint chips were a primary source of lead to the chicks. Both small and large particles are consumed during this activity.

In 2008, large paint chips were not as frequently as visible as before and it is believe they have weathered and been “pulverized” into small particles or dust. The smaller particles are mixed into the soil around select buildings and chicks were noted to ingest lead contaminated soils when preening (Taylor and Gorbics, unpublished data).

The above mentioned reports have documented that lead levels in some Laysan albatross chicks on Midway are so high that it damages their peripheral nervous systems, leading to a symptom known as "droopwing.” In this syndrome the chicks are unable to hold their wings tucked up

against their bodies, and their wings often drag on the ground (Figure 7). It is a classic symptom of lead poisoning, comparable to the "wrist drop" symptom in humans. Chicks experiencing lead toxicity severe enough to cause droopwing may survive as long as their parents are feeding them, but once they reach the fledgling stage and their parent leave, they will starve because they can't fly to obtain food. According to refuge staff, Laysan albatross chicks with droopwing are common around the buildings on the island.

Figure 7. Laysan albatross chicks with lead toxicity causing droopwing, on Sand Island, Midway Atoll National Wildlife Refuge, 2008. (Sharon Taylor)

2.3 Problem Formulation

This ecological risk assessment was designed to evaluate the potential threats to ecological receptors from the direct exposure to lead contaminated soil and sediment as well as from the direct ingestion of lead paint chips of varying size. The problem formulation process for this risk assessment includes the identification of the contaminant of concern, the identification of the exposure pathways for the contaminant of concern, a determination of the assessment endpoints for the site, the formulation of testable hypotheses, the development of a conceptual model, the determination of the measurement endpoints for the site, and an analysis of the uncertainties that may be associated with the risk assessment. The problem formulation presented below was developed according to the Ecological Risk Assessment Guidance for Superfund (USEPA 1997).

2.4 Selection of Assessment Endpoints

Assessment endpoints are explicit expressions of the actual environmental values (e.g., ecological resources) that are to be protected. Valuable ecological resources include those without which ecosystem function would be significantly impaired or those providing critical resources (e.g., habitat). Appropriate selection and definition of assessment endpoints are critical to the utility of a risk assessment as they focus risk assessment design and analysis.

A review of the Midway Atoll National Wildlife Refuge and its associated marine and terrestrial habitat provided information for the selection of assessment endpoints, and an evaluation of the food chain routes for exposure. A variety of invertebrates, vertebrates, and plants inhabit the area. Therefore, assessment endpoints are identified for these biological groups.

All of the assessment endpoints suggested by the conceptual model are listed in Section 2.6 of this report. However, as directed by the USFWS, Region 1 Division of Engineering, the investigation was focused only on one assessment endpoint, the protection of nesting avian species. Specifically, Laysan albatross chicks were used as assessment endpoint for this risk assessment. Other receptor species potentially covered by this assessment endpoint are discussed and evaluated qualitatively for future consideration.

2.5 Selection of Measurement Endpoints

As shown for other risk assessments, "measurement endpoints are ecological characteristics that are related to the valued characteristics selected as assessment endpoints. Measurement endpoints are often linked to assessment endpoints by the mechanism of toxicity and the route of exposure. Measurement endpoints are used to derive a quantitative estimate of potential effects, and to form a basis for extrapolation to the assessment endpoints" (Suter et al. 1993).

Measurement endpoints were selected on the basis of potential presence of receptors at the site, and the potential for exposure to contaminants of concern. The availability of the appropriate toxicity information on which risk calculations could be based was also an important consideration. Endpoints selected were determined to be representative of exposure pathways and assessment endpoints identified for the site.

However, as directed by the USFWS, Region 1 Division of Engineering, this investigation was focused only on one assessment endpoint, the protection of nesting avian species, specifically Laysan albatross chicks. Thus, this project concentrated on the soil substrate used as nesting habitat, and the distance from the buildings as our measurement endpoints. Receptor species were selected due to their exposure to lead in paint chips and soil; either by ingestion or skin exposure. Organisms that are likely to be exposed to contaminants because of specific behaviors, patterns of habitat use, or feeding habits were evaluated in this risk assessment, however due to the timing of this project, avian species were used specifically in this risk assessment.

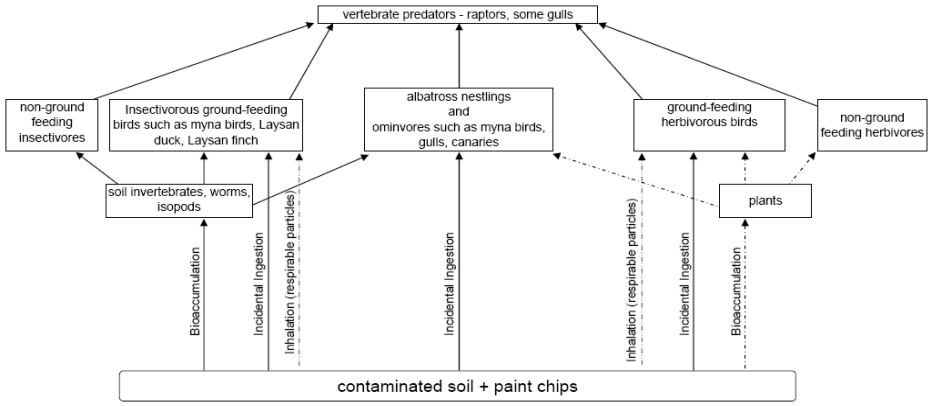
2.6 Conceptual Model

The conceptual model initially developed for this project was based on contaminant and species habitat characteristics (Figure 8).

I. Plants
    - Direct contact with soils

II. Avian nesting species
    - Ingestion of soil
    - Cutaneous contact with soil
    - Ingestion of invertebrates
    - Inhalation of particles

III Soil invertebrates
    - Ingestion of soil
    - Contact with soil



- - - > Pathway expected to be insignificant.
Exposure via inhalation of small respirable particles is expected to be less than exposure via ingestion of particles of all sizes. Exposure for this web is primarily through incidental ingestion through behavior and preening (absent hyperaccumulators, bioaccumulation factors for plants are low and biomagnifications at upper trophic levels is low as well) Bioaccumulation by soil invertebrates may be significant (e.g., spiders, beetles, worms & pill bugs: Heikens et al. 2001)

Figure 8. Conceptual model of lead paint exposure on Sand Island.

Three potential receptor groups that occur on the island include; (1) piscivorous species that obtain food form offshore sources, but whose chicks exhibit oral nest building behaviors that lead to incidentally ingestion of lead contaminated paint chips and possibly soil particles through preening; (2) piscivorous species that nest in burrows which can lead to high levels of contact with and incidental ingestion of contaminated soil; and, (3) omnivorous ground-feeding species (e.g., Laysan duck) that consume terrestrial insects and vegetation that may have accumulated high levels of soil-borne contaminants in their tissues. Of these, only the first was addressed in detail for this assessment, as directed by USFWS Region 1 Division of Engineering.

Organisms that were likely to be exposed to the contaminant of concern because of specific behaviors, patterns of habitat use, or feeding habits were considered to in this risk assessment. The scope of this project concentrated on lead contaminated soil used in nests, and the distance from the buildings shedding lead-based paint chips as measurement endpoints.

2.7 Assessment Endpoint No. 1 - Protection of Laysan Albatross Chicks

Ground nesting avian species are the dominant terrestrial vertebrates found on Midway. The ground-nesting species on the island, including Laysan albatross and bonin petrel, are considered important for their overall numbers (and area that they occupy), their contributions to world populations, and the potential exposure to contaminants on and in soil. Chicks of ground nesting birds are in direct contact with soil in the immediate vicinity of the nest throughout early stages of development. Incidental ingestion of soil and material, dermal exposure, inhalation and consumption of invertebrates that have accumulated contaminants in their tissues are the potential primary routes of exposure to contaminants on and in soil.

The toxic effects of lead extend from alterations in blood chemistry to acute poisoning, often observed in birds that have consumed lead shot or sinkers. Clinical signs of lead toxicity in birds include loss of appetite, lethargy, weakness, emaciation, tremors, droopwing, green liquid feces, and impaired locomotion (Eisler 1988). Studies on adverse effects in avian species and exposure levels associated with those effects have been the subject of reviews such as by Eisler (1988), Franson (1996), and USEPA (2005).

Two measurement endpoints were selected for piscivorous species whose chicks exhibit soil ingesting behavior. The first is the concentration of lead in whole blood (ug/dL) collected from nestlings. The blood lead concentration is a direct measure of exposure that was compared with literature-based benchmarks relating blood lead levels to adverse effects in avian species. The second measurement endpoint for this receptor group was frequency at which symptoms of lead toxicity, most notably droopwing, were observed in nestlings. The incidence of affected individuals from nests in areas with high levels of lead in soil was compared with the incidence of affected individuals from nests in reference areas.

The receptor species, Laysan albatross chicks were selected by Region 1 Engineering Division, due to their documented exposure via ingestion to lead paint chips and soil, and the adverse clinical impacts this had caused, as summarized in Section 2.2 of this report (Sileo and Fefer 1987, Sileo et al. 1990, Work and Smith 1996, Burger and Gochfeld 2000a, b, c), Finkelstein et al. 2003). By 2008, paint chips were not as visible and believed to be pulverized, and chicks were ingesting them along with lead contaminated soil when preening (Taylor and Gorbics, unpublished data).

It should be noted that additional routes of lead exposure could also include inhalation and cutaneous absorption. While inhalation has been a significant route of lead exposure observed in humans, mammals and perhaps even avian species (ATSDR 2007; Schilderman et al. 1997), the exposure is limited to particles that are small enough to be respirable, which is typically <10µM in size (approximate size of very fine silt and much smaller). For the young albatrosses at least exposure to lead via inhalation is expected to be much less significant than lead exposure by ingestion. Inhalation of fine particles may contribute more to total lead exposure by burrowing species that (1) do not intentionally ingest soil or paint chips and (2) spend time excavating, resting and nesting in enclosed space, and where fine particles disturbed by these activities are not dispersed by air movement such as occurs above ground.

During this study, it became apparent that due to the increasing bonin petrel population on the island that lead contaminated soil was being cycled up and down due to the burrowing behavior. Blood samples were collected from a limited number of bonin petrel chicks to gather some baseline lead information on this species. Samples were also collected from several Myna birds.

3.0 METHODS

All sample soil and bird locations were noted with a Global Positioning System (GPS). The data collected was entered into the database daily.

3.1 Sampling methodology

Soil samples and blood samples were collected from multiple reference sites and around seven buildings selected by USFWS, Region 1, Engineering Division (Tables 3, 4, 5 and Appendix A, Figures 1-8). Building selection was also based on building type (poured concrete, wood, metal). Reference stations were selected from random locations in areas determined to be more than 15 meters from any identifiable potential source (i.e., building or structure) of lead-based paint.

Table 3. Locations of lead sampling sites and types of samples collected at each location, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

Number	Building Name	Albatross Blood	Soil (various depths)	Study Buildings 0-5 m inner zone	Study Buildings 5-15 m outer zone	Reference sites	Residences 0-5 m zone
259	**Midway Mall Complex**	x	x	x	x		
342	**Paint & Oil Storage**	x	x	x	x		
353	**Carpentry Shop**	x	x	x	x		
357	**Machine Shop**	x	x	x	x		
414	**Midway House**		x				x
416	**Historic Officers Quarters**		x				x
4203	**BOQ Bravo Barracks**		x				x
4210	**Concrete Duplex**		x				x
424	**Historic Officers Quarters**		x				x
5309	**Transmitter Building**	x	x	x	x		
578	**Marine barracks**	x	x	x	x		
643	**Cable building**	x	x	x	x		
	Reference sites	x	x			x	

Table 4. Summary of number of soil samples by zone (m) and depth (cm), Sand Island, Midway Atoll National Wildlife Refuge, 2008.

Zone	surface	0-7.5	7.5-15	15-22.5	22.5-30	30-45	45-60	60-75	75-90	Total
Reference sites	28	28	26	24	24					130
Residences	34	34								68
Inner 0-5 m	41	35	35	28	29	5	5	5	5	188
Outer 5-15m	40	37	36	34	27	1	1	1		177
Total	143	134	97	86	80	6	6	6	5	563

Table 5. Summary of all avian samples, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

Species	Sample Type			
	blood sample	blood slide	feathers	health assessment
Laysan albatross	103	103	103	103
Bonin Petrel	22	22	22	
Common Myna	3	3	3	
Total	128	128	128	103

Soil and Laysan albatross chick blood samples were collected from two distance zones from the buildings which included an inner zone (0 to 5 meters from the buildings) and an outer zone (5 to 15 meters from the buildings). Each sample location also had soil collected at multiple depths (usually 5 depths) that ranged from a surface scrape to 30 centimeters (or as deep as was possible to sample due to asphalt, rock or coral debris). In addition, 6 locations were sampled down to 90 centimeters. The sample soil collection data sheet can be found in Appendix B.

A minimum of 3 soil and bird samples per 500 square meters were collected in the inner zone around structures which was defined as 0 to 5 meters from the building. A minimum of 3 soil and bird samples per 1000 square meters were collected in the outer zone around structures which was defined as 5 to 15 meters from the building. Actual sample locations were randomly selected over a 2 meter grid established for each building sampled.

Due to concerns about human health, at the end of the planned study, soil samples were also systematically collected around 5 residences with 6 to 8 samples per residence, depending on building size. Samples were taken in the inner zone only and at shallow depths only (surface scrape and 0 to 7.5 cm composite sample).

Avian sampling included three species: Laysan albatross, bonin petrel, and myna bird. Blood lead and bird health condition were evaluated for all Laysan albatross chick samples. Unfortunately, the timing of this project occurred, just as the first chicks with droopwing occurred and not 1-2 weeks later when more cases would have been observed. The location of Laysan albatross chicks sampled was as close as possible to the location of the corresponding soil sample. The bird health assessment data sheet that was used can be found in Appendix C. At the direction of Region 1 Engineering Division, data on bonin petrel are limited and myna bird samples are not included at all.

Insects were also collected using 20 pit traps at each of two locations known to have elevated soil lead concentrations (Appendix A, Figures 15-16). However, at the direction of Region 1 Engineering Division, these samples were not analyzed.

3.2 Sampling Methods: Soil

Standardized methodology was developed specifically for this project. Soil sampling included the following method, with each soil sample location sampled as follows, and in order:

1. Surface sample (shallow scrape from the surface prior to digging)
2. 0 to 7.5 cm (0 to 3 inch) composite sample
3. 7.5 to 15 cm (3 to 6 inch) composite sample
4. 15 cm to 22.5 cm (6 to 9 inch) composite sample
5. 22.5 to 30 cm (9 to 12 inch) composite sample

However, for the additional residence study, only shallow samples were taken as follows:

1. Surface sample (shallow scrape from the surface prior to digging)
2. 0 to 7.5 cm (0 to 3 inch) composite sample

Samples were hand dug with a trowel that was cleaned off between samples. Soil samples were placed in a whirlpak™ bag labeled with the Sample ID number and soil collection depth. A minimum of 50 g of soil per sample was collected for analytical analysis within 24 hours.

3.3 Sampling Methods: Avian

Health Assessment: Systematic evaluations were conducted to assess the overall health of individual birds. Birds were hooded, if necessary, to calm them and reduce stress. Physical examinations were performed, which included standard clinical observations for any abnormalities. Body condition and health were evaluated and scored. The health assessment included but was not limited to:

General appearance – Observations were made on the attitude, posture, activity level, and presence or absence of detectable droop-wing. Clues of illness including ruffling of feathers, partially closed eyes, frequent blinking, tucking head under wing, labored breathing, hunched stance, and shivering were noted.

Body condition and body weight – Body condition was evaluated by manual palpation of the breast muscles and assessment of musculature and fat. Body weight (kg) was determined using a spring scale.

Feathers were checked for being dull or soiled, patchy plumage or loss, and broken feathers.

Skin was checked for scaly, crusty, wounds, pruritus, and swollen discolored lesions.

Eyes were checked for corneal opacities, cataracts, proptosis, and abnormalities in pupillary size or response. In addition, they were checked for crusty or watering, swelling eyelids.

Ears were checked for crusty or sticky exudates with otitis, growths and foreign bodies.

Beak was checked to determine if it was cracked or crusty, misshapen, overgrown, and/or soiled. The oral cavity for mucosal lesions, parasitic or fungal infections, and abscesses. Nares were checked for discharge, crusting, or fracture operculum.

Thorax was checked for asymmetry of pectoreal musculature, sternal fractures, and misshapen sternum.

Abdomen was checked for emaciation, distention, tumors, and fractures.

Cloaca was checked for green soiling, prolapse, and tears.

Wings were checked for neurological disorders, fractures, luxations, joint swelling, necrosis, and broken feathers

Legs and feet were checked for deformities, fractures, paresis, neurological disorders, dermatitisis, talon deformities, and necrosis.

Sample Collection from Live Birds: Blood was drawn using a 1 or 3 cc syringe and 23 or 25 gauge beveled needle from the cutaneous ulnar vein. Blood was then alloquated into lithium heparin (green top), EDTA (purple top), or 1 ml serum (red top) microtainer tubes. In some cases, blood volume drawn from the birds (i.e. chicks) was insufficient for all samples. The green and purple top blood tubes were rotated to mix the anticoagulants with the blood. Blood slides were made using traditional clinical pathology methods. All blood tubes were stored in coolers, and refrigerated when possible. Several feathers from each bird were collected into sterile whirlpak™ bags for future lead and isotope analysis.

3.4 Sampling Methods: Insects

Approximately 20 pitfall traps were established within a 5 meter buffer zone around each of two buildings known to have lead contamination and also designated for soil and bird sampling (buildings # 643 and 578). Holes were dug with a trowel or bulb planter the same width as the cups used in the study. Each trap consisted of two or more nested 8-oz. plastic cups.

Each inner cup was partially filled with a mixture of water and detergent to contain the insects. The outer cup was left in place to preserve the shape of the hole between sampling periods. Sampling continued over a 5-day period. During each sampling period, pitfall traps were emptied of all insects. Insects from each building and zone were combined and placed into bags and frozen future off-site laboratory analysis for lead. Chemical analyses were not conducted at the request of Region 1 Engineering.

3.5 Sample Preparation and Analysis Methods

3.5.1 Soil Sample Preparation and Lead Analysis

Soil samples were sieved through a #14 (1.4 mm) sieve to remove rocks, coral and other large debris, yet still retain coarse and fine sand material, and mixed thoroughly. The large debris was examined for large paint chips, and the sieved material was sampled. Approximately 25 grams of sieved material was placed in a drying pan and dried in a 150 degree F oven for a minimum of three hours to remove moisture and then analyzed. The remaining split sample was retained undried for archiving in the whirlpak™ bag. These archived soil samples were shipped to Region 1 Engineering in June 2009.

The lead content in soil was determined with a portable X-Ray fluorescence device (XRF) (InnovX Alpha Series XRF). The XRF device is a portable hand-held detector designed to make fast and accurate non-destructive measurements of lead concentrations in soil. XRF technology is universally recognized as a very accurate method of measuring the atomic composition of a material by irradiating a sample with high energy photons such as x-rays and observing the resulting x-ray fluorescence emitted by the sample.

Although field sample testing using the XRF is considered a field-screening method, it is a valuable technique because it generates a great deal of data rapidly. In order to ensure the XRF was operating effectively, an energy calibration check was performed during every operating period. The XRF factory supplied calibration is based on the Compton Normalization method. This method (recognized in EPA 6200) offers speed, ease of use, and generally good accuracy for concentration ranges from the parts per million (ppm) levels up to 2-3 percent concentrations and was considered acceptable. All the calibration checks passed. In addition, periodically an instrument blank using the SiO2 (silicon dioxide) blank provided with the analyzer was performed. The purpose of this test is to verify there is no contamination on the analyzer window or other component that is “seen” by the x-rays. All the analyses of the blank resulted in a non-detectable lead level.

Finally, while conducting this study, there were regular calibration verification preformed using National Institute of Standards and Technology (NIST) standard reference material (SRM) samples. The difference between the XRF result for an element and the value of the standard is recommended to be 20% or less by EPA Method 6200. The mean difference from NIST SRMs was less than 22% for all three SRMs. This was considered acceptable for this project’s field-screening method.

Table 6. XRF calibration check results (ppm) for lead, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

	Low (NIST 2709)	**Medium (NIST 2711)**	**High (NIST 2710)**
NIST value	18.9	1162	5532
22% range	14.7-23.1	906.4-1417.6	4315.0-6749.0
Midway Mean	14.8	907.7	4379.8

Sample moisture can be of concern in XRF field assessment. Sample moisture alters the soil chemistry, since water is another chemical compound that comprises the soil matrix. Additionally, moisture impedes the ability to properly prepare samples. Moisture in the field analyzed samples would also prevent a meaningful comparison of off-site laboratory results since laboratory results are provided on a "dry weight" basis. Thus, with all other factors the same, the laboratory will report results higher than portable XRF if undried samples are analyzed with the XRF. The results will be higher by the amount of moisture content in the sample. For example laboratory results will be 10% higher compared to XRF results, if the sample contained 10% by weight water when it was tested with XRF. Therefore, in this study samples were dried in a 150 degree F oven for a minimum of 3 hours to remove soil moisture prior to analyzing with the XRF to remove this source of potential interference.

Sample homogenization was also an important consideration. Samples in this study were sieved and mixed; however, they were not ground. Samples were composed of small grain sand that could not be further pulverized with a mortar and pestle. Therefore, some inconsistencies with off-site laboratory analyses may potentially be realized. However, this preparation was determined to be acceptable for this project.

Procedures for the operation of the XRF, were followed as found in the manual. The lead concentration in ppm and the confidence interval were recorded for each sample in the XRF onboard computer. The data stored in the XRF was downloaded to a personal computer on a daily basis. The detection limit for lead in soil by this analysis is 13 ppm.

