Public Health Assessment for

NORMANDY PARK APARTMENTS
TEMPLE TERRACE, HILLSBOROUGH COUNTY, FLORIDA
CERCLIS NO. FLD984229773
APRIL 20, 1999

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

PUBLIC HEALTH ASSESSMENT

NORMANDY PARK APARTMENTS

TEMPLE TERRACE, HILLSBOROUGH COUNTY, FLORIDA

CERCLIS NO. FLD984229773

Prepared by:

Florida Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

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SUMMARY

The Normandy Park Apartments site is in Temple Terrace near Tampa, Florida. Between 1953 and 1963, Gulf Coast Lead, now known as Gulf Coast Recycling Inc., recycled batteries and smelted lead at this site. In 1971, Gulf Coast Recycling built the 144-unit Normandy Park Apartments complex. In 1991, an apartment resident complained of children playing with battery chips in the soil. Upon investigation, local environmental officials discovered high soil lead concentrations. The Florida Department of Health *(FDOH)* addressed the public health significance of the site in a draft Public Health Assessment distributed in 1996. The findings in the report were that Normandy Park Apartments site was a public health hazard in the past because the concentrations of lead found in the soil were enough to affect people's health. Residents were exposed to the lead by accidentally eating small amounts of soil and breathing dust contaminated with lead. The site was designated as an indeterminate health hazard in the present because some of the areas with high concentrations of lead in the soil were capped with concrete or wooden decking. We did not have enough information to determine if the site was still a public health hazard.

Since 1996, FDOH has reviewed more information about the lead contamination at the apartment site. We have determined that the site is no apparent public health threat because the soils with the highest lead contamination are either capped with concrete, asphalt, or wooden decking. Areas that are covered by grass or mulch or is bare soil, generally have lead concentrations that are below levels of health concern; less than 400 milligrams per kilogram (mg/kg), EPA's no risk level for lead-contaminated soil. Indoor dust sampling indicated that lead was not a problem in indoor dust. Drinking water for the site is supplied by the City of Temple Terrace municipal water system.

There are subsurface soils (deeper than 6 inches) that have concentrations of lead that might affect human health if people are exposed to them. In the future, if deeper soils at the site are disturbed, workers and residents could be exposed to lead-contaminated soil that might impact their health.

Although the site does not currently pose a threat to children, we advise that residents minimize lead exposure to themselves and their children. We recommend that Normandy Park Apartment residents take steps to reduce their potential exposure to lead contaminated dust by removing their shoes at apartment entry ways, and washing their hands and faces after working or playing outside, especially before