3.5.2 Avian Blood Preparation and Lead Analysis

Blood was refrigerated after collection and within 8 hours underwent the treatment reagent (1% Hydrochloric Acid; Chemical Abstract Service (CAS) # 7647-01-0) and analyzed using the LeadCare II kit.

The lead content in the collected blood for all species was determined through the use of a blood lead analyzer (LeadCare II) (ESA, Inc. 22 Alpha Road, Chelmsford, MA 01824; www.esainc.com). This instrument analyzes lead by the anodic stripping voltammetery principle, by electroplating lead in the sample onto a gold anode, and then removing the lead with a stripping current and integrating the total current released during the stripping. The total current produced in the release phase is proportional to the lead concentration in the sample. The detection limit reported by the manufacturer is 3.3 ug/dL (0.033 ppm); range of the instrument is 3.3-65 ug/dL (0.033-0.65 ppm); analysis time is 3 minutes.

In order to ensure the LeadCare II was operating effectively during the field effort, the quality control procedures recommended by the manufacturer were followed. The machine was calibrated daily the level 1 and level 2 control samples (bovine serum albumin solution with salts, dye and lead; CAS # 7439-92-1) supplied by the manufacturer. In all cases, the control values were within the acceptable range provided for that control.

The efficacy of the LeadCare II compared with conventional laboratory results was considered. A correlation of lab results with LeadCare II results was provided by the manufacturer and showed a high correlation for human blood (r^2=0.984) (Feeney and Zinc 2006). They analyzed 108 whole blood human samples by the LeadCare® II system and the reference method, Graphite Furnace Atomic Absorption Spectroscopy (GFAAS). A similar comparison using bird blood (i.e. California Condor) also showed a high correlation (r^2 = 0.828; Fry 2003). This correlation was considered to be acceptable.

4.0 RESULTS

A total of 563 soil and 128 avian samples were analyzed for lead on Sand Island in April 2008 as part of this project.

4.1 Results of Soil Analysis

Table 7 and Figures 9, 10 provide a summaries of the results obtained with soil using arithmetic means, with non-detects (i.e. concentrations <13 ppm) set at 0.0 ppm (as per Region 1 Engineering). Appendix F, Figures 1-9 provide the complete data set and maps of lead levels by soil depth.

Mean concentrations measured in soils from reference locations ranged from only 15 ppm to 67 ppm, depending on the depth interval (Table 7). Reference stations were selected, with input from Region 1 Engineering Division, from areas known to be >15 meters from known buildings. As such, the reference stations are presumed to be uncontaminated, but with some potential for a fraction of the samples to have higher levels of contaminants. For example, the maximum lead concentrations measured in subsurface samples from reference station #16 (1,041 ppm at 15 cm depth) and station #18 (358 ppm at 15 cm depth) appear to be elevated to the extent of being statistical being outliers. Because of the locations (i.e. >15 meters from a building), results from stations #16 and #18 are still considered part of the reference pool. However, it may be desirable in the future to evaluate the occurrence of lead further at station #16 at least.

The arithmetic mean concentrations used for this report allow for simple estimates of summary data, particularly given that non-detects were set to 0.0 ppm and lead levels in approximately half of the samples from reference areas are below the limits of detection. The frequency of non-detects in reference area samples impeded efforts to characterize the distribution of the data, and efforts to normalize the distribution by applying transformations (even to detected concentrations only) were unsuccessful. As a result, it was not possible to ascertain if the high concentrations reported for two reference sample stations are statistical outliers, and all of the reported values were included in estimates of means as representative of randomly selected sites away from buildings. Absent a separate and extensive analysis of the distribution of data for the reference areas, and therefore the calculation of statistical limits, the higher of the means (67 ppm) is considered a rough estimate of the upper limit for lead concentrations in reference area soils. A review of all the data for reference area samples, regardless of depth indicates that lead concentrations are below 67 ppm in 93% of all of the samples (N=130).

Table 7. Mean lead concentrations (ppm) in soil at each sample location by building distance zone (inner and outer) and depth (cm), Sand Island, Midway Atoll National Wildlife Refuge, 2008.

		Inner Zone 0 to 5m from building Sample Depth (cm)					Outer Zone 5 to 15m from building Sample Depth (cm)				
Building Number	**Building Name**	**surface**	**0 to 7.5**	**7.5 to 15**	**15 to 22.5**	**22.5 to 30**	**surface**	**0 to 7.5**	**7.5 to 15**	**15 to 22.5**	**22.5 to 30**
643	**Cable building**	725	806	752	771	456	88	93	100	108	100
578	**Marine barracks**	442	385	610	320	85	48	65	55	55	73
259	**Midway Mall Complex**	177	139	114	106	61	68	107	74	38	45
357	**Machine Shop**	445	269	284	159	60	235	227	123	100	85
5309	**Transmitter Building**	81	59	38	36	10	130	124	127	585	160
342	**Paint & Oil Storage**	474	651	570	135	275	214	1183	1044	210	212
353	**Carpentry Shop**	331	317	129	180	117	281	306	508	170	64
	Reference	25	32	67	15	20					

Figure 9. Mean soil lead concentrations (ppm) by building, depth (surface to 30 cm) and zone, Sand Island, Midway Atoll National Wildlife Refuge, 2008. Red bars represent inner (0-5m from building) zone; yellow bars represent outer (5-15m from building) zone; green bars represent reference sites.

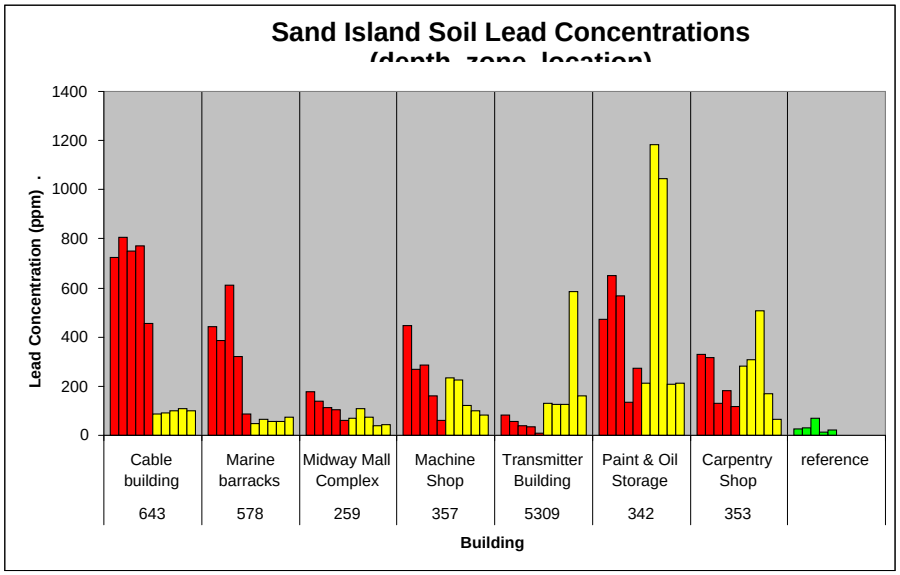
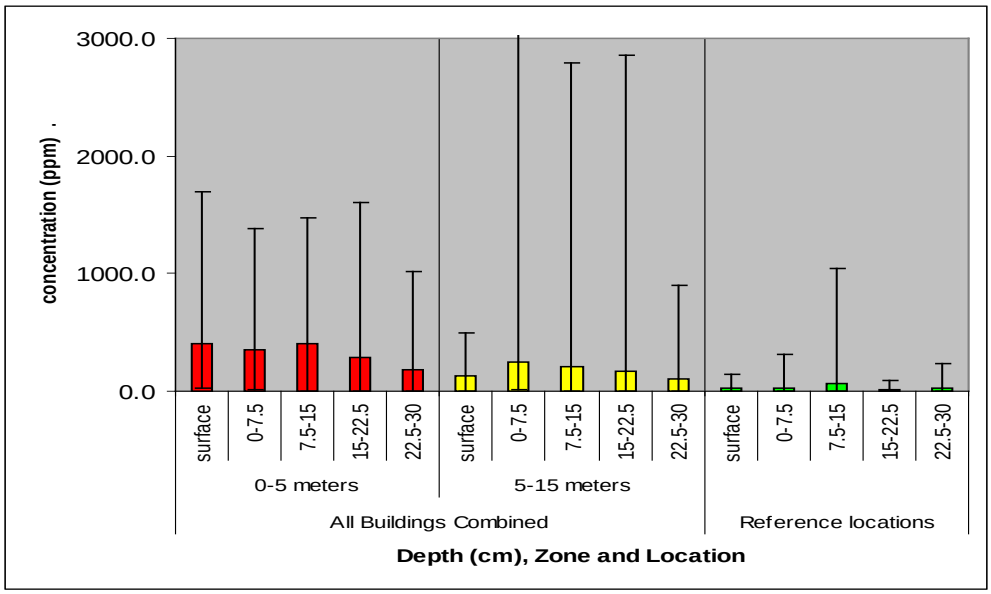


Figure 10. Mean soil lead concentrations (ppm) by depth and zone and locations combined, Sand Island, Midway Atoll National Wildlife Refuge, 2008**.** Red bars represent inner (0-5m from building) zone; yellow bars represent outer (5-15m from building) zone; green bars represent reference sites.



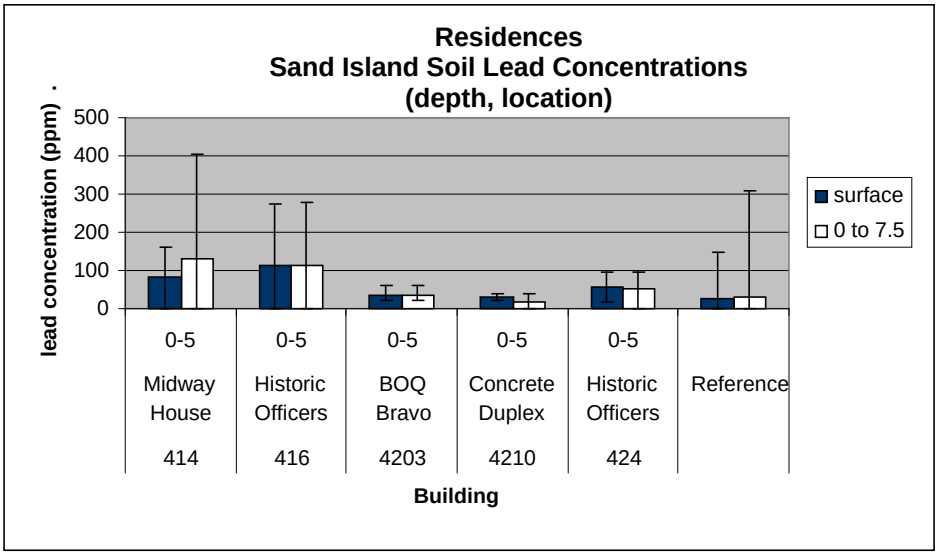
4.2 Results of Soil Analysis - Residential Buildings

Table 8 and Figure 11 provide a summary of the preliminary results for residential buildings (with non-detects calculated as 0.0 ppm for this analysis, as per Region 1 Engineering). Appendix F, Figures 10-11 provides the complete data set of lead level maps by soil depth.

Table 8. Mean lead concentrations (ppm) in soil at each residential location and each depth, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

Building Number	Building Name	Inner Zone (m)	Surface			0 to 7.5 cm		
			mean	min	max	mean	min	max
414	**Midway House**	0-5	84	0	159	131	0	403
416	**Historic Officers Quarters**	0-5	112	0	273	113	0	280
4203	**BOQ Bravo Barracks**	0-5	33	21	61	35	22	60
4210	**Concrete Duplex**	0-5	30	22	41	16	0	38
424	**Historic Officers Quarters**	0-5	57	18	96	54	0	96
	Reference		25	0	149	32	0	310

Figure 11. Mean soil lead concentrations (ppm) at each residential location, Sand Island, Midway Atoll National Wildlife Refuge, 2008. All soil depths are combined. Bars show minimum and maximum concentrations.



4.3 Birds - Blood and Body Condition

Tables 9 and 10 and Figures 12 - 14 provide a summary of the preliminary results on blood lead levels and body condition obtained with Laysan albatross and Bonin petrel nestlings. Mean blood lead levels were calculated using 0.0 ug/dL as a surrogate for non-detects, and 66 ug/dL as a surrogate for concentrations too high to read by the instrument (i.e., >65 ug/dL). Appendix G provides the complete data set for birds. Briefly, results indicate that nearness to buildings has a noticeable effect on lead exposure by Laysan albatross nestlings.

Table 9. Mean blood lead concentrations (ug/dL) by avian species, zone and location, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

		Inner Zone 0 to 5m from building Blood Lead ug/dL		Outer Zone 5 to 15m from building Blood Lead ug/dL	Reference Sites Blood Lead ug/dL	
Building Number	**Building Name**	**Bonin petrel**	**Laysan albatross**	**Laysan albatross**	**Bonin petrel**	**Laysan albatross**
643	**Cable building**	15.24	29.02	10.80		
259	**Midway Mall Complex**		35.90	5.14		
342	**Paint & Oil Storage**		29.07	29.40		
353	**Carpentry Shop**		66.00	18.23		
357	**Machine Shop**		41.38	4.64		
5309	**Transmitter Building**		3.23	2.12		
578	**Marine barracks**		43.62	3.18		
	Reference Sites				2.67	1.64

Figure 12. Mean Laysan albatross chick blood lead concentrations (ug/dL) by location, Sand Island, Midway Atoll National Wildlife Refuge, 2008. Red bars represent inner (0-5m from building) zone; yellow bars represent outer (5-15m from building) zone; green bars represent reference sites.

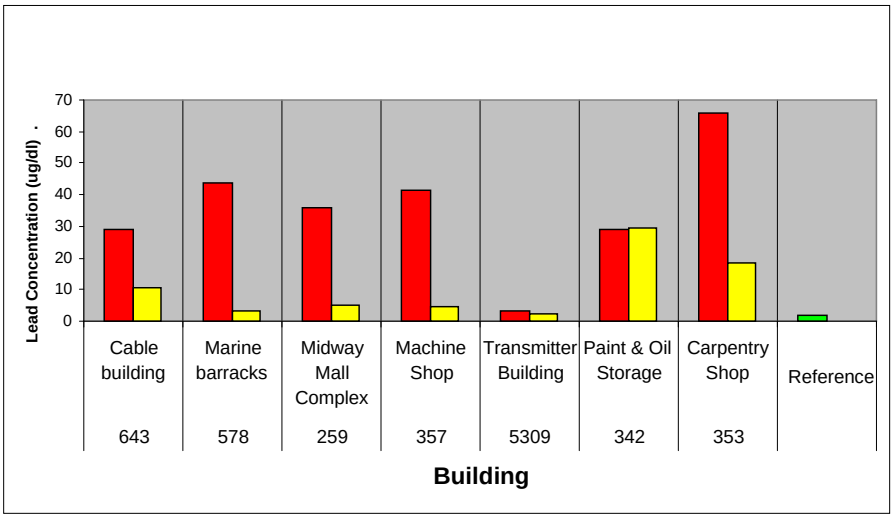


Figure 13. Summarized Laysan albatross chick blood concentrations (ug/dL) by zone and reference site, Sand Island, Midway Atoll National Wildlife Refuge, 2008. Red bars represent inner (0-5m from building) zone; yellow bars represent outer (5-15m from building) zone; green bars represent reference sites.

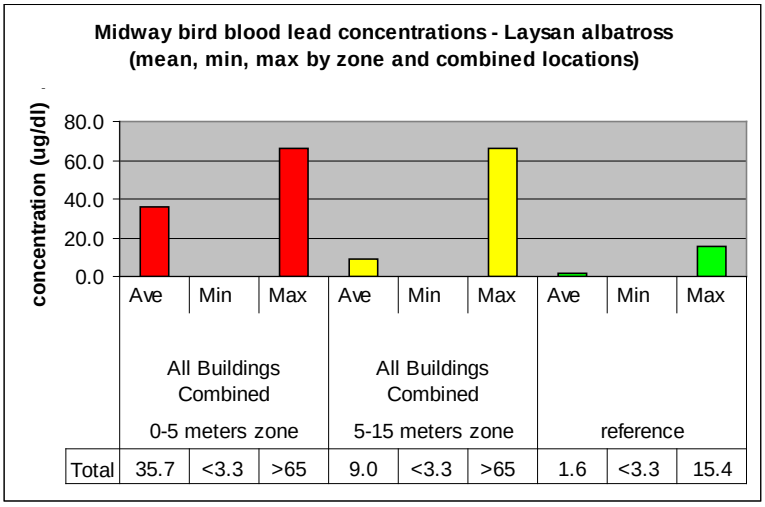


Figure 14. Summarized bonin petrel blood concentrations (ug/dL) by zone and reference site, Sand Island, Midway Atoll National Wildlife Refuge, 2008. Red bars represent inner (0-5m from building) zone; yellow bars represent outer (5-15m from building) zone; green bars represent reference sites.

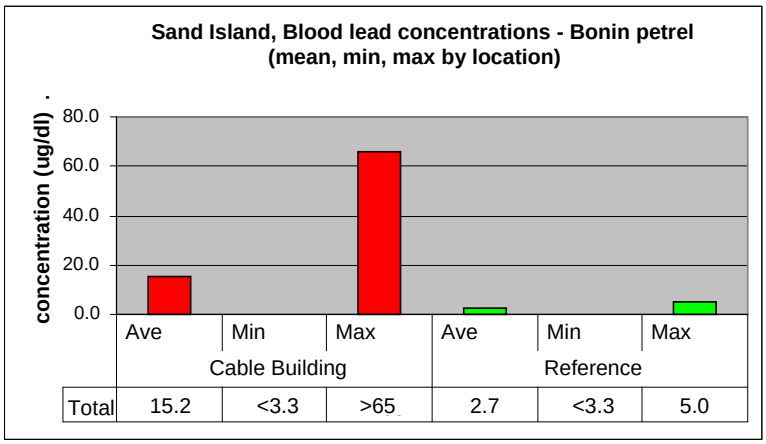


Table 10. Laysan albatross chick body condition and weight summary, Sand Island, Midway Atoll, National Wildlife Refuge, 2008.

Physical Condition Score*	Chick Weight (kg)	Zone or Location		
		Inner 0-5m	Outer 5-15m	Reference
1	average	1.4	1.4	1.1
	minimum	0.7	1.1	1.1
	maximum	2.3	1.7	1.1
	n =	6	4	1
2	average	2.1	1.6	
	minimum	1.8	1.1	
	maximum	2.6	1.9	
	n =	6	6	
3	average	2.2	2.2	2.3
	minimum	1.1	1.2	1.5
	maximum	3.2	3.3	3.1
	n =	12	12	11
4	average	2.9	2.3	2.4
	minimum	2.5	1.7	1.7
	maximum	3.3	2.9	3.1
	n =	1	9	7
5	average	2.7	2.5	3.3
	minimum	2.0	1.9	2.0
	maximum	3.3	3.1	4.7
	n =	9	8	9

* In general, a score of 1 indicates the bird is emaciated, while a score of 5 indicates the bird is obese

5.0 RISK CHARACTERIZATION

5.1 Risk Characterization Assumptions

Lead exposure by Laysan albatross chicks, and to a lesser extent by bonin petrel chicks, was measured directly. Consequently, it was unnecessary to model exposure, which would have entailed the use of conservative (i.e. protective) assumptions where there is uncertainty about exposure factors, such as the amount of food ingested per day. There is a great deal of uncertainty about the amount of soil and paint chip ingestion that may occur with Laysan albatross chicks, which actively seek and may incidentally ingest lead-contaminated paint chips and, coincidentally, lead contaminated soil. Obtaining direct measures of exposure as lead ug/dL blood eliminated the need to identify what would be reasonable and conservative assumptions needed to estimate exposure. The assessment incorporated conservative assumptions beyond those that may have been used to estimate exposure.

As requested by USFWS Region 1 Division of Engineering, a detailed and quantitative characterization of risk was focused on one receptor group only, Laysan albatross chicks.

The following conservative protocols were employed to conduct the risk characterization:

> Blood lead levels measured in Laysan albatross chicks were compared with benchmarks based on low observed effects concentrations (LOECs; as lead ug/dL whole blood) for most sensitive toxic responses observed under chronic exposure conditions by sensitive avian species. While the selected benchmark is a LOEC for a biochemical response (reduced activity of delta-aminolevulinic acid dehydratase or ALAD), it is a no observed effect concentration (NOEC) for sensitive clinical response (hematological changes associated with anemia) in avian species. A LOEC for ALAD inhibition is considered to be a conservative benchmark for adverse effects, because NOECs for clinical effects in studies where both ALAD inhibition and other endpoints were considered tend to be higher than the LOECs for ALAD inhibition only. In his review, Franson (1996) indicated that a concentration >10 ug/dL is a threshold for clinical effects in sensitive species. This is the low end for clinical effects in falconiformes (Franson et al. 1983) and is lower than approximate thresholds for members of the columbiformes (>20 ug/dL) and galliformes (>50 ug/dL). Work and Smith (1996) identified a potential NOEC of 0.3 to 0.5 µg/dL for ALAD inhibition in albatrosses. It was based on ALAD activity in adults which, because they spend so little time on land have very little contact with lead contaminated media. At less than 2 µg/dL, the NOEC for ALAD inhibition in adult albatrosses is below what is considered background for species tied to terrestrial settings (Franson 1996), and may be unachievable for the land-based albatross chicks. In addition, ALAD activity responds quickly to changes in lead exposure and activity will recover when exposure ceases.
>
> Lead exposure was evaluated on an individual-by-individual basis, thereby ensuring assessment of risk by all individuals, including those from areas of heaviest soil contamination.

5.2 Risk Characterization Methodology

Risk to Laysan albatross chicks was quantitatively characterized by comparing measured blood lead levels to a NOEC-based benchmark of 10 ug Pb/dL (or 1 part per million wet weight) for whole blood. A hazard quotient (HQ) was calculated for each bird as the ratio of the measured concentration to the 10 ug/dL benchmark. It was concluded that there is no risk of adverse lead-related effects for individuals with an HQ $\leq$1.0.

Grouping nests according to zones representing proximity to buildings (and leaded paint chips) was part of the sampling strategy to help ascertain relationships between the lead concentration in nestling blood and lead concentrations in the soils around the nest. Results of HQ estimates were evaluated according to zone.

5.3 Risk Characterization Results - Protection of Laysan Albatross Chicks

A review of studies on toxic levels as daily dose rates (mg/kg-day) in avian species, indicates that hematological responses (inhibition of ALAD, anemia) are the most sensitive of the endpoints studied for evidence of effects, followed at increasing dose rates by impacts on reproduction, behavior, pathology, growth and survival (USEPA 2005).

Franson (1996) identified three basic levels of adverse effects in avian species and the corresponding tissue lead levels associated with those effects. The least severe is "subclinical" for which there is evidence of biochemical response (e.g., reduced ALAD activity) but no physiological response (e.g., anemia), and for which the individual will recover normal function upon cessation of exposure. "Toxic" levels are approximate thresholds for onset of clinical symptoms which include, with increasing exposure, anemia, lesions in tissues, weight loss, poor coordination, diarrhea and loss of appetite. The most severe effect is death. Raptors appear to be among the most sensitive to lead of species tested, which include galliformes and collumbiformes. Approximate threshold blood lead levels identified for raptors by Franson (1996) are 2 - 15 ug/dL for subclinical effects, >10 ug/dL for toxicity and >50 ug/dL for compatible with death.

Blood lead levels are reported for 103 Laysan albatross chicks. Of those, 69 had concentrations below thresholds for sensitive clinical effects (<10 ug/dL), 23 had concentrations associated with toxicity (10 ug/dL - 50 ug/dL), and 11 had concentrations consistent with lethality (> 50 ug/dL) in sensitive avian species. Based on results in Table 9, lead exposure poses more risk to albatross chicks from nests near buildings (HQs >1.0 and up to 6.6) than for chicks from reference areas (HQs <1.0). Hazard quotients were higher and more frequently exceeded a value of 1.0 for chicks from nests within 5 meters of buildings, than for chicks from nests between 5 and 15 meters from buildings. Hazard quotients based on blood lead levels indicate that albatross chicks, particularly those in nests near buildings with lead-based paint are at elevated risk of adverse effects from exposure to lead. Blood samples were collected in the middle of the nesting season, and a higher incidence of elevated blood lead levels may have been observed if samples were collected later in the season.

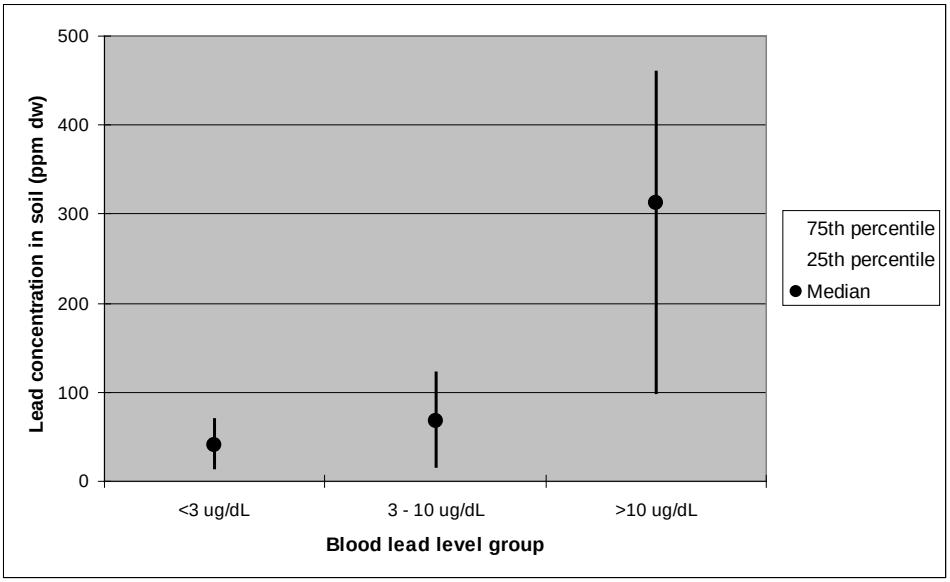
Studies that report doses, but not tissue or blood lead levels are reviewed by USEPA (2005), and provide evidence of other effects that may occur with lead exposure in the "toxic" range by Franson (1996). Other adverse effects from sublethal exposure to lead include decreased egg laying capacity, accompanied by hypocalcemia in females, eggshell thinning and immune dysfunction (USEPA 2005; Edens and Melvin 1989). Droopwing is one symptom of lead poisoning reported for albatross chicks on Midway (Sileo and Fefer 1987; Work and Smith 1996; Finkelstein et al. 2003). Blood lead levels associated with wing droop in albatross chicks from the 2000 & 2001 nesting seasons at Midway were >100 µg/dL, which is in the "compatible with death" range identified by Franson (1996). This, and recognizing that droopwing can be caused by other factors (USFWS 1987) indicate that wing droop is not necessarily the most reliable or protective measure of lead exposure at levels associated with other toxic effects.

5.4 Potential Cleanup Goal for Protection of Laysan Albatross Chicks

The relationship between blood lead level and soil lead level was evaluated to help identify potential soil cleanup goals that would be protective of the albatross. Ideally, a soil cleanup goal can be selected that will ensure that blood lead levels in albatross nestlings not exceed 10 ug/dL (Figure 15).

Initially, results were evaluated for evidence of correlation between the concentration of lead in nestling blood and that of lead in soils around the nestling's nest. Data pairs for which lead was detected in both nestling blood and surface soil (depth = 0 inches) were used. A total of 103 potential records were identified. Of those, 49 provide specific values for lead concentrations in surface soil and in the blood of nestlings. However, the data were variable and efforts to develop a regression were unsuccessful. Instead, data on blood lead levels were grouped according to a threshold for detection of lead in the blood (<3 ug/dL), and the threshold for assessing risk (10 ug/dL). This approach enabled the inclusion of results that were reported as less than the limit of detection (approximately 3 ug/dL for blood and 13 mg/kg in soil) and greater than an upper analytical limit for blood lead analysis (i.e., >65 ug/dL). A total of 103 data pairs were categorized according to blood lead levels, and the associated soil lead levels in each category were characterized using non-parametric descriptors (quartiles with linear interpolation between two points if necessary), which are not sensitive to assumptions about how the data are distributed. Median, upper (75th) and lower (25th) quartile concentrations of lead in soil for each blood lead-based category reflect a distinct dichotomy exhibited by the data (Figure 15): Soil lead concentrations where chick blood levels are below 10 ug/dL are generally less than 100 ppm and are less than 300 ppm approximately 95% of the time (i.e., in 65 out of 69 samples), whereas soil lead concentrations where chick blood lead levels exceed levels of concern are generally around 340 ppm and are below 100 ppm less than 15% of the time (i.e., in 5 out of 34 samples). This suggests that maintaining soil lead concentrations below 100 ppm will be protective of albatross chicks, such that blood lead levels are not likely to exceed 10 ug/dL and may indeed not even exceed the limits of detection (3 ug/dL).

Figure 15. Lead levels in soil compared to Laysan albatross chick blood concentrations (ug/dL) by clinical lead group, Sand Island, Midway Atoll National Wildlife Refuge, 2008.



6.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the data analysis and site investigation:

Background lead soil levels on Sand Island are likely to be less than 67 ppm, based on results from multiple reference sites, which by definition were randomly selected from areas away from buildings or other structures.

Ideally, a soil cleanup goal can be selected that will ensure that blood lead levels in albatross nestlings not exceed 10 ug/dL.

Maintaining soil lead concentrations below 100 ppm will be protective of albatross chicks, such that blood lead levels are not likely to exceed 10 ug/dL and may indeed not even exceed the limits of detection (3 ug/dL).

A review of the current activities indicates that ongoing deterioration of abandoned buildings and maintenance of existing buildings could continue to add lead contamination to Sand Island. Other potential sources of lead appear to be stable or potentially decreasing in deposition level (atmospheric).

Additional soil sampling will be necessary to map the boundaries (depth and distance) of contaminated areas. It is recommended that an XRF be used to efficiently delineate contamination of soil around individual buildings scheduled to be remediated.

Although elevated lead concentrations occurred primarily at shallow depths, it was observed at deeper depths in some locations. Some locations with little or no elevated surface concentrations had high subsurface concentrations. These results suggest there are buried wastes in some of the locations sampled.

Lead concentrations measured in shallow soils (down to 15 cm, or 6 inches) from the outer zone of the Paint and Oil Storage building, and at reference station #16 are sufficient to consider cleanup or further investigation.

Laysan albatross chicks that are located within 5 meters of a building known to have lead contaminated soil at higher levels are at a higher risk of lead poisoning. These contaminated soils pose continued risk to chicks if left in place.

During the site investigation, few visible paint chips on the ground were observed including in areas where birds had elevated blood lead levels. However, soil lead was elevated in areas where birds had elevated blood lead levels. Therefore, the conclusion is that elevated lead concentrations in soil (this study) or paint chips on the ground (other studies) can contribute to lead toxicity severe enough to cause Laysan albatross chick adverse effects.

Bonin petrels burrow below ground and there was evidence of soil cycling from below ground to above ground and vice versa.

Blood lead levels of some bonin petrel chicks were elevated around buildings with increased lead soil levels but not at reference sites. Additional study is required to determine (a) depth of burrows, (b) effects levels for lead in bonin petrels chicks, (c) exposure of adult bonin petrels, and (d) extent of movement of lead through the soil column due to petrel burrowing activity.

Additional study is required on the lead pathway to determine if Laysan ducks or Laysan finches are at risk.

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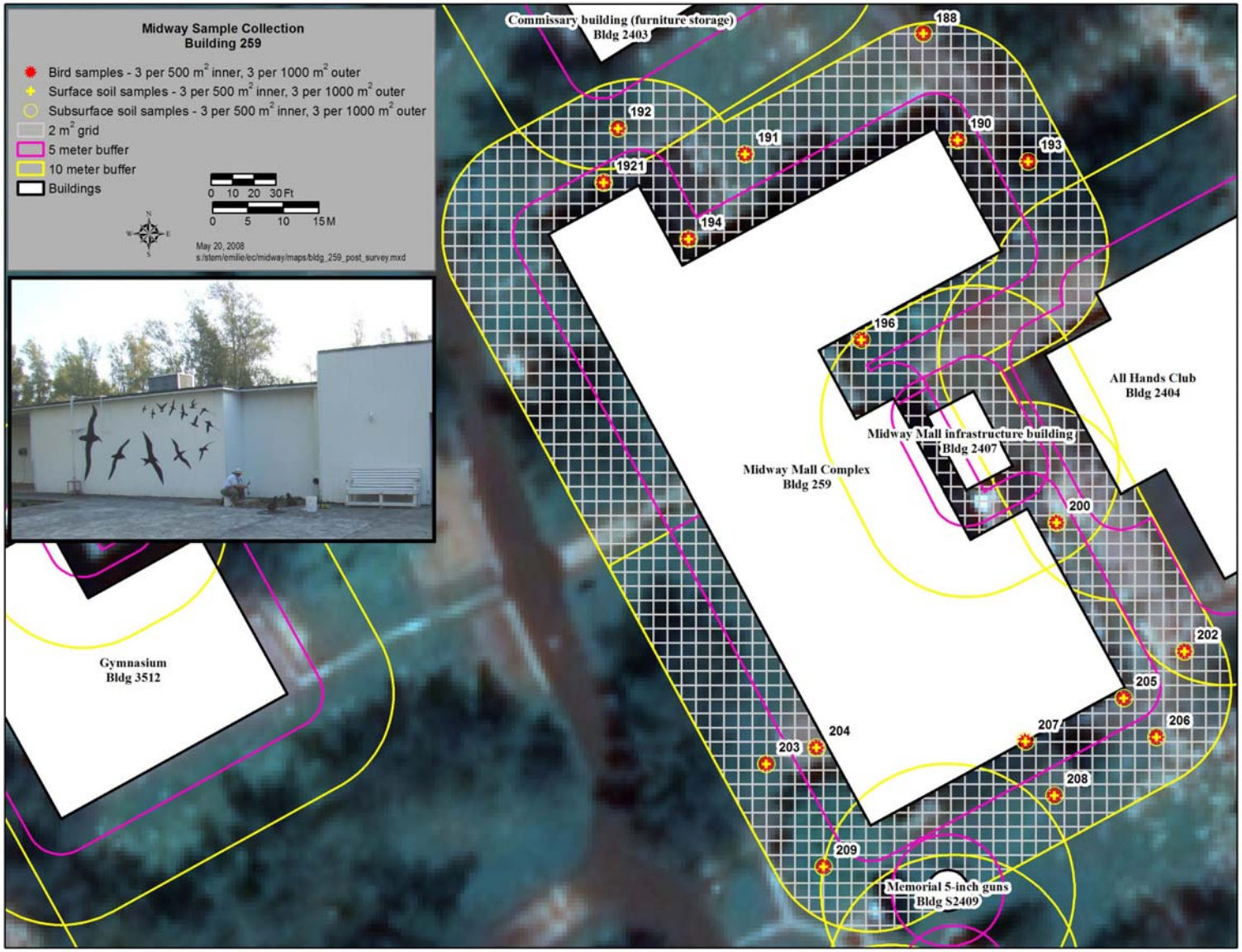
1.

Appendix A, Figure 1. Building locations for Lead Study, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

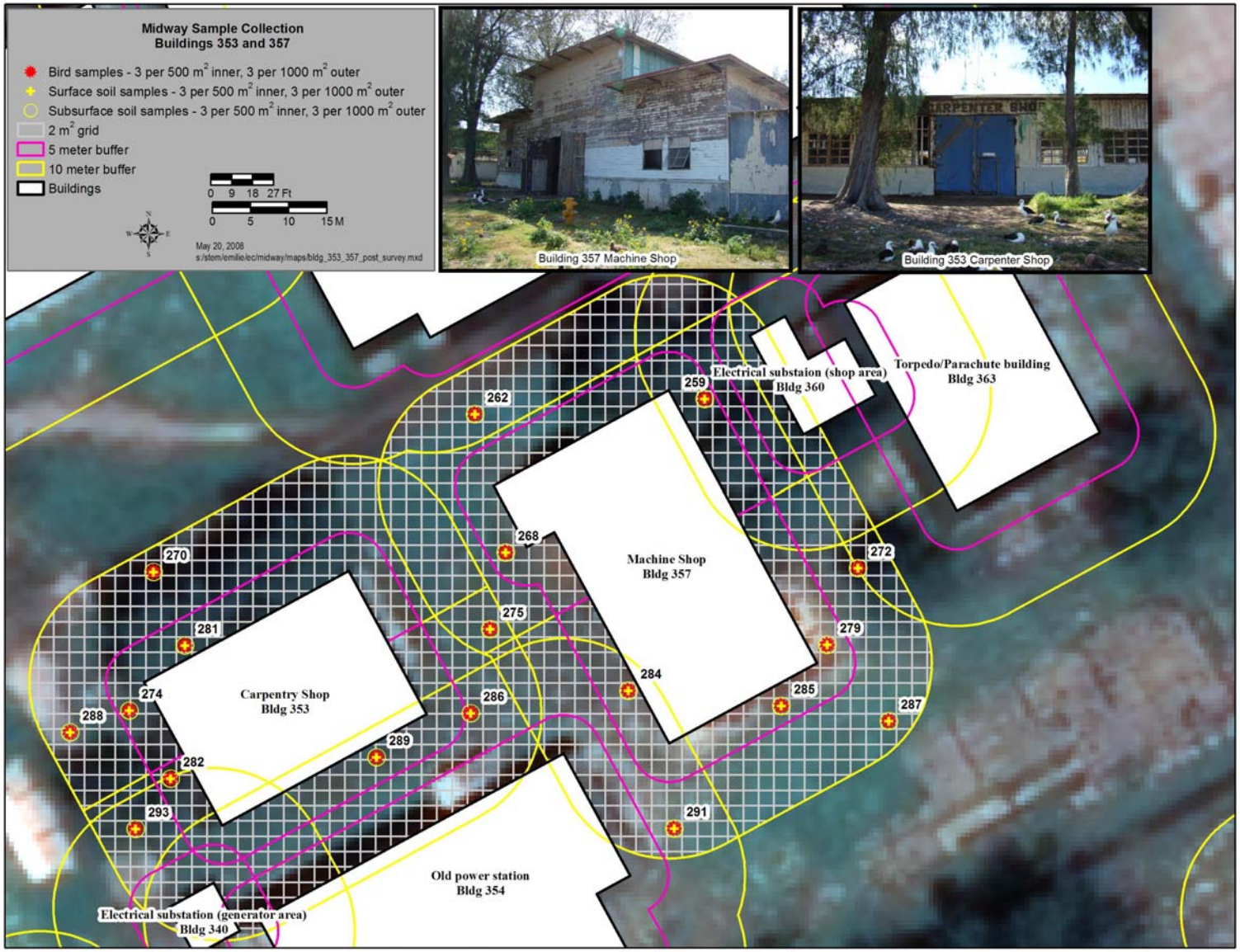


2.

Appendix A, Figure 2. Lead Study sample locations for Building 259, Sand Island, Midway Atoll National Wildlife Refuge, 2008.
Note: Part of the building was surrounded by pavement and was not sampled.

3.

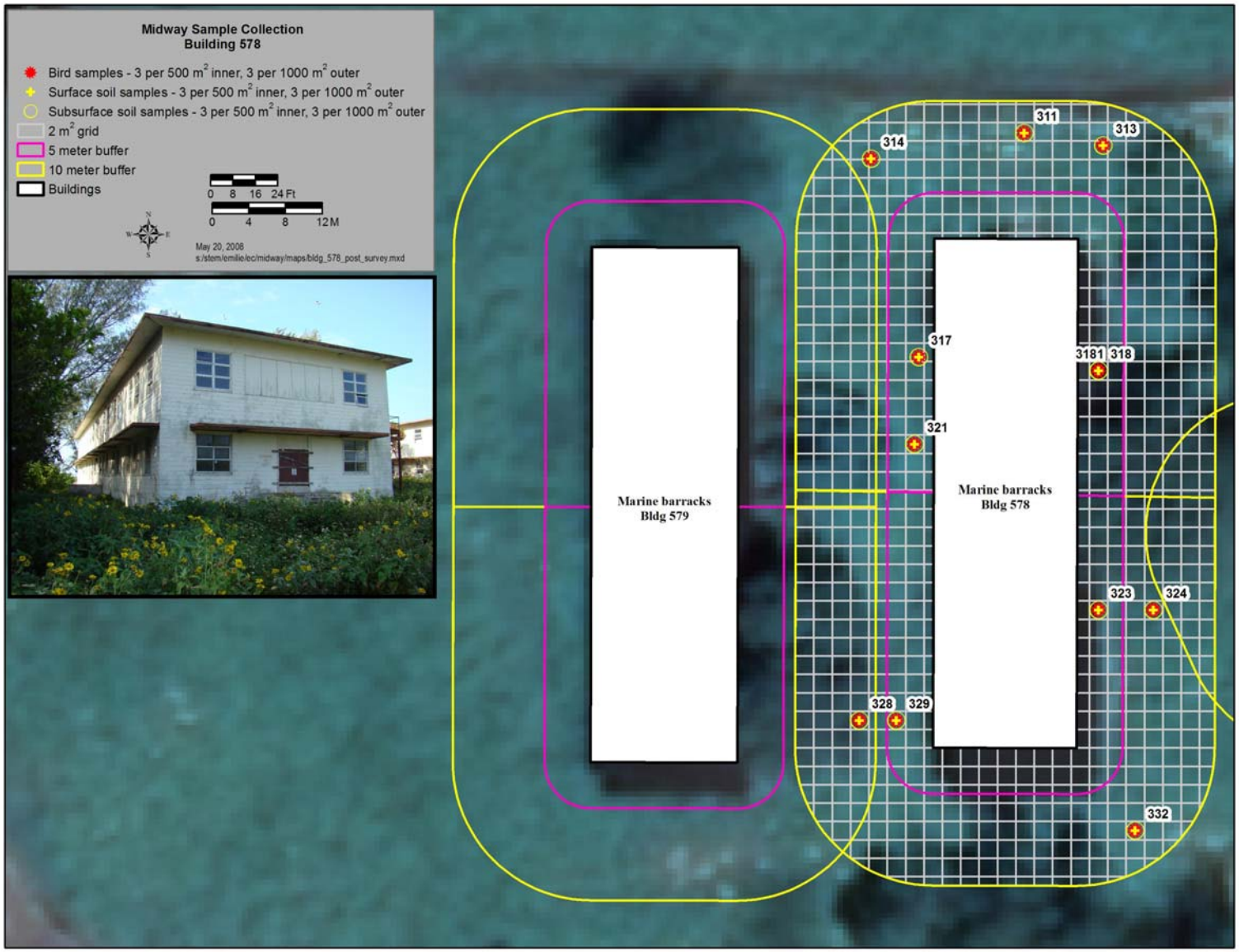
Appendix A, Figure 3. Lead Study sample locations for Building 342, Sand Island, Midway Atoll National Wildlife Refuge, 2008.
Note: Part of the building was surrounded by pavement and was not sampled.



4.

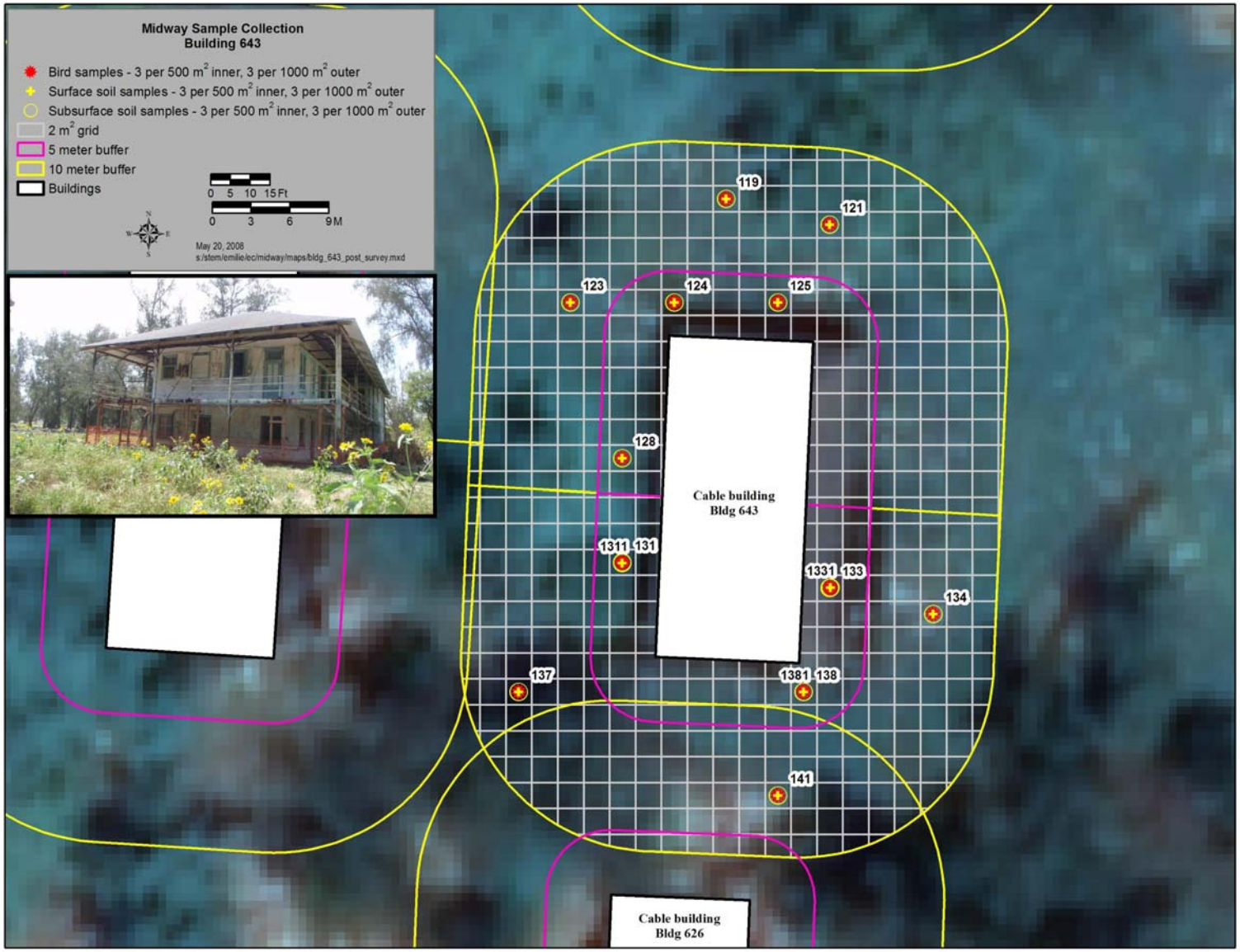
Appendix A, Figure 4. Lead Study sample locations for Buildings 353 and 357, Sand Island, Midway Atoll National Wildlife Refuge, 2008

Note: Part of the building was surrounded by pavement and was not sampled.



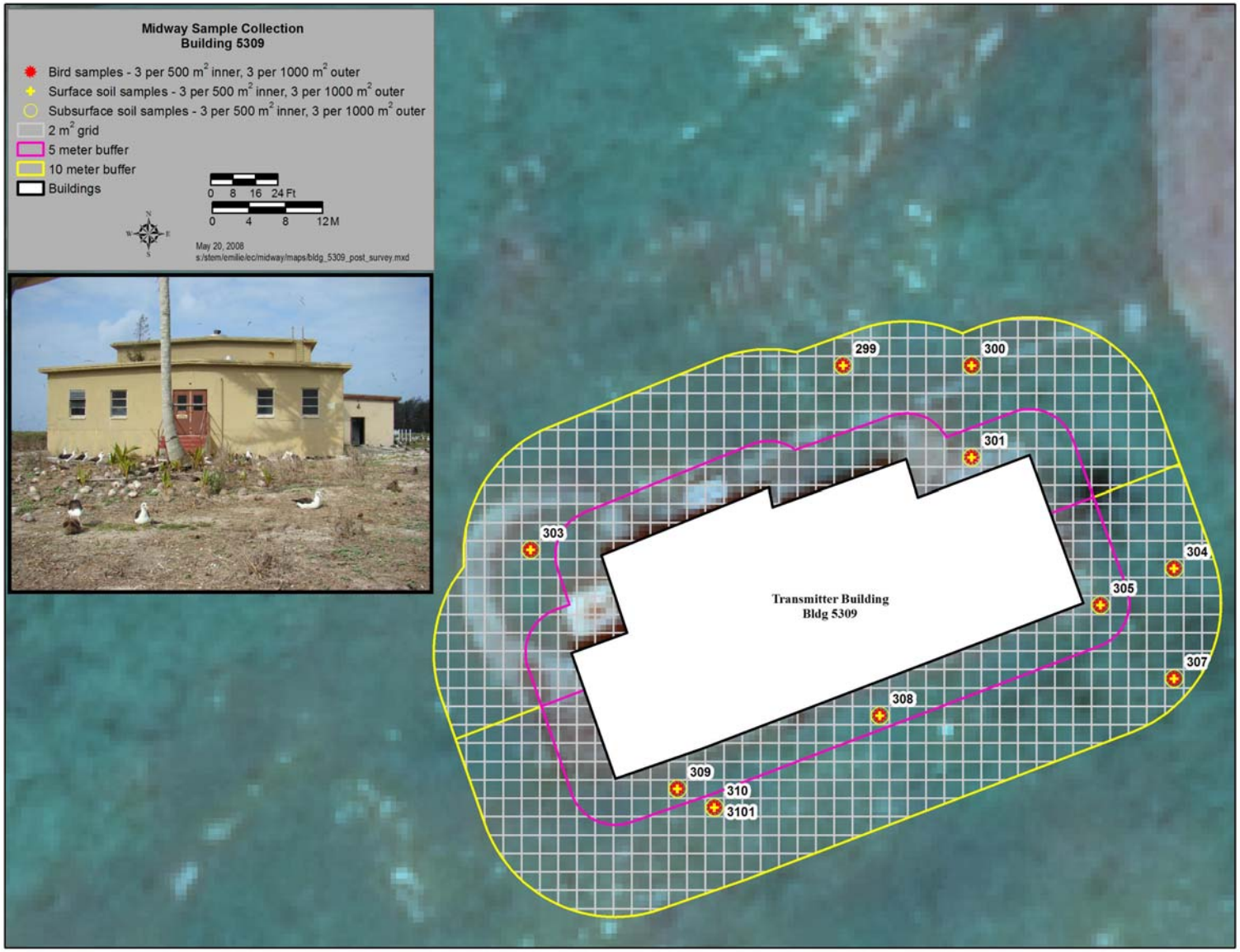
5.

Appendix A, Figure 5. Lead Study sample locations for Building 578, Sand Island, Midway Atoll National Wildlife Refuge, 2008



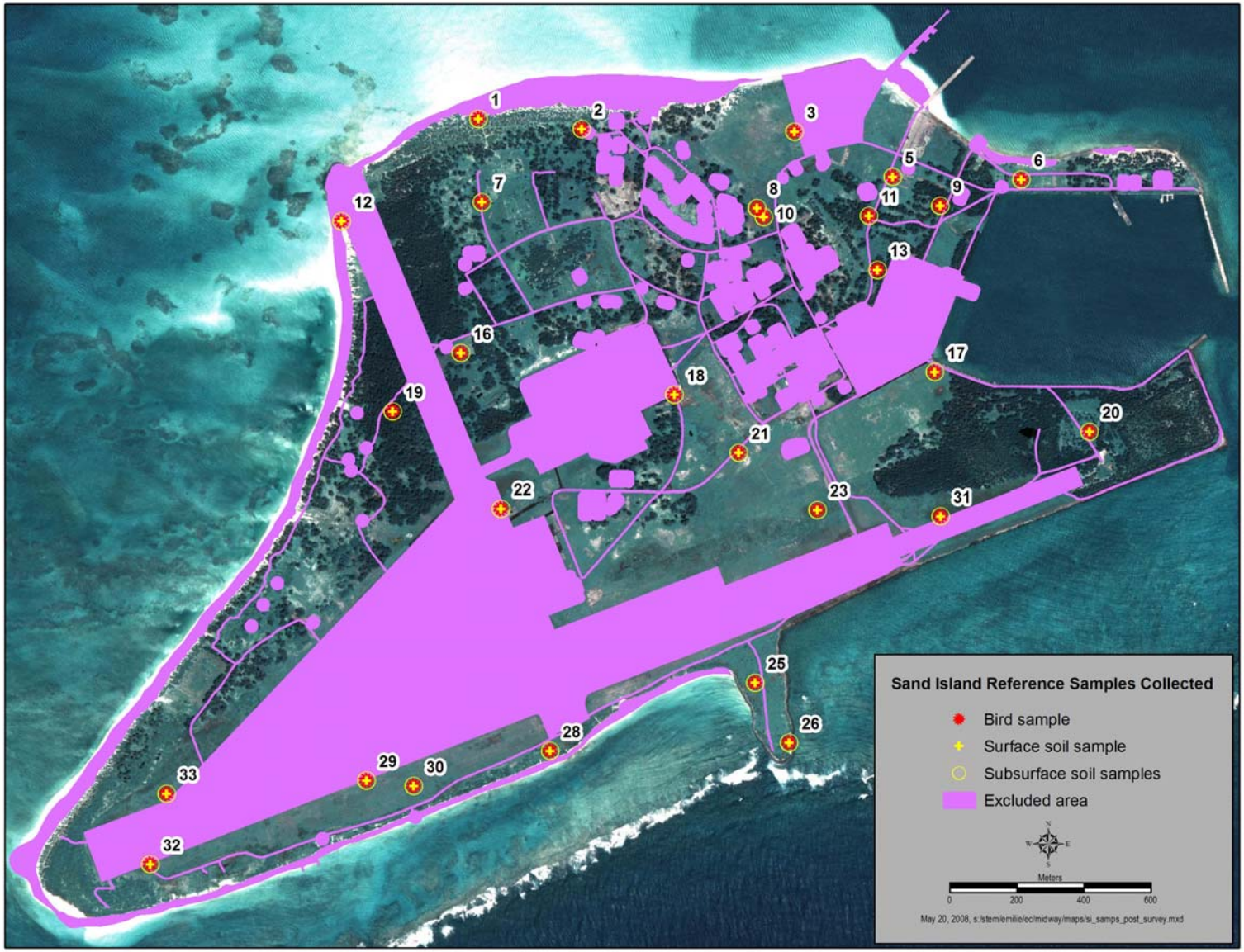
6.

Appendix A, Figure 6. Lead Study sample locations for Building 643, Sand Island, Midway Atoll National Wildlife Refuge, 2008



7.

Appendix A, Figure 7. Lead Study sample locations for Building 5309, Sand Island, Midway Atoll National Wildlife Refuge, 2008



8.

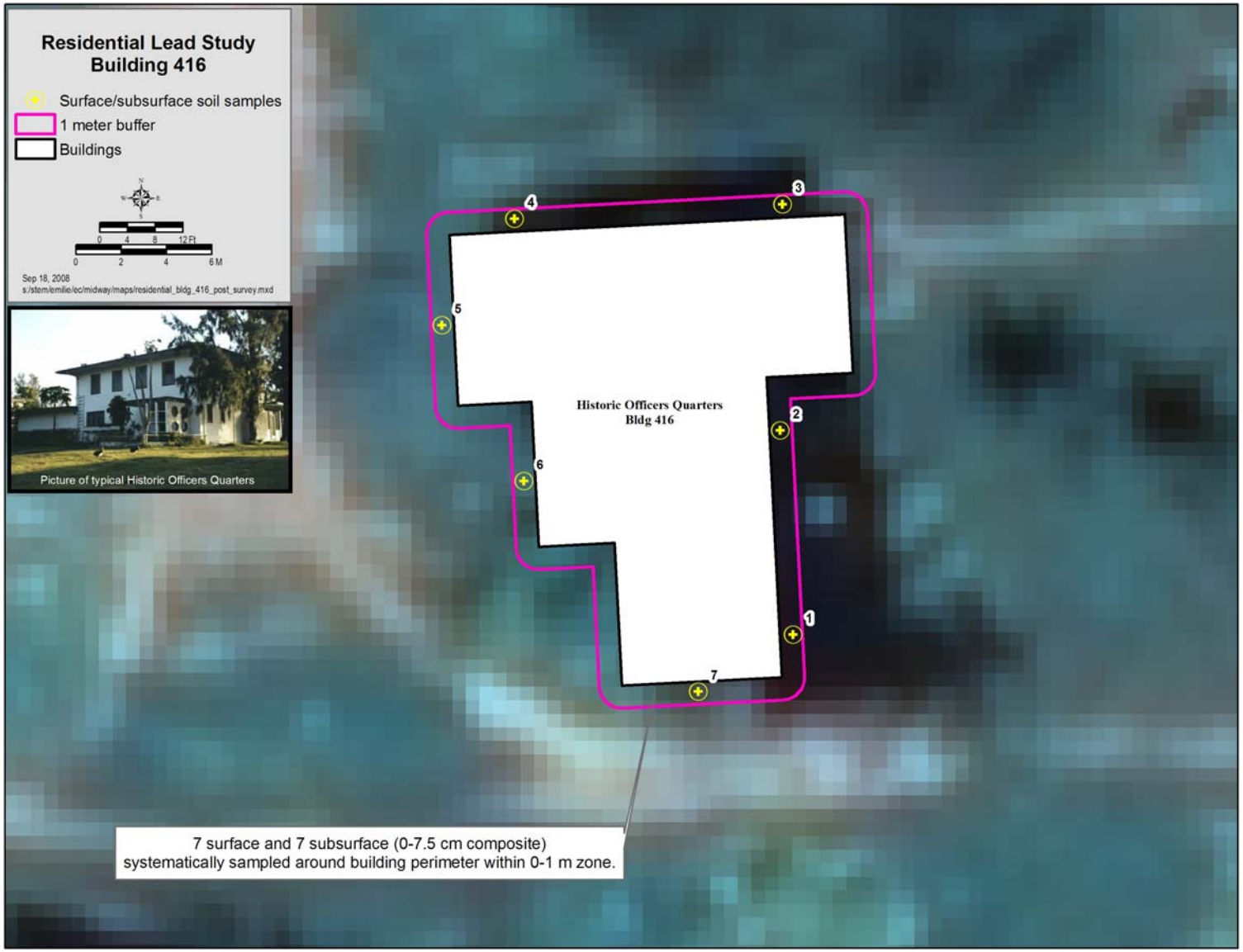
Appendix A, Figure 8. Lead Study sample locations for reference sites, Sand Island, Midway Atoll National Wildlife Refuge, 2008

9.

Appendix A, Figure 9. Building locations for Residential Lead Study, Sand Island, Midway Atoll National Wildlife Refuge, 2008.

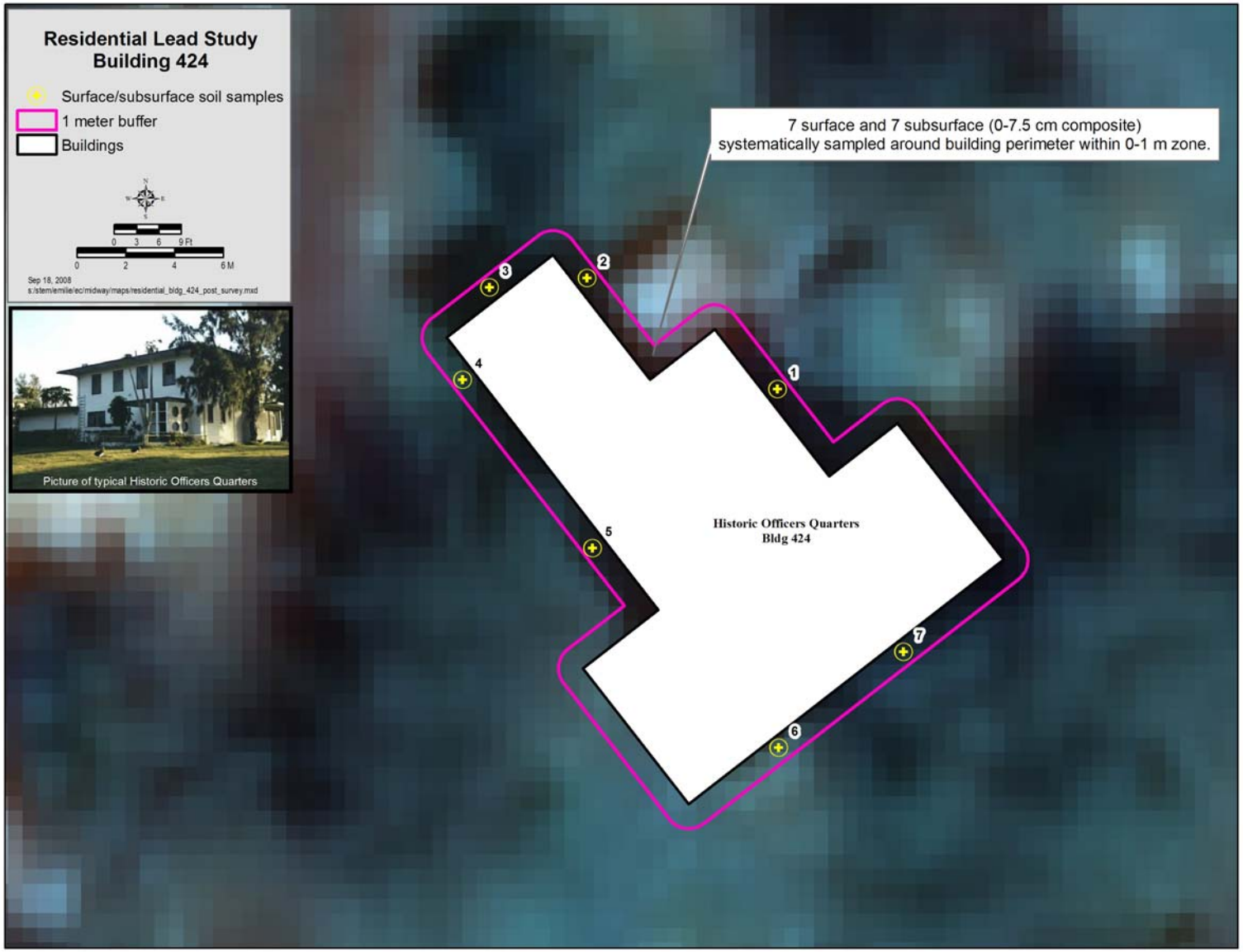
10.

Appendix A, Figure 10. Residential Lead Study sample locations for Building 414, Sand Island, Midway Atoll National Wildlife Refuge, 2008



11.

Appendix A, Figure 11. Residential Lead Study sample locations for Building 416, Sand Island, Midway Atoll National Wildlife Refuge, 2008

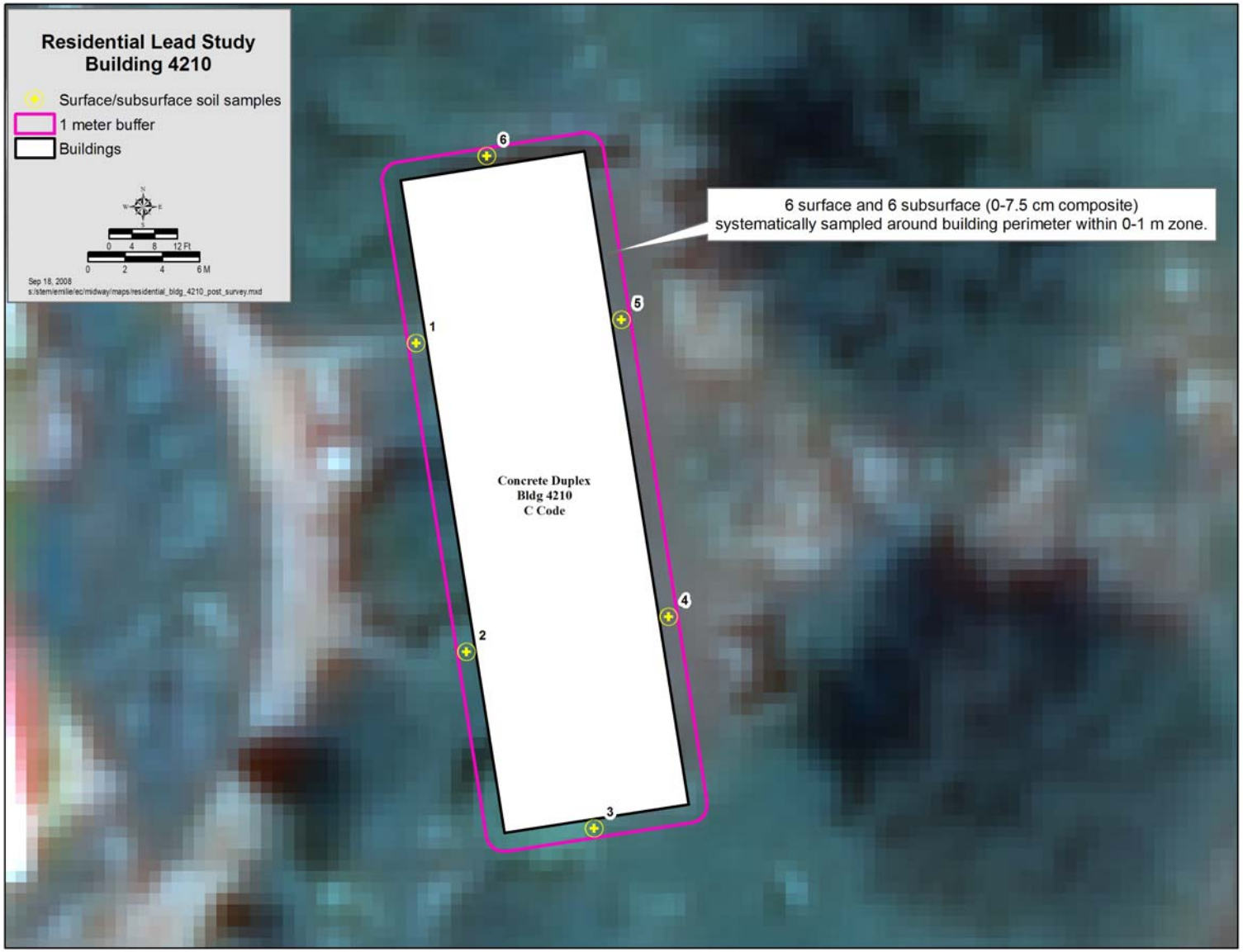


12.

Appendix A, Figure 12. Residential Lead Study sample locations for Building 424, Sand Island, Midway Atoll National Wildlife Refuge, 2008

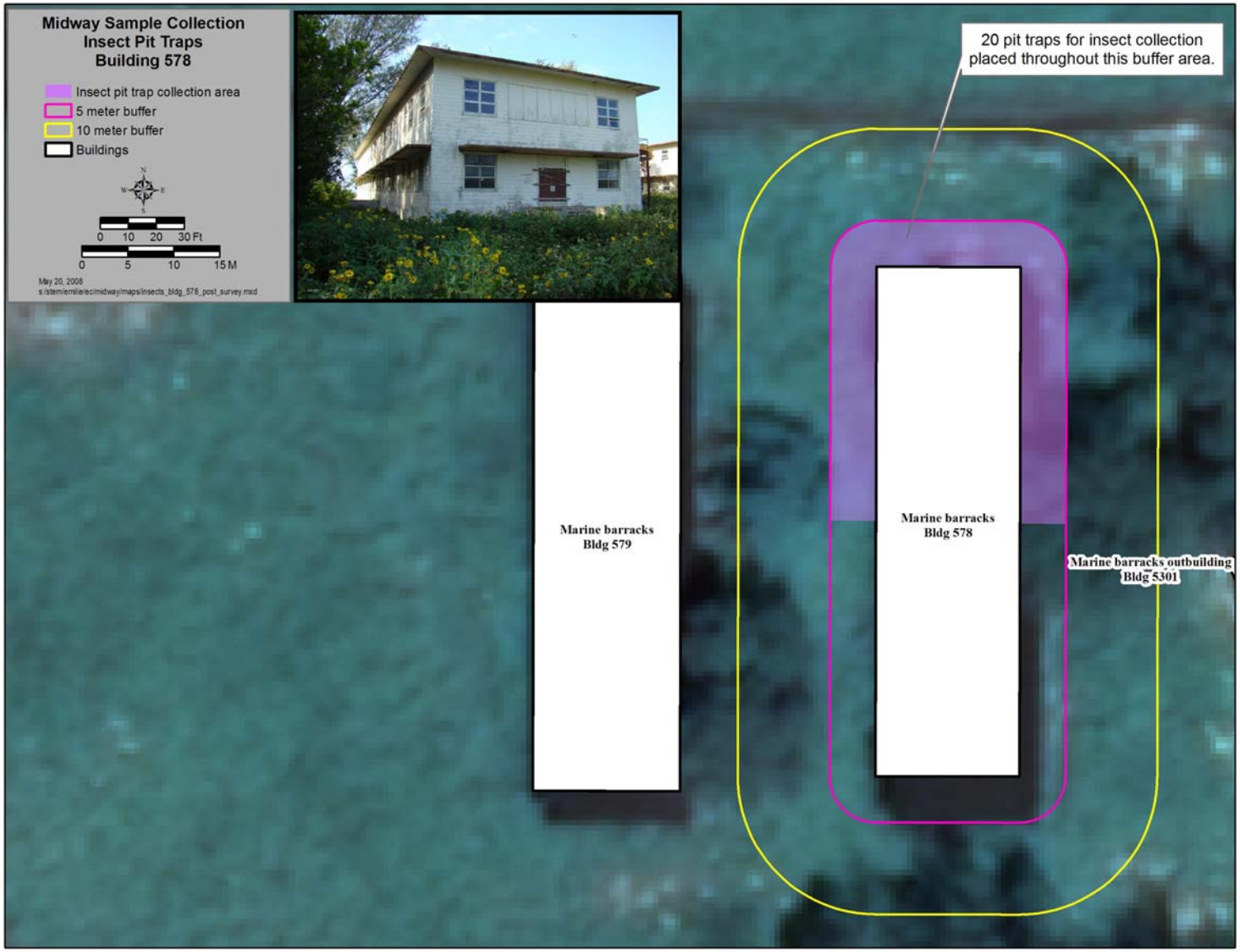
13.

Appendix A, Figure 13. Residential Lead Study sample locations for Building 4203, Sand Island, Midway Atoll National Wildlife Refuge, 2008



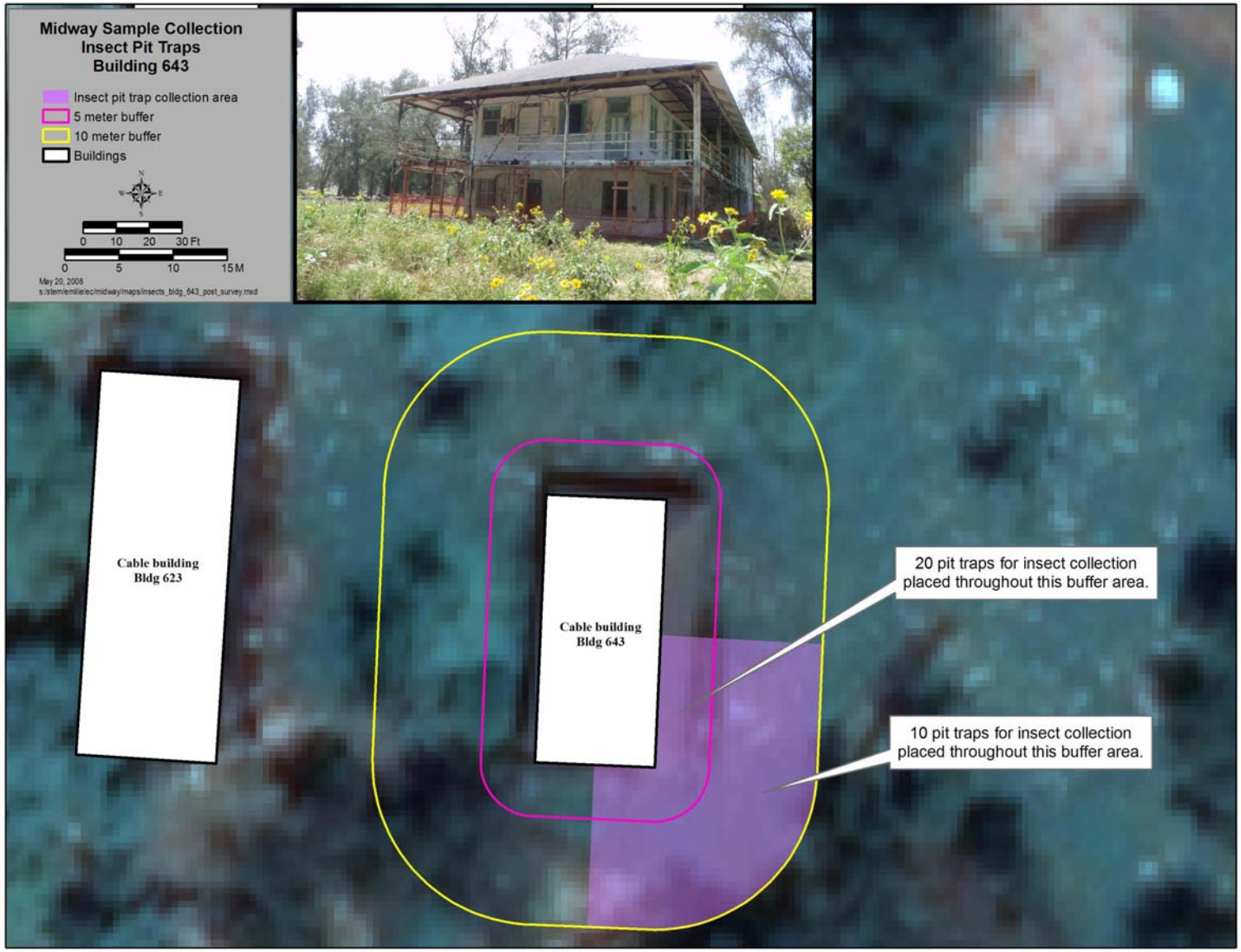
14.

Appendix A, Figure 14. Residential Lead Study sample locations for Building 4210, Sand Island, Midway Atoll National Wildlife Refuge, 2008



15.

Appendix A, Figure 15. Residential Lead Study sample locations for Building 578, Sand Island, Midway Atoll National Wildlife Refuge, 2008



16.

Appendix A, Figure 16. Lead Study sample information for insect pit traps at Building 643. Sand Island, Midway Atoll NWR, 2008

Appendix B – Avian Sample Collection Data Sheet

Sand Island, Midway Atoll National Wildlife Refuge, 2008

17.

Date
Time
Sample ID
Building Number
Lat
Long

Investigators (multiple answers ok)
- Sharon Taylor (CFWO project leader)
- Carol Gorbics (CFWO staff)
- John Klavitter (NWR biologist)
- Dan Forney (Region 1 Engineer)
- Matt Brown (NWR Asst Refuge Manager)
- Brent Newhouse (FWS volunteer)

Type of Soil Sample (choose one only)
- Surface Soil (surface scrape)
- Subsurface Soil
  - 0" to 3" (0 to 7.5 cm)
  - 3" to 6" (7.5 to 15 cm)
  - 6" to 9" (15 to 22.5 cm)
  - 9" to 12" (22.5 to 30 cm)
- 36" Soil Pit
  - Surface scrape
  - 0" to 6" (0 to 15cm)
  - 6" to 12" (15 to 30 cm)
  - 12" to 18" (30 to 45 cm)
  - 18" to 24" (45 to 60 cm)
  - 24" to 30" (60 to 75 cm)
  - 30" to 36" (75 to 90 cm)

Bird Blood (species)
- Laysan albatross
- Black-footed albatross
- Bonin petrel
- Other_____

18.

19.

Petrel Burrow Score
- 0 (none)
- 1 (present, but minimal)
- 2 (low)
- 3 (moderate)
- 4 (high)
- 5 (very high)

For Bird Samples
- droopwing (yes/no)
- Physical condition score (1=worst; 5=best)
- physical description comment
- sex (male/female/unknown)
- age (fledgling/adult)
- body weight (kg)
- nest condition comment
- For below, note normal/abnormal/not examined
  - feathers/fur
  - skin
  - musculoskeletal
  - legs and feet
  - wings
  - eyes
  - ears
  - oral
  - neuro
  - genital/urinary
  - heart
  - lungs
  - abdominal cavity
- external parasites (yes/no)
- external parasites (ticks/fleas/lice)
- abnormal findings - comments

20.

Appendix C – Bird Health Assessment Data Sheet, Sand Island, Midway Atoll National Wildlife Refuge, 2008

WILDLIFE HEALTH DATA

21. Species: 22. _____ 23. Date: 24. _____
25. Location: 26. _____
27. Researchers present: 28. _____
29. Purpose of Handling: 30. _____
31. Temp: 32. _____ 33. Weather conditions: 34. _____
35. Sex: 36. _____ 37. Age est: 38. _____ 39. Body wt: 40. _____ 41. kg / lb actual / estimate
42. Physical Condition Score: (1=Best, 5=Worst) 43. _____
44. Physical Description: (muscle, fat, fur / feather quality, etc.) 45. _____
46. _____

47. Parentage: 48. Dam 49. _____ 50. Sire 51. _____ 52. Siblings 53. _____ 54. Offspring 55. _____

Physical Exam Check List			Comments
56. Fur / Feathers	57. N	58. AB	59.
60. Skin	61. N	62. AB	63.
64. Musculoskeletal	65. N	66. AB	67.
68. Legs & Feet	69. N	70. AB	71.
72. Wings	73. N	74. AB	75.
76. Eyes	77. N	78. AB	79.
80. Ears	81. N	82. AB	83.
84. Oral	85. N	86. AB	87.
88. Neuro	89. N	90. AB	91.
92. Genital/Urinary	93. N	94. AB	95.
96. Heart	97. N	98. AB	99.
100. Lungs	101. N	102. AB	103.
104. Abdominal Cavity	105. N	106. AB	107.
108. External Cavity	109. N	110. AB	111.
112. External Parasites	113. Yes	114. No	115. Ticks/ 116. Fleas/ 117. Lice/ 11
119. Abnormal Findings	120.		
121.	122.		

123.	**Samples**	124. # tube	125. sent where
125.	Serum (Red)	126.	127.
128.	EDTA (Pur)	129.	130.
131.	Heparin (Gr)	132.	133.
134.	Hair / Feathers	135.	136.
137.	Feces	138.	139.
140.	Ectoparasites	141.	142.
143.	Swab	144.	145.

Appendix D – Soil and Bird Data from Lead Study, Sand Island, Midway Atoll National Wildlife Refuge, 2008

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
1	12	nd	12	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.5	462440	3121288.1
1	9	nd	12	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.5	462440	3121288.1
1	0	nd	13	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.5	462440	3121288.1
1	6	nd	13	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.5	462440	3121288.1
1	3	nd	13	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.5	462440	3121288.1
2	9	nd	11	reference	reference	reference	>15	No	4	24-Apr-08	low <3.3 ug/dl		3.1	462747.7	3121257.6
2	3	nd	12	reference	reference	reference	>15	No	4	24-Apr-08	low <3.3 ug/dl		3.1	462747.7	3121257.6
2	12	nd	13	reference	reference	reference	>15	No	4	24-Apr-08	low <3.3 ug/dl		3.1	462747.7	3121257.6
2	6	nd	13	reference	reference	reference	>15	No	4	24-Apr-08	low <3.3 ug/dl		3.1	462747.7	3121257.6
2	0	nd	13	reference	reference	reference	>15	No	4	24-Apr-08	low <3.3 ug/dl		3.1	462747.7	3121257.6
3	3	18	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		3.6	463383.5	3121249.4
3	6	20	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		3.6	463383.5	3121249.4
3	0	nd	12	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		3.6	463383.5	3121249.4
3	9	15	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		3.6	463383.5	3121249.4
3	12	24	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		3.6	463383.5	3121249.4
5	9	19	5	reference	reference	reference	>15	No	4	17-Apr-08	low <3.3 ug/dl		2.5	463676.8	3121115.4
5	3	33	5	reference	reference	reference	>15	No	4	17-Apr-08	low <3.3 ug/dl		2.5	463676.8	3121115.4
5	12	nd	14	reference	reference	reference	>15	No	4	17-Apr-08	low <3.3 ug/dl		2.5	463676.8	3121115.4
5	0	22	4	reference	reference	reference	>15	No	4	17-Apr-08	low <3.3 ug/dl		2.5	463676.8	3121115.4
5	6	24	5	reference	reference	reference	>15	No	4	17-Apr-08	low <3.3 ug/dl		2.5	463676.8	3121115.4
6	3	nd	13	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.1	464061.6	3121106.4
6	6	nd	13	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.1	464061.6	3121106.4
6	12	20	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.1	464061.6	3121106.4
6	9	15	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.1	464061.6	3121106.4
6	0	13	4	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.1	464061.6	3121106.4
7	0	21	5	reference	reference	reference	>15	No	5	19-Apr-08	low <3.3 ug/dl		3.1	462450.5	3121038.8
7	3	16	5	reference	reference	reference	>15	No	5	19-Apr-08	low <3.3 ug/dl		3.1	462450.5	3121038.8
7	12	18	5	reference	reference	reference	>15	No	5	19-Apr-08	low <3.3 ug/dl		3.1	462450.5	3121038.8
7	9	nd	13	reference	reference	reference	>15	No	5	19-Apr-08	low <3.3 ug/dl		3.1	462450.5	3121038.8
7	6	nd	13	reference	reference	reference	>15	No	5	19-Apr-08	low <3.3 ug/dl		3.1	462450.5	3121038.8
8	12	18	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.1	463271.6	3121021.7

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
8	0	25	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.1	463271.6	3121021.7
8	3	25	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.1	463271.6	3121021.7
8	6	19	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.1	463271.6	3121021.7
8	9	33	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.1	463271.6	3121021.7
9	9	nd	14	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.6	463819.1	3121028.5
9	3	89	6	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.6	463819.1	3121028.5
9	12	17	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.6	463819.1	3121028.5
9	6	nd	13	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.6	463819.1	3121028.5
9	0	52	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.6	463819.1	3121028.5
10	0	nd	13	reference	reference	reference	>15	No	4	17-Apr-08	value	4.6	2.3	463292.1	3120995.6
10	12	27	5	reference	reference	reference	>15	No	4	17-Apr-08	value	4.6	2.3	463292.1	3120995.6
10	9	36	5	reference	reference	reference	>15	No	4	17-Apr-08	value	4.6	2.3	463292.1	3120995.6
10	3	14	4	reference	reference	reference	>15	No	4	17-Apr-08	value	4.6	2.3	463292.1	3120995.6
10	6	18	5	reference	reference	reference	>15	No	4	17-Apr-08	value	4.6	2.3	463292.1	3120995.6
11	12	nd	14	reference	reference	reference	>15	No	1	17-Apr-08	value	3.7	1.1	463605.4	3120998.7
11	0	nd	13	reference	reference	reference	>15	No	1	17-Apr-08	value	3.7	1.1	463605.4	3120998.7
11	3	nd	14	reference	reference	reference	>15	No	1	17-Apr-08	value	3.7	1.1	463605.4	3120998.7
11	9	nd	13	reference	reference	reference	>15	No	1	17-Apr-08	value	3.7	1.1	463605.4	3120998.7
11	6	47	5	reference	reference	reference	>15	No	1	17-Apr-08	value	3.7	1.1	463605.4	3120998.7
12	6	nd	13	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462031.4	3120981.6
12	0	nd	12	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462031.4	3120981.6
12	9	nd	13	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462031.4	3120981.6
12	3	nd	13	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462031.4	3120981.6
12	12	nd	12	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462031.4	3120981.6
13	0	56	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.2	463631	3120837
13	3	56	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.2	463631	3120837
13	6	52	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.2	463631	3120837
13	9	34	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.2	463631	3120837
13	12	18	5	reference	reference	reference	>15	No	3	17-Apr-08	low <3.3 ug/dl		2.2	463631	3120837
16	6	1041	22	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		2.8	462386.7	3120588.3
16	3	154	8	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		2.8	462386.7	3120588.3
16	0	103	7	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		2.8	462386.7	3120588.3
17	12	31	5	reference	reference	reference	>15	No	4	20-Apr-08	value	15.4	2	463803	3120531.2

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
17	9	53	6	reference	reference	reference	>15	No	4	20-Apr-08	value	15.4	2	463803	3120531.2
17	0	64	6	reference	reference	reference	>15	No	4	20-Apr-08	value	15.4	2	463803	3120531.2
17	6	74	6	reference	reference	reference	>15	No	4	20-Apr-08	value	15.4	2	463803	3120531.2
17	3	53	6	reference	reference	reference	>15	No	4	20-Apr-08	value	15.4	2	463803	3120531.2
18	9	42	5	reference	reference	reference	>15	No	4	20-Apr-08	low <3.3 ug/dl		1.7	463024.6	3120464.5
18	0	149	8	reference	reference	reference	>15	No	4	20-Apr-08	low <3.3 ug/dl		1.7	463024.6	3120464.5
18	6	358	11	reference	reference	reference	>15	No	4	20-Apr-08	low <3.3 ug/dl		1.7	463024.6	3120464.5
18	12	236	10	reference	reference	reference	>15	No	4	20-Apr-08	low <3.3 ug/dl		1.7	463024.6	3120464.5
18	3	310	11	reference	reference	reference	>15	No	4	20-Apr-08	low <3.3 ug/dl		1.7	463024.6	3120464.5
19	3	nd	13	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462183.1	3120414.5
19	6	nd	13	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462183.1	3120414.5
19	0	nd	11	reference	reference	reference	>15	No	5	23-Apr-08	low <3.3 ug/dl		3.7	462183.1	3120414.5
20	3	nd	13	reference	reference	reference	>15	No	3	20-Apr-08	low <3.3 ug/dl		2.1	464264.8	3120354
20	12	nd	13	reference	reference	reference	>15	No	3	20-Apr-08	low <3.3 ug/dl		2.1	464264.8	3120354
20	9	nd	12	reference	reference	reference	>15	No	3	20-Apr-08	low <3.3 ug/dl		2.1	464264.8	3120354
20	6	nd	13	reference	reference	reference	>15	No	3	20-Apr-08	low <3.3 ug/dl		2.1	464264.8	3120354
20	0	nd	12	reference	reference	reference	>15	No	3	20-Apr-08	low <3.3 ug/dl		2.1	464264.8	3120354
21	9	17	5	reference	reference	reference	>15	No	5	20-Apr-08	value	5	2.4	463217.7	3120290.5
21	0	nd	14	reference	reference	reference	>15	No	5	20-Apr-08	value	5	2.4	463217.7	3120290.5
21	6	22	5	reference	reference	reference	>15	No	5	20-Apr-08	value	5	2.4	463217.7	3120290.5
21	3	nd	13	reference	reference	reference	>15	No	5	20-Apr-08	value	5	2.4	463217.7	3120290.5
21	12	17	5	reference	reference	reference	>15	No	5	20-Apr-08	value	5	2.4	463217.7	3120290.5
22	9	94	7	reference	reference	reference	>15	No	5	20-Apr-08	value	3.5	2	462507.3	3120124
22	3	54	6	reference	reference	reference	>15	No	5	20-Apr-08	value	3.5	2	462507.3	3120124
22	12	64	6	reference	reference	reference	>15	No	5	20-Apr-08	value	3.5	2	462507.3	3120124
22	0	40	5	reference	reference	reference	>15	No	5	20-Apr-08	value	3.5	2	462507.3	3120124
22	6	57	6	reference	reference	reference	>15	No	5	20-Apr-08	value	3.5	2	462507.3	3120124
23	0	nd	11	reference	reference	reference	>15	No	3	20-Apr-08	value	5.8	1.5	463452.6	3120120.3
23	3	nd	10	reference	reference	reference	>15	No	3	20-Apr-08	value	5.8	1.5	463452.6	3120120.3
25	6	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.7	463265.5	3119604.7
25	12	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.7	463265.5	3119604.7
25	9	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.7	463265.5	3119604.7
25	3	14	5	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.7	463265.5	3119604.7

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
25	0	nd	14	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.7	463265.5	3119604.7
26	3	nd	12	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.8	463367.4	3119425.6
26	0	nd	13	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.8	463367.4	3119425.6
26	9	nd	12	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.8	463367.4	3119425.6
26	6	nd	13	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.8	463367.4	3119425.6
26	12	nd	13	reference	reference	reference	>15	No	4	19-Apr-08	low <3.3 ug/dl		2.8	463367.4	3119425.6
28	6	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.1	462654.2	3119401.7
28	9	nd	12	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.1	462654.2	3119401.7
28	0	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.1	462654.2	3119401.7
28	12	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.1	462654.2	3119401.7
28	3	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	value	3.9	2.1	462654.2	3119401.7
29	0	47	5	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		2.2	462105.6	3119313.3
29	3	32	5	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		2.2	462105.6	3119313.3
30	6	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		3.1	462246.3	3119297.2
30	12	nd	14	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		3.1	462246.3	3119297.2
30	0	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		3.1	462246.3	3119297.2
30	9	nd	13	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		3.1	462246.3	3119297.2
30	3	nd	12	reference	reference	reference	>15	No	3	19-Apr-08	low <3.3 ug/dl		3.1	462246.3	3119297.2
31	3	35	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		2.8	463820.1	3120102
31	12	nd	12	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		2.8	463820.1	3120102
31	9	nd	13	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		2.8	463820.1	3120102
31	0	40	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		2.8	463820.1	3120102
31	6	19	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		2.8	463820.1	3120102
32	3	nd	13	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.7	461459.2	3119063.1
32	9	nd	13	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.7	461459.2	3119063.1
32	0	41	5	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.7	461459.2	3119063.1
32	6	nd	13	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.7	461459.2	3119063.1
32	12	nd	13	reference	reference	reference	>15	No	5	24-Apr-08	low <3.3 ug/dl		4.7	461459.2	3119063.1
33	0	19	5	reference	reference	reference	>15	No	3	24-Apr-08	low <3.3 ug/dl		2.3	461508.5	3119273.7
33	3	nd	12	reference	reference	reference	>15	No	3	24-Apr-08	low <3.3 ug/dl		2.3	461508.5	3119273.7
33	6	nd	14	reference	reference	reference	>15	No	3	24-Apr-08	low <3.3 ug/dl		2.3	461508.5	3119273.7
33	9	nd	13	reference	reference	reference	>15	No	3	24-Apr-08	low <3.3 ug/dl		2.3	461508.5	3119273.7
33	12	nd	13	reference	reference	reference	>15	No	3	24-Apr-08	low <3.3 ug/dl		2.3	461508.5	3119273.7

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
119	0	27	5	Cable building	643	wood	5-15	No	3	12-Apr-08	value	3.6	1.2	462853	3121173
119	12	29	5	Cable building	643	wood	5-15	No	3	12-Apr-08	value	3.6	1.2	462853	3121173
119	3	28	5	Cable building	643	wood	5-15	No	3	12-Apr-08	value	3.6	1.2	462853	3121173
119	6	27	5	Cable building	643	wood	5-15	No	3	12-Apr-08	value	3.6	1.2	462853	3121173
119	9	37	5	Cable building	643	wood	5-15	No	3	12-Apr-08	value	3.6	1.2	462853	3121173
121	6	53	6	Cable building	643	wood	5-15	No	3	12-Apr-08	low <3.3 ug/dl		2.1	462861	3121171
121	0	32	5	Cable building	643	wood	5-15	No	3	12-Apr-08	low <3.3 ug/dl		2.1	462861	3121171
121	9	45	6	Cable building	643	wood	5-15	No	3	12-Apr-08	low <3.3 ug/dl		2.1	462861	3121171
121	3	47	6	Cable building	643	wood	5-15	No	3	12-Apr-08	low <3.3 ug/dl		2.1	462861	3121171
123	6	60	6	Cable building	643	wood	5-15	No	4	12-Apr-08	value	11.3	2.3	462841	3121165
123	12	48	6	Cable building	643	wood	5-15	No	4	12-Apr-08	value	11.3	2.3	462841	3121165
123	9	98	13	Cable building	643	wood	5-15	No	4	12-Apr-08	value	11.3	2.3	462841	3121165
123	0	74	6	Cable building	643	wood	5-15	No	4	12-Apr-08	value	11.3	2.3	462841	3121165
123	3	42	5	Cable building	643	wood	5-15	No	4	12-Apr-08	value	11.3	2.3	462841	3121165
124	3	251	10	Cable building	643	wood	0-5	No	5	12-Apr-08	high >65 ug/dl		2.8	462849	3121165
124	0	356	11	Cable building	643	wood	0-5	No	5	12-Apr-08	high >65 ug/dl		2.8	462849	3121165
124	6	272	10	Cable building	643	wood	0-5	No	5	12-Apr-08	high >65 ug/dl		2.8	462849	3121165
124	9	183	9	Cable building	643	wood	0-5	No	5	12-Apr-08	high >65 ug/dl		2.8	462849	3121165
124	12	271	10	Cable building	643	wood	0-5	No	5	12-Apr-08	high >65 ug/dl		2.8	462849	3121165
125	12	332	12	Cable building	643	wood	0-5	No	5	12-Apr-08	test failed		2.7	462857	3121165
125	9	450	14	Cable building	643	wood	0-5	No	5	12-Apr-08	test failed		2.7	462857	3121165
125	6	172	9	Cable building	643	wood	0-5	No	5	12-Apr-08	test failed		2.7	462857	3121165
125	0	202	10	Cable building	643	wood	0-5	No	5	12-Apr-08	test failed		2.7	462857	3121165
125	3	153	8	Cable building	643	wood	0-5	No	5	12-Apr-08	test failed		2.7	462857	3121165
128	3	1062	22	Cable building	643	wood	0-5	No	3	12-Apr-08	low <3.3 ug/dl		2	462845	3121153
128	6	811	19	Cable building	643	wood	0-5	No	3	12-Apr-08	low <3.3 ug/dl		2	462845	3121153
128	0	477	13	Cable building	643	wood	0-5	No	3	12-Apr-08	low <3.3 ug/dl		2	462845	3121153
128	9	67	6	Cable building	643	wood	0-5	No	3	12-Apr-08	low <3.3 ug/dl		2	462845	3121153
131	6	1288	26	Cable building	643	wood	0-5	No	3	12-Apr-08	value	20.3	2.1	462845	3121145
131	3	1378	25	Cable building	643	wood	0-5	No	3	12-Apr-08	value	20.3	2.1	462845	3121145
131	0	1314	25	Cable building	643	wood	0-5	No	3	12-Apr-08	value	20.3	2.1	462845	3121145
131	9	1608	29	Cable building	643	wood	0-5	No	3	12-Apr-08	value	20.3	2.1	462845	3121145
133	6	1475	29	Cable building	643	wood	0-5	No	3	12-Apr-08	value	6.8	1.5	462861	3121143

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
133	9	1378	26	Cable building	643	wood	0-5	No	3	12-Apr-08	value	6.8	1.5	462861	3121143
133	3	1090	22	Cable building	643	wood	0-5	No	3	12-Apr-08	value	6.8	1.5	462861	3121143
133	12	1020	22	Cable building	643	wood	0-5	No	3	12-Apr-08	value	6.8	1.5	462861	3121143
133	0	1043	23	Cable building	643	wood	0-5	No	3	12-Apr-08	value	6.8	1.5	462861	3121143
134	12	56	6	Cable building	643	wood	5-15	No	5	12-Apr-08	value	25.4	2.1	462869	3121141
134	6	50	6	Cable building	643	wood	5-15	No	5	12-Apr-08	value	25.4	2.1	462869	3121141
134	9	59	6	Cable building	643	wood	5-15	No	5	12-Apr-08	value	25.4	2.1	462869	3121141
134	0	97	7	Cable building	643	wood	5-15	No	5	12-Apr-08	value	25.4	2.1	462869	3121141
134	3	126	7	Cable building	643	wood	5-15	No	5	12-Apr-08	value	25.4	2.1	462869	3121141
137	3	160	8	Cable building	643	wood	5-15	No	2	12-Apr-08	value	7.6	1.8	462837	3121135
137	9	154	8	Cable building	643	wood	5-15	No	2	12-Apr-08	value	7.6	1.8	462837	3121135
137	12	131	7	Cable building	643	wood	5-15	No	2	12-Apr-08	value	7.6	1.8	462837	3121135
137	6	180	8	Cable building	643	wood	5-15	No	2	12-Apr-08	value	7.6	1.8	462837	3121135
137	0	145	8	Cable building	643	wood	5-15	No	2	12-Apr-08	value	7.6	1.8	462837	3121135
138	6	780	18	Cable building	643	wood	0-5	Yes	1	12-Apr-08	value	15	0.7	462859	3121135
138	3	901	19	Cable building	643	wood	0-5	Yes	1	12-Apr-08	value	15	0.7	462859	3121135
138	12	838	19	Cable building	643	wood	0-5	Yes	1	12-Apr-08	value	15	0.7	462859	3121135
138	9	942	20	Cable building	643	wood	0-5	Yes	1	12-Apr-08	value	15	0.7	462859	3121135
138	0	1695	30	Cable building	643	wood	0-5	Yes	1	12-Apr-08	value	15	0.7	462859	3121135
141	12	235	10	Cable building	643	wood	5-15	No	5	12-Apr-08	value	16.9	2.6	462857	3121127
141	6	229	9	Cable building	643	wood	5-15	No	5	12-Apr-08	value	16.9	2.6	462857	3121127
141	3	156	8	Cable building	643	wood	5-15	No	5	12-Apr-08	value	16.9	2.6	462857	3121127
141	9	253	10	Cable building	643	wood	5-15	No	5	12-Apr-08	value	16.9	2.6	462857	3121127
141	0	155	8	Cable building	643	wood	5-15	No	5	12-Apr-08	value	16.9	2.6	462857	3121127
188	3	202	9	Midway Mall Complex	259	wood, cinder	5-15	No	5	13-Apr-08	value	6	2.7	463424.2	3120914.1
188	0	68	6	Midway Mall Complex	259	wood, cinder	5-15	No	5	13-Apr-08	value	6	2.7	463424.2	3120914.1
188	6	49	6	Midway Mall Complex	259	wood, cinder	5-15	No	5	13-Apr-08	value	6	2.7	463424.2	3120914.1
188	9	39	5	Midway Mall Complex	259	wood, cinder	5-15	No	5	13-Apr-08	value	6	2.7	463424.2	3120914.1
190	0	74	6	Midway Mall Complex	259	wood, cinder	0-5	No	5	13-Apr-08	value	47.9	3	463429	3120899
190	6	354	12	Midway Mall Complex	259	wood, cinder	0-5	No	5	13-Apr-08	value	47.9	3	463429	3120899
190	3	69	6	Midway Mall Complex	259	wood, cinder	0-5	No	5	13-Apr-08	value	47.9	3	463429	3120899
190	9	34	5	Midway Mall Complex	259	wood, cinder	0-5	No	5	13-Apr-08	value	47.9	3	463429	3120899
190	12	nd	13	Midway Mall Complex	259	wood, cinder	0-5	No	5	13-Apr-08	value	47.9	3	463429	3120899

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
191	9	43	5	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	15.3	2.4	463399	3120897
191	3	72	6	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	15.3	2.4	463399	3120897
191	0	47	6	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	15.3	2.4	463399	3120897
191	6	93	7	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	15.3	2.4	463399	3120897
192	3	243	9	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		1.8	463381	3120900.7
192	0	280	10	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		1.8	463381	3120900.7
192	6	15	5	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		1.8	463381	3120900.7
192	9	98	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		1.8	463381	3120900.7
192	12	74	6	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		1.8	463381	3120900.7
193	6	169	8	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	value	5.5	1.1	463439	3120896
193	3	143	7	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	value	5.5	1.1	463439	3120896
193	0	126	7	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	value	5.5	1.1	463439	3120896
193	12	56	6	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	value	5.5	1.1	463439	3120896
193	9	58	6	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	value	5.5	1.1	463439	3120896
194	3	136	8	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	52.9	2.1	463391	3120885
194	6	193	9	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	52.9	2.1	463391	3120885
194	9	330	12	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	52.9	2.1	463391	3120885
194	12	124	8	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	52.9	2.1	463391	3120885
194	0	108	7	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	52.9	2.1	463391	3120885
196	9	81	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		2	463415.4	3120870.8
196	6	119	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		2	463415.4	3120870.8
196	12	101	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		2	463415.4	3120870.8
196	0	115	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		2	463415.4	3120870.8
196	3	95	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	test failed		2	463415.4	3120870.8
200	0	158	8	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	value	14.7	2	463443	3120845
200	3	107	7	Midway Mall Complex	259	wood, cinder	0-5	No	2	13-Apr-08	value	14.7	2	463443	3120845
202	12	nd	12	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	value	8.3	2.4	463461.1	3120826.8
202	0	104	7	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	value	8.3	2.4	463461.1	3120826.8
202	3	166	8	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	value	8.3	2.4	463461.1	3120826.8
202	9	17	5	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	value	8.3	2.4	463461.1	3120826.8
202	6	73	6	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	value	8.3	2.4	463461.1	3120826.8
203	9	98	7	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.9	463402	3120810.9
203	12	123	7	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.9	463402	3120810.9

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
203	3	62	6	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.9	463402	3120810.9
203	0	36	5	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.9	463402	3120810.9
204	12	68	6	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	3.4	2.2	463409.1	3120813.2
204	6	81	7	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	3.4	2.2	463409.1	3120813.2
204	3	93	6	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	3.4	2.2	463409.1	3120813.2
204	0	56	6	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	3.4	2.2	463409.1	3120813.2
204	9	68	6	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	value	3.4	2.2	463409.1	3120813.2
205	3	76	6	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	low <3.3 ug/dl		2.5	463452.4	3120820.1
205	0	69	6	Midway Mall Complex	259	wood, cinder	0-5	No	3	13-Apr-08	low <3.3 ug/dl		2.5	463452.4	3120820.1
206	6	25	5	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	low <3.3 ug/dl		2.1	463457.1	3120814.6
206	0	23	5	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	low <3.3 ug/dl		2.1	463457.1	3120814.6
206	9	14	5	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	low <3.3 ug/dl		2.1	463457.1	3120814.6
206	3	51	5	Midway Mall Complex	259	wood, cinder	5-15	No	4	13-Apr-08	low <3.3 ug/dl		2.1	463457.1	3120814.6
207	6	nd	13	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	value	6.2	0.7	463438.6	3120814
207	0	39	5	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	value	6.2	0.7	463438.6	3120814
207	3	15	4	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	value	6.2	0.7	463438.6	3120814
207	12	nd	13	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	value	6.2	0.7	463438.6	3120814
207	9	nd	13	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	value	6.2	0.7	463438.6	3120814
208	0	68	6	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.4	463442.6	3120806.4
208	9	22	5	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.4	463442.6	3120806.4
208	3	74	6	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.4	463442.6	3120806.4
208	6	70	6	Midway Mall Complex	259	wood, cinder	5-15	No	2	13-Apr-08	low <3.3 ug/dl		1.4	463442.6	3120806.4
209	3	83	7	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	6	2.1	463410.1	3120796.3
209	6	40	5	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	6	2.1	463410.1	3120796.3
209	0	68	6	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	6	2.1	463410.1	3120796.3
209	12	nd	13	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	6	2.1	463410.1	3120796.3
209	9	15	5	Midway Mall Complex	259	wood, cinder	5-15	No	3	13-Apr-08	value	6	2.1	463410.1	3120796.3
243	3	135	8	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	29.2	2.5	463298	3120575.7
243	0	340	11	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	29.2	2.5	463298	3120575.7
250	6	1239	25	Paint & Oil Storage	342	cinder	0-5	No	2	18-Apr-08	value	40.3	2.2	463319	3120574.9
250	0	902	20	Paint & Oil Storage	342	cinder	0-5	No	2	18-Apr-08	value	40.3	2.2	463319	3120574.9
250	3	1028	22	Paint & Oil Storage	342	cinder	0-5	No	2	18-Apr-08	value	40.3	2.2	463319	3120574.9
255	12	24	5	Paint & Oil Storage	342	cinder	0-5	No	3	18-Apr-08	value	28.6	3.2	463313.1	3120578.9

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
255	6	154	8	Paint & Oil Storage	342	cinder	0-5	No	3	18-Apr-08	value	28.6	3.2	463313.1	3120578.9
255	0	236	9	Paint & Oil Storage	342	cinder	0-5	No	3	18-Apr-08	value	28.6	3.2	463313.1	3120578.9
255	9	18	5	Paint & Oil Storage	342	cinder	0-5	No	3	18-Apr-08	value	28.6	3.2	463313.1	3120578.9
255	3	191	9	Paint & Oil Storage	342	cinder	0-5	No	3	18-Apr-08	value	28.6	3.2	463313.1	3120578.9
256	9	292	11	Paint & Oil Storage	342	cinder	5-15	No	2	18-Apr-08	high >65 ug/dl		1.8	463330.7	3120550.8
256	6	2787	42	Paint & Oil Storage	342	cinder	5-15	No	2	18-Apr-08	high >65 ug/dl		1.8	463330.7	3120550.8
256	3	4297	63	Paint & Oil Storage	342	cinder	5-15	No	2	18-Apr-08	high >65 ug/dl		1.8	463330.7	3120550.8
256	0	338	12	Paint & Oil Storage	342	cinder	5-15	No	2	18-Apr-08	high >65 ug/dl		1.8	463330.7	3120550.8
259	3	218	9	Machine Shop	357	wood, cinder	0-5	No	3	15-Apr-08	high >65 ug/dl		3.2	463449	3120555
259	0	334	10	Machine Shop	357	wood, cinder	0-5	No	3	15-Apr-08	high >65 ug/dl		3.2	463449	3120555
262	6	111	7	Machine Shop	357	wood, cinder	5-15	No	1	15-Apr-08	value	7.9	1.1	463419	3120553
262	0	104	7	Machine Shop	357	wood, cinder	5-15	No	1	15-Apr-08	value	7.9	1.1	463419	3120553
262	9	37	5	Machine Shop	357	wood, cinder	5-15	No	1	15-Apr-08	value	7.9	1.1	463419	3120553
262	3	155	8	Machine Shop	357	wood, cinder	5-15	No	1	15-Apr-08	value	7.9	1.1	463419	3120553
262	12	66	6	Machine Shop	357	wood, cinder	5-15	No	1	15-Apr-08	value	7.9	1.1	463419	3120553
264	6	548	15	Paint & Oil Storage	342	cinder	0-5	No	4	18-Apr-08	value	18.3	3.3	463305.8	3120574.4
264	0	569	15	Paint & Oil Storage	342	cinder	0-5	No	4	18-Apr-08	value	18.3	3.3	463305.8	3120574.4
264	3	733	17	Paint & Oil Storage	342	cinder	0-5	No	4	18-Apr-08	value	18.3	3.3	463305.8	3120574.4
264	9	251	10	Paint & Oil Storage	342	cinder	0-5	No	4	18-Apr-08	value	18.3	3.3	463305.8	3120574.4
264	12	384	13	Paint & Oil Storage	342	cinder	0-5	No	4	18-Apr-08	value	18.3	3.3	463305.8	3120574.4
267	3	123	7	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	22.4	3.3	463322	3120577.8
267	6	151	8	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	22.4	3.3	463322	3120577.8
267	9	209	9	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	22.4	3.3	463322	3120577.8
267	12	251	10	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	22.4	3.3	463322	3120577.8
267	0	107	7	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	value	22.4	3.3	463322	3120577.8
268	0	280	10	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	low <3.3 ug/dl		2.6	463423	3120535
268	3	52	6	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	low <3.3 ug/dl		2.6	463423	3120535
268	12	31	5	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	low <3.3 ug/dl		2.6	463423	3120535
268	6	31	5	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	low <3.3 ug/dl		2.6	463423	3120535
268	9	32	5	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	low <3.3 ug/dl		2.6	463423	3120535
269	6	193	9	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	low <3.3 ug/dl		2.6	463311.8	3120585
269	9	129	7	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	low <3.3 ug/dl		2.6	463311.8	3120585
269	12	173	8	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	low <3.3 ug/dl		2.6	463311.8	3120585

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
269	0	70	6	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	low <3.3 ug/dl		2.6	463311.8	3120585
269	3	178	8	Paint & Oil Storage	342	cinder	5-15	No	3	18-Apr-08	low <3.3 ug/dl		2.6	463311.8	3120585
270	0	70	6	Carpentry Shop	353	cinder	5-15	No	3	21-Apr-08	value	6.4	1.6	463377.1	3120532.5
272	12	112	7	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	low <3.3 ug/dl		1.8	463469	3120533
272	0	363	12	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	low <3.3 ug/dl		1.8	463469	3120533
272	6	198	9	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	low <3.3 ug/dl		1.8	463469	3120533
272	9	185	9	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	low <3.3 ug/dl		1.8	463469	3120533
272	3	656	17	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	low <3.3 ug/dl		1.8	463469	3120533
274	3	133	8	Carpentry Shop	353	cinder	0-5	No	3	21-Apr-08	high >65 ug/dl		2	463373.9	3120514.4
274	0	165	8	Carpentry Shop	353	cinder	0-5	No	3	21-Apr-08	high >65 ug/dl		2	463373.9	3120514.4
275	6	67	6	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	3.7	2.9	463421	3120525
275	9	77	6	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	3.7	2.9	463421	3120525
275	3	227	9	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	3.7	2.9	463421	3120525
275	0	493	14	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	3.7	2.9	463421	3120525
279	6	350	11	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	value	47.5	2.1	463465	3120523
279	0	471	13	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	value	47.5	2.1	463465	3120523
279	9	162	8	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	value	47.5	2.1	463465	3120523
279	3	255	10	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	value	47.5	2.1	463465	3120523
279	12	50	6	Machine Shop	357	wood, cinder	0-5	No	2	15-Apr-08	value	47.5	2.1	463465	3120523
281	3	357	11	Carpentry Shop	353	cinder	0-5	Yes	1	21-Apr-08	test failed		1.5	463381.2	3120522.9
281	6	34	5	Carpentry Shop	353	cinder	0-5	Yes	1	21-Apr-08	test failed		1.5	463381.2	3120522.9
281	9	228	10	Carpentry Shop	353	cinder	0-5	Yes	1	21-Apr-08	test failed		1.5	463381.2	3120522.9
281	0	221	9	Carpentry Shop	353	cinder	0-5	Yes	1	21-Apr-08	test failed		1.5	463381.2	3120522.9
281	12	82	7	Carpentry Shop	353	cinder	0-5	Yes	1	21-Apr-08	test failed		1.5	463381.2	3120522.9
282	9	132	8	Carpentry Shop	353	cinder	0-5	No	5	21-Apr-08	high >65 ug/dl		3.3	463379.3	3120505.5
282	3	408	12	Carpentry Shop	353	cinder	0-5	No	5	21-Apr-08	high >65 ug/dl		3.3	463379.3	3120505.5
282	6	75	7	Carpentry Shop	353	cinder	0-5	No	5	21-Apr-08	high >65 ug/dl		3.3	463379.3	3120505.5
282	0	510	13	Carpentry Shop	353	cinder	0-5	No	5	21-Apr-08	high >65 ug/dl		3.3	463379.3	3120505.5
282	12	152	9	Carpentry Shop	353	cinder	0-5	No	5	21-Apr-08	high >65 ug/dl		3.3	463379.3	3120505.5
284	0	700	18	Machine Shop	357	wood, cinder	0-5	No	4	15-Apr-08	value	27.4	2.5	463439	3120517
284	9	283	11	Machine Shop	357	wood, cinder	0-5	No	4	15-Apr-08	value	27.4	2.5	463439	3120517
284	12	99	7	Machine Shop	357	wood, cinder	0-5	No	4	15-Apr-08	value	27.4	2.5	463439	3120517
284	6	472	14	Machine Shop	357	wood, cinder	0-5	No	4	15-Apr-08	value	27.4	2.5	463439	3120517

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
284	3	772	18	Machine Shop	357	wood, cinder	0-5	No	4	15-Apr-08	value	27.4	2.5	463439	3120517
285	3	49	6	Machine Shop	357	wood, cinder	0-5	No	3	15-Apr-08	test failed		2.4	463459	3120515
285	0	440	13	Machine Shop	357	wood, cinder	0-5	No	3	15-Apr-08	test failed		2.4	463459	3120515
286	0	292	11	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	10.1	2.9	463418.5	3120514.1
286	3	171	9	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	10.1	2.9	463418.5	3120514.1
286	6	95	7	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	10.1	2.9	463418.5	3120514.1
286	12	58	6	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	10.1	2.9	463418.5	3120514.1
286	9	48	6	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	10.1	2.9	463418.5	3120514.1
287	3	58	6	Machine Shop	357	wood, cinder	5-15	No	5	15-Apr-08	value	4.8	3	463473	3120513
287	12	131	7	Machine Shop	357	wood, cinder	5-15	No	5	15-Apr-08	value	4.8	3	463473	3120513
287	9	143	8	Machine Shop	357	wood, cinder	5-15	No	5	15-Apr-08	value	4.8	3	463473	3120513
287	0	142	8	Machine Shop	357	wood, cinder	5-15	No	5	15-Apr-08	value	4.8	3	463473	3120513
287	6	177	9	Machine Shop	357	wood, cinder	5-15	No	5	15-Apr-08	value	4.8	3	463473	3120513
288	0	362	11	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	41.4	2.6	463366.1	3120511.6
288	3	263	10	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	41.4	2.6	463366.1	3120511.6
288	6	263	10	Carpentry Shop	353	cinder	5-15	No	4	21-Apr-08	value	41.4	2.6	463366.1	3120511.6
289	0	428	14	Carpentry Shop	353	cinder	0-5	No	4	21-Apr-08	high >65 ug/dl		2.8	463406.2	3120508.3
289	6	277	10	Carpentry Shop	353	cinder	0-5	No	4	21-Apr-08	high >65 ug/dl		2.8	463406.2	3120508.3
289	3	369	12	Carpentry Shop	353	cinder	0-5	No	4	21-Apr-08	high >65 ug/dl		2.8	463406.2	3120508.3
291	12	29	5	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	6.8	2	463445	3120499
291	0	71	6	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	6.8	2	463445	3120499
291	3	41	5	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	6.8	2	463445	3120499
291	6	62	6	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	6.8	2	463445	3120499
291	9	59	6	Machine Shop	357	wood, cinder	5-15	No	3	15-Apr-08	value	6.8	2	463445	3120499
293	3	484	14	Carpentry Shop	353	cinder	5-15	No	2	21-Apr-08	value	15	1.5	463374.7	3120498.9
293	0	401	12	Carpentry Shop	353	cinder	5-15	No	2	21-Apr-08	value	15	1.5	463374.7	3120498.9
293	12	69	6	Carpentry Shop	353	cinder	5-15	No	2	21-Apr-08	value	15	1.5	463374.7	3120498.9
293	9	291	11	Carpentry Shop	353	cinder	5-15	No	2	21-Apr-08	value	15	1.5	463374.7	3120498.9
293	6	1167	23	Carpentry Shop	353	cinder	5-15	No	2	21-Apr-08	value	15	1.5	463374.7	3120498.9
299	0	154	7	Transmitter Building	5309	cinder?	5-15	No	3	14-Apr-08	low <3.3 ug/dl		2.3	463387	3120331
299	9	57	6	Transmitter Building	5309	cinder?	5-15	No	3	14-Apr-08	low <3.3 ug/dl		2.3	463387	3120331
299	6	86	6	Transmitter Building	5309	cinder?	5-15	No	3	14-Apr-08	low <3.3 ug/dl		2.3	463387	3120331
299	3	316	10	Transmitter Building	5309	cinder?	5-15	No	3	14-Apr-08	low <3.3 ug/dl		2.3	463387	3120331

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
299	12	nd	13	Transmitter Building	5309	cinder?	5-15	No	3	14-Apr-08	low <3.3 ug/dl		2.3	463387	3120331
300	0	110	7	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	value	4.2	1.4	463401	3120331
301	9	23	5	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	value	9.4	2.3	463401	3120321
301	0	175	8	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	value	9.4	2.3	463401	3120321
301	3	66	6	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	value	9.4	2.3	463401	3120321
301	12	20	5	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	value	9.4	2.3	463401	3120321
301	6	53	6	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	value	9.4	2.3	463401	3120321
303	12	17	5	Transmitter Building	5309	cinder?	5-15	No	4	14-Apr-08	value	5	2.6	463353	3120311
303	9	nd	13	Transmitter Building	5309	cinder?	5-15	No	4	14-Apr-08	value	5	2.6	463353	3120311
303	6	57	6	Transmitter Building	5309	cinder?	5-15	No	4	14-Apr-08	value	5	2.6	463353	3120311
303	0	238	9	Transmitter Building	5309	cinder?	5-15	No	4	14-Apr-08	value	5	2.6	463353	3120311
303	3	90	7	Transmitter Building	5309	cinder?	5-15	No	4	14-Apr-08	value	5	2.6	463353	3120311
304	9	15	4	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	low <3.3 ug/dl		1.2	463423	3120309
304	12	33	5	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	low <3.3 ug/dl		1.2	463423	3120309
304	6	34	5	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	low <3.3 ug/dl		1.2	463423	3120309
304	0	56	5	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	low <3.3 ug/dl		1.2	463423	3120309
304	3	80	7	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	low <3.3 ug/dl		1.2	463423	3120309
305	9	18	5	Transmitter Building	5309	cinder?	0-5	No	3	14-Apr-08	value	3.5	2.1	463415	3120305
305	12	nd	13	Transmitter Building	5309	cinder?	0-5	No	3	14-Apr-08	value	3.5	2.1	463415	3120305
305	6	55	6	Transmitter Building	5309	cinder?	0-5	No	3	14-Apr-08	value	3.5	2.1	463415	3120305
305	0	33	5	Transmitter Building	5309	cinder?	0-5	No	3	14-Apr-08	value	3.5	2.1	463415	3120305
305	3	85	6	Transmitter Building	5309	cinder?	0-5	No	3	14-Apr-08	value	3.5	2.1	463415	3120305
307	9	nd	13	Transmitter Building	5309	cinder?	5-15	No	5	14-Apr-08	low <3.3 ug/dl		2.6	463423	3120297
307	6	16	4	Transmitter Building	5309	cinder?	5-15	No	5	14-Apr-08	low <3.3 ug/dl		2.6	463423	3120297
307	3	19	5	Transmitter Building	5309	cinder?	5-15	No	5	14-Apr-08	low <3.3 ug/dl		2.6	463423	3120297
307	0	40	5	Transmitter Building	5309	cinder?	5-15	No	5	14-Apr-08	low <3.3 ug/dl		2.6	463423	3120297
307	12	14	4	Transmitter Building	5309	cinder?	5-15	No	5	14-Apr-08	low <3.3 ug/dl		2.6	463423	3120297
308	3	25	5	Transmitter Building	5309	cinder?	0-5	No	5	14-Apr-08	low <3.3 ug/dl		2.8	463391	3120293
308	12	nd	14	Transmitter Building	5309	cinder?	0-5	No	5	14-Apr-08	low <3.3 ug/dl		2.8	463391	3120293
308	6	27	5	Transmitter Building	5309	cinder?	0-5	No	5	14-Apr-08	low <3.3 ug/dl		2.8	463391	3120293
308	0	25	5	Transmitter Building	5309	cinder?	0-5	No	5	14-Apr-08	low <3.3 ug/dl		2.8	463391	3120293
308	9	23	5	Transmitter Building	5309	cinder?	0-5	No	5	14-Apr-08	low <3.3 ug/dl		2.8	463391	3120293
309	12	21	5	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	low <3.3 ug/dl		1.7	463369	3120285

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
309	6	17	5	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	low <3.3 ug/dl		1.7	463369	3120285
309	3	58	6	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	low <3.3 ug/dl		1.7	463369	3120285
309	0	90	6	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	low <3.3 ug/dl		1.7	463369	3120285
309	9	78	6	Transmitter Building	5309	cinder?	0-5	No	1	14-Apr-08	low <3.3 ug/dl		1.7	463369	3120285
310	12	895	21	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	value	3.5	1.7	463373	3120283
310	9	2852	45	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	value	3.5	1.7	463373	3120283
310	6	271	10	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	value	3.5	1.7	463373	3120283
310	3	115	7	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	value	3.5	1.7	463373	3120283
310	0	171	8	Transmitter Building	5309	cinder?	5-15	No	1	14-Apr-08	value	3.5	1.7	463373	3120283
311	0	16	4	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	3.5	1.9	462798.9	3120172.9
311	9	29	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	3.5	1.9	462798.9	3120172.9
311	3	22	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	3.5	1.9	462798.9	3120172.9
311	6	30	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	3.5	1.9	462798.9	3120172.9
311	12	27	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	3.5	1.9	462798.9	3120172.9
313	3	56	6	Marine barracks	578	wood	5-15	No	5	11-Apr-08	low <3.3 ug/dl		3.1	462807.5	3120171.5
313	6	52	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	low <3.3 ug/dl		3.1	462807.5	3120171.5
313	0	48	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	low <3.3 ug/dl		3.1	462807.5	3120171.5
314	9	28	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	7.6	2.1	462782.2	3120170.1
314	0	49	5	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	7.6	2.1	462782.2	3120170.1
314	3	110	7	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	7.6	2.1	462782.2	3120170.1
314	6	69	6	Marine barracks	578	wood	5-15	No	5	11-Apr-08	value	7.6	2.1	462782.2	3120170.1
317	3	57	6	Marine barracks	578	wood	0-5	No	5	11-Apr-08	low <3.3 ug/dl		2.9	462787.5	3120148.5
317	0	109	7	Marine barracks	578	wood	0-5	No	5	11-Apr-08	low <3.3 ug/dl		2.9	462787.5	3120148.5
317	6	101	6	Marine barracks	578	wood	0-5	No	5	11-Apr-08	low <3.3 ug/dl		2.9	462787.5	3120148.5
317	12	164	8	Marine barracks	578	wood	0-5	No	5	11-Apr-08	low <3.3 ug/dl		2.9	462787.5	3120148.5
317	9	251	9	Marine barracks	578	wood	0-5	No	5	11-Apr-08	low <3.3 ug/dl		2.9	462787.5	3120148.5
318	9	704	17	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.3	462807	3120147
318	3	590	16	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.3	462807	3120147
318	12	33	5	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.3	462807	3120147
318	0	364	12	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.3	462807	3120147
318	6	731	18	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.3	462807	3120147
321	0	1091	21	Marine barracks	578	wood	0-5	No	5	11-Apr-08	value	20.1	2	462787	3120139
323	6	127	7	Marine barracks	578	wood	0-5	No	3	11-Apr-08	high >65 ug/dl		1.1	462807	3120121

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
323	12	82	7	Marine barracks	578	wood	0-5	No	3	11-Apr-08	high >65 ug/dl		1.1	462807	3120121
323	9	49	5	Marine barracks	578	wood	0-5	No	3	11-Apr-08	high >65 ug/dl		1.1	462807	3120121
323	0	691	17	Marine barracks	578	wood	0-5	No	3	11-Apr-08	high >65 ug/dl		1.1	462807	3120121
323	3	221	9	Marine barracks	578	wood	0-5	No	3	11-Apr-08	high >65 ug/dl		1.1	462807	3120121
324	0	58	6	Marine barracks	578	wood	5-15	Yes	4	11-Apr-08	low <3.3 ug/dl		2.6	462813	3120121
324	12	41	5	Marine barracks	578	wood	5-15	Yes	4	11-Apr-08	low <3.3 ug/dl		2.6	462813	3120121
324	3	35	5	Marine barracks	578	wood	5-15	Yes	4	11-Apr-08	low <3.3 ug/dl		2.6	462813	3120121
324	9	61	6	Marine barracks	578	wood	5-15	Yes	4	11-Apr-08	low <3.3 ug/dl		2.6	462813	3120121
324	6	67	6	Marine barracks	578	wood	5-15	Yes	4	11-Apr-08	low <3.3 ug/dl		2.6	462813	3120121
328	3	147	8	Marine barracks	578	wood	5-15	No	4	11-Apr-08	value	8	1.7	462781	3120109
328	6	109	7	Marine barracks	578	wood	5-15	No	4	11-Apr-08	value	8	1.7	462781	3120109
328	9	158	8	Marine barracks	578	wood	5-15	No	4	11-Apr-08	value	8	1.7	462781	3120109
328	0	117	7	Marine barracks	578	wood	5-15	No	4	11-Apr-08	value	8	1.7	462781	3120109
328	12	222	10	Marine barracks	578	wood	5-15	No	4	11-Apr-08	value	8	1.7	462781	3120109
329	0	244	10	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.1	462785	3120109
329	3	673	17	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.1	462785	3120109
329	9	274	10	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.1	462785	3120109
329	6	884	19	Marine barracks	578	wood	0-5	No	5	11-Apr-08	high >65 ug/dl		2.1	462785	3120109
332	9	nd	13	Marine barracks	578	wood	5-15	No	4	11-Apr-08	low <3.3 ug/dl		1.8	462811	3120097
332	6	nd	13	Marine barracks	578	wood	5-15	No	4	11-Apr-08	low <3.3 ug/dl		1.8	462811	3120097
332	12	nd	12	Marine barracks	578	wood	5-15	No	4	11-Apr-08	low <3.3 ug/dl		1.8	462811	3120097
332	0	nd	13	Marine barracks	578	wood	5-15	No	4	11-Apr-08	low <3.3 ug/dl		1.8	462811	3120097
332	3	18	5	Marine barracks	578	wood	5-15	No	4	11-Apr-08	low <3.3 ug/dl		1.8	462811	3120097
1311	30	nd	13	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1311	18	nd	13	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1311	24	nd	13	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1311	6	806	19	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1311	0	395	13	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1311	12	45	5	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1311	36	nd	12	Cable building	643	wood	0-5	No	3	22-Apr-08	value	20.3	2.1	462845	3121144.9
1331	0	751	19	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143
1331	36	17	4	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143
1331	6	563	16	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
1331	18	nd	13	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143
1331	30	20	5	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143
1331	24	nd	13	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143
1331	12	35	5	Cable building	643	wood	0-5	No	3	22-Apr-08	value	6.8	1.5	462861.1	3121143
1381	12	653	17	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1381	36	23	5	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1381	30	nd	15	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1381	24	123	8	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1381	18	424	13	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1381	0	291	11	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1381	6	597	16	Cable building	643	wood	0-5	Yes	1	23-Apr-08	value	15	0.7	462859	3121135
1921	3	421	12	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	test failed		1.7	463379	3120893
1921	6	37	5	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	test failed		1.7	463379	3120893
1921	0	694	16	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	test failed		1.7	463379	3120893
1921	9	130	8	Midway Mall Complex	259	wood, cinder	0-5	Yes	1	13-Apr-08	test failed		1.7	463379	3120893
2501	18	86	7	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
2501	6	337	12	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
2501	30	15	5	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
2501	36	14	5	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
2501	24	nd	14	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
2501	0	190	9	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
2501	12	416	13	Paint & Oil Storage	342	cinder	0-5	No	2	24-Apr-08	value	40.3	2.2	463319	3120574.9
3101	12	nd	13	Transmitter Building	5309	cinder?	5-15	No	1	22-Apr-08	value	3.5	1.7	463373	3120283
3101	24	nd	13	Transmitter Building	5309	cinder?	5-15	No	1	22-Apr-08	value	3.5	1.7	463373	3120283
3101	6	300	11	Transmitter Building	5309	cinder?	5-15	No	1	22-Apr-08	value	3.5	1.7	463373	3120283
3101	18	nd	13	Transmitter Building	5309	cinder?	5-15	No	1	22-Apr-08	value	3.5	1.7	463373	3120283
3101	0	138	8	Transmitter Building	5309	cinder?	5-15	No	1	22-Apr-08	value	3.5	1.7	463373	3120283
3101	30	nd	13	Transmitter Building	5309	cinder?	5-15	No	1	22-Apr-08	value	3.5	1.7	463373	3120283
3181	12	61	6	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147
3181	36	nd	13	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147
3181	6	1209	25	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147
3181	0	151	8	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147
3181	18	nd	14	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147

Sample ID	depth (inches)	Pb (ppm)	Pb +/- (ppm)	NAME	Building Number	Structure Type	Zone (meters from building)	Droop Wing	Physical Condition (1 poor to 5 excellent)	Sample Date	Blood Lead Reading	Blood Lead results ug/dl	Weight (kg)	Easting	Northing
3181	24	nd	13	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147
3181	30	nd	14	Marine barracks	578	wood	0-5	No	5	23-Apr-08	high >65 ug/dl		2.3	462807	3120147

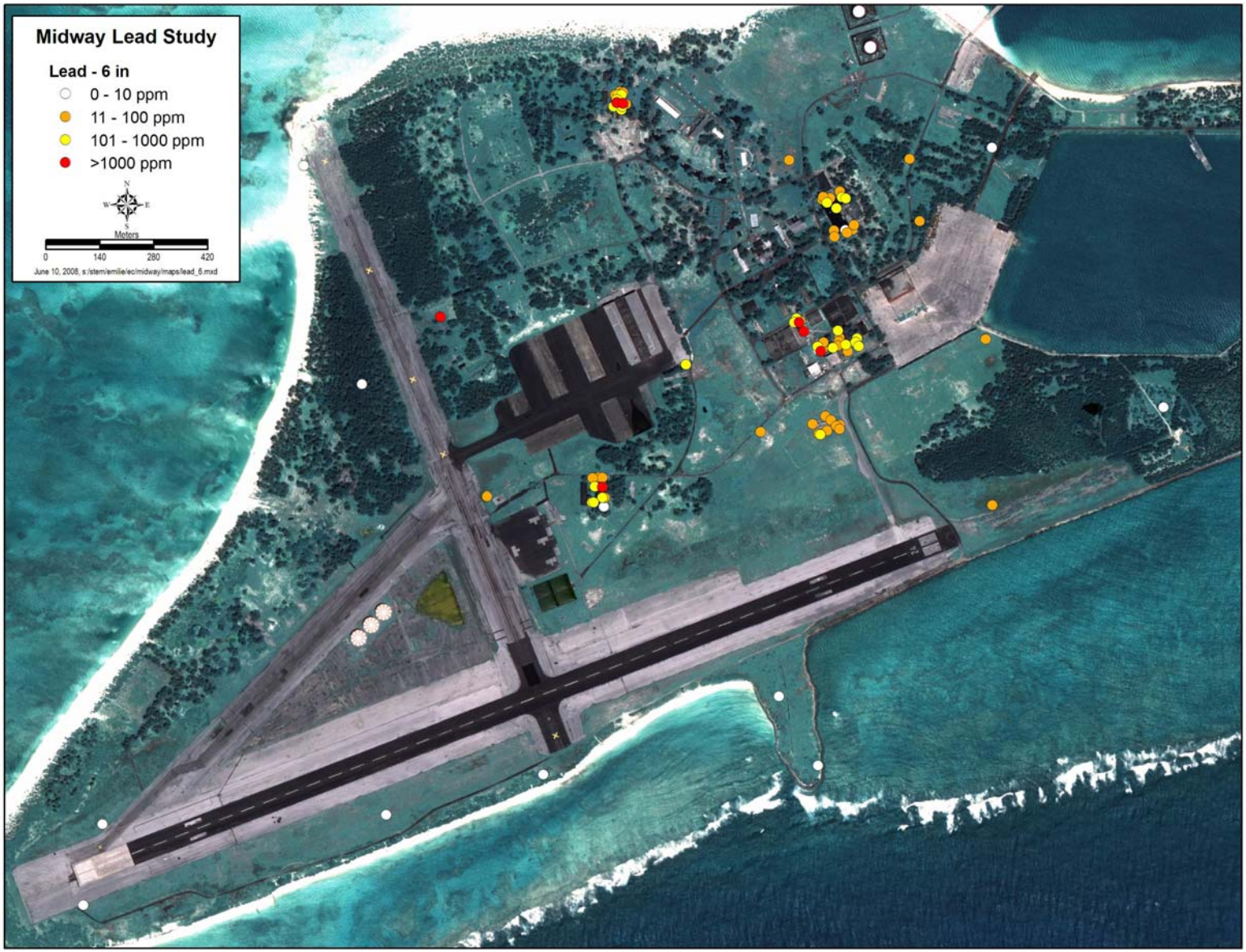
Appendix E – Soil Data from Residential Lead Study Sampling, Sand Island, Midway Atoll National Wildlife Refuge, 2008

Sample ID	depth (inches)	NAME	Building Number	Zone (meters from building)	Pb (ppm)	Pb +/- (ppm)	Bldg type	Sampling Date
42407	0	Historic Officers Quarters	424	0-5	78	6	wood	23-Apr-08
42407	3	Historic Officers Quarters	424	0-5	58	6	wood	23-Apr-08
42406	0	Historic Officers Quarters	424	0-5	50	7	wood	23-Apr-08
42406	3	Historic Officers Quarters	424	0-5	70	6	wood	23-Apr-08
42405	0	Historic Officers Quarters	424	0-5	37	6	wood	23-Apr-08
42405	3	Historic Officers Quarters	424	0-5	29	5	wood	23-Apr-08
42404	0	Historic Officers Quarters	424	0-5	18	5	wood	23-Apr-08
42404	3	Historic Officers Quarters	424	0-5	nd	14	wood	23-Apr-08
42403	0	Historic Officers Quarters	424	0-5	77	6	wood	23-Apr-08
42403	3	Historic Officers Quarters	424	0-5	96	7	wood	23-Apr-08
42402	0	Historic Officers Quarters	424	0-5	96	7	wood	23-Apr-08
42402	3	Historic Officers Quarters	424	0-5	94	7	wood	23-Apr-08
42401	0	Historic Officers Quarters	424	0-5	41	6	wood	23-Apr-08
42401	3	Historic Officers Quarters	424	0-5	30	5	wood	23-Apr-08
421006	0	Concrete Duplex	4210	0-5	22	5	cinder	23-Apr-08
421006	3	Concrete Duplex	4210	0-5	38	5	cinder	23-Apr-08
421005	0	Concrete Duplex	4210	0-5	28	5	cinder	23-Apr-08
421005	3	Concrete Duplex	4210	0-5	19	5	cinder	23-Apr-08
421004	0	Concrete Duplex	4210	0-5	36	5	cinder	23-Apr-08
421004	3	Concrete Duplex	4210	0-5	21	5	cinder	23-Apr-08
421003	0	Concrete Duplex	4210	0-5	23	5	cinder	23-Apr-08
421003	3	Concrete Duplex	4210	0-5	nd	13	cinder	23-Apr-08
421002	0	Concrete Duplex	4210	0-5	41	5	cinder	23-Apr-08
421002	3	Concrete Duplex	4210	0-5	16	5	cinder	23-Apr-08
421001	0	Concrete Duplex	4210	0-5	28	5	cinder	23-Apr-08
421001	3	Concrete Duplex	4210	0-5	nd	13	cinder	23-Apr-08
420308	0	BOQ Bravo Barracks	4203	0-5	21	5	cinder	23-Apr-08
420308	3	BOQ Bravo Barracks	4203	0-5	28	5	cinder	23-Apr-08
420307	0	BOQ Bravo Barracks	4203	0-5	32	5	cinder	23-Apr-08
420307	3	BOQ Bravo Barracks	4203	0-5	28	6	cinder	23-Apr-08
420306	0	BOQ Bravo Barracks	4203	0-5	45	5	cinder	23-Apr-08
420306	3	BOQ Bravo Barracks	4203	0-5	39	5	cinder	23-Apr-08
420305	0	BOQ Bravo Barracks	4203	0-5	28	5	cinder	23-Apr-08
420305	3	BOQ Bravo Barracks	4203	0-5	41	5	cinder	23-Apr-08
420304	0	BOQ Bravo Barracks	4203	0-5	61	6	cinder	23-Apr-08
420304	3	BOQ Bravo Barracks	4203	0-5	60	6	cinder	23-Apr-08
420303	0	BOQ Bravo Barracks	4203	0-5	27	5	cinder	23-Apr-08
420303	3	BOQ Bravo Barracks	4203	0-5	35	5	cinder	23-Apr-08
420302	0	BOQ Bravo Barracks	4203	0-5	24	5	cinder	23-Apr-08
420302	3	BOQ Bravo Barracks	4203	0-5	22	5	cinder	23-Apr-08

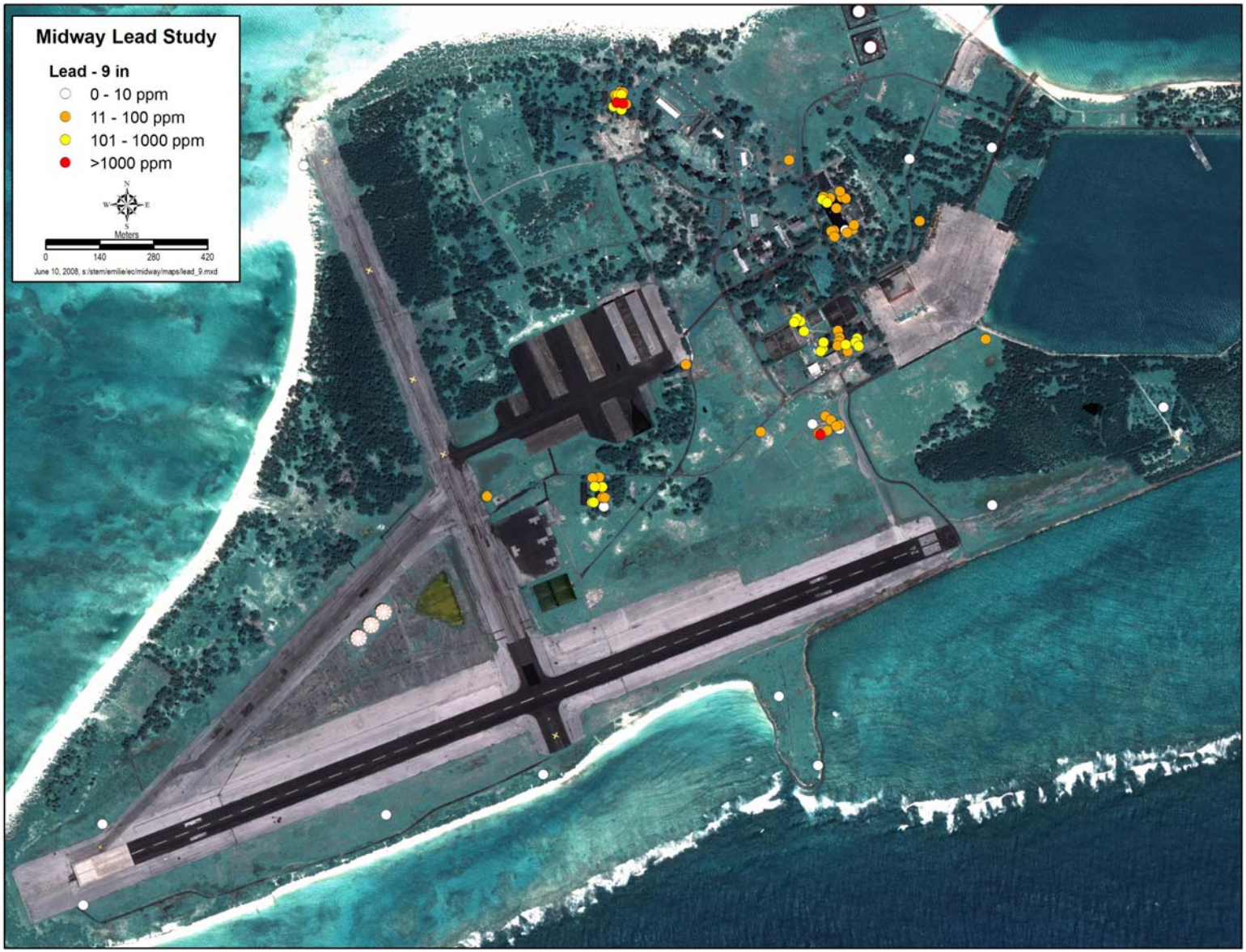
Sample ID	depth (inches)	NAME	Building Number	Zone (meters from building)	Pb (ppm)	Pb +/- (ppm)	Bldg type	Sampling Date
420301	0	BOQ Bravo Barracks	4203	0-5	28	5	cinder	23-Apr-08
420301	3	BOQ Bravo Barracks	4203	0-5	24	5	cinder	23-Apr-08
41607	0	Historic Officers Quarters	416	0-5	199	9	wood	23-Apr-08
41607	3	Historic Officers Quarters	416	0-5	280	10	wood	23-Apr-08
41606	0	Historic Officers Quarters	416	0-5	112	7	wood	23-Apr-08
41606	3	Historic Officers Quarters	416	0-5	67	6	wood	23-Apr-08
41605	0	Historic Officers Quarters	416	0-5	nd	14	wood	23-Apr-08
41605	3	Historic Officers Quarters	416	0-5	nd	13	wood	23-Apr-08
41604	0	Historic Officers Quarters	416	0-5	273	10	wood	23-Apr-08
41604	3	Historic Officers Quarters	416	0-5	48	5	wood	23-Apr-08
41603	0	Historic Officers Quarters	416	0-5	60	6	wood	23-Apr-08
41603	3	Historic Officers Quarters	416	0-5	86	7	wood	23-Apr-08
41602	0	Historic Officers Quarters	416	0-5	103	7	wood	23-Apr-08
41602	3	Historic Officers Quarters	416	0-5	280	11	wood	23-Apr-08
41601	0	Historic Officers Quarters	416	0-5	37	6	wood	23-Apr-08
41601	3	Historic Officers Quarters	416	0-5	32	5	wood	23-Apr-08
41406	0	Midway House	414	0-5	115	7	wood	23-Apr-08
41406	3	Midway House	414	0-5	403	13	wood	23-Apr-08
41405	0	Midway House	414	0-5	nd	14	wood	23-Apr-08
41405	3	Midway House	414	0-5	nd	15	wood	23-Apr-08
41404	0	Midway House	414	0-5	159	8	wood	23-Apr-08
41404	3	Midway House	414	0-5	189	9	wood	23-Apr-08
41403	0	Midway House	414	0-5	148	8	wood	23-Apr-08
41403	3	Midway House	414	0-5	106	7	wood	23-Apr-08
41402	0	Midway House	414	0-5	nd	13	wood	23-Apr-08
41402	3	Midway House	414	0-5	42	5	wood	23-Apr-08
41401	0	Midway House	414	0-5	79	7	wood	23-Apr-08
41401	3	Midway House	414	0-5	47	6	wood	23-Apr-08

Appendix F, Figure 1. Surface Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008

Appendix F, Figure 2. Subsurface (3 in) Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008



Appendix F, Figure 3. Subsurface (6 in) Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008



Appendix F, Figure 4. Subsurface (9 in) Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008

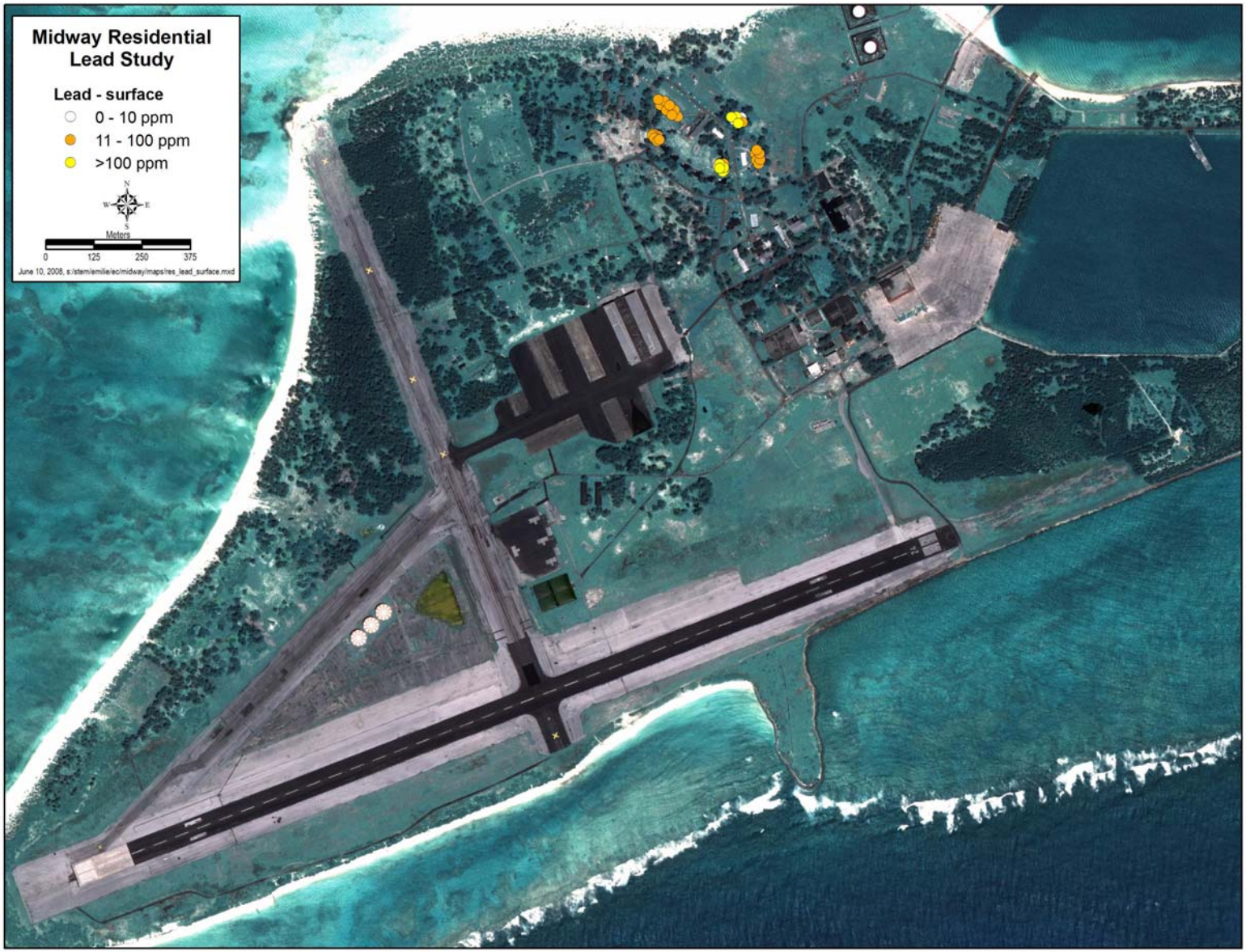
Appendix F, Figure 5. Subsurface (12 in) Lead Soil Level. Sand Island, Midway Atoll National Wildlife Refuge, 2008

Appendix F, Figure 6. Subsurface (18 in) Lead Soil Level. Sand Island, Midway Atoll National Wildlife Refuge, 2008

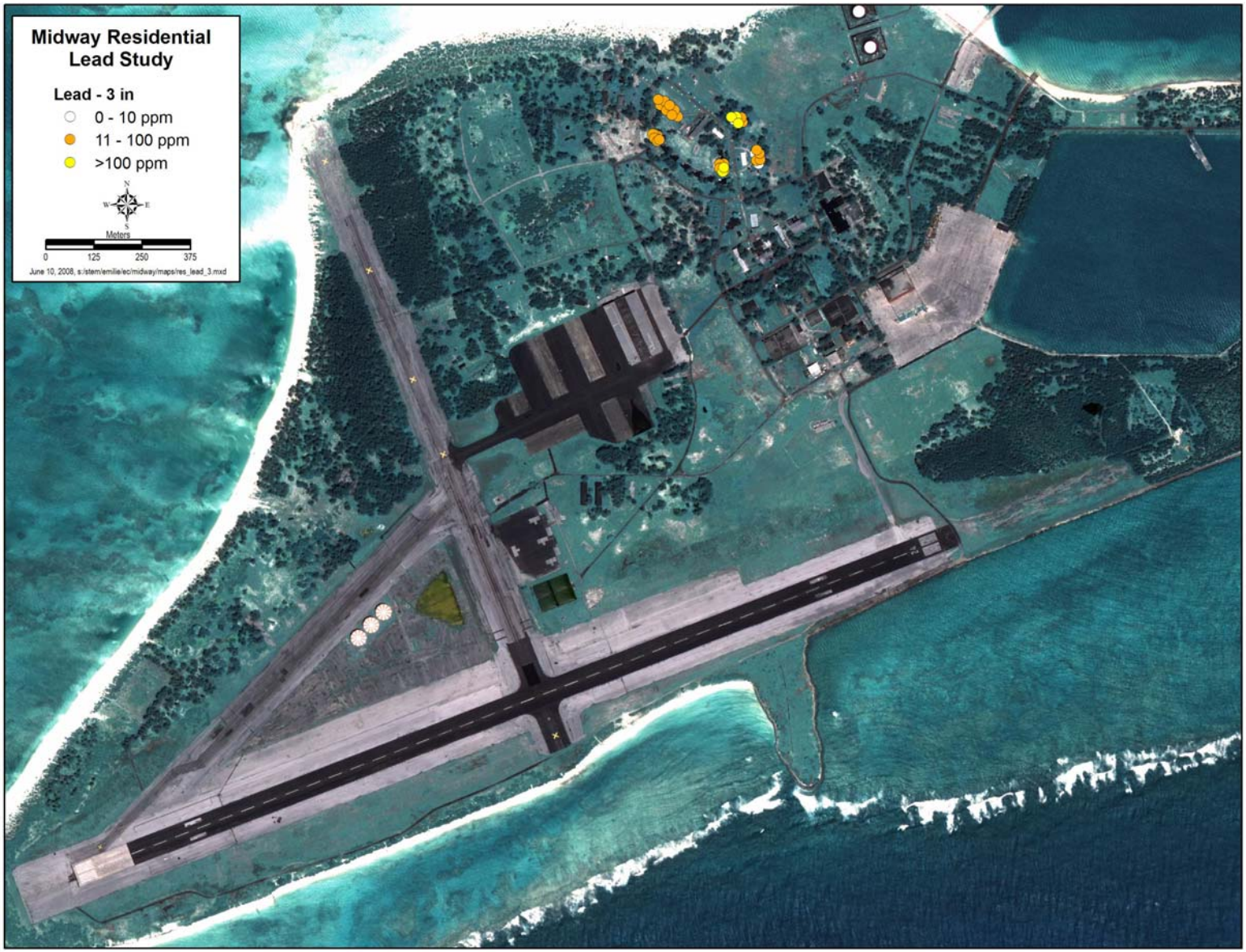
Appendix F, Figure 7. Subsurface (24 in) Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008

Appendix F, Figure 8. Subsurface (30 in) Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008

Appendix F, Figure 9. Subsurface (36 in) lead values. Sand Island, Midway Atoll National Wildlife Refuge, 2008



Appendix F, Figure 10. Residential Surface Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008



Appendix F, Figure 11. Residential Subsurface (3 in) Lead Soil Levels. Sand Island, Midway Atoll National Wildlife Refuge, 2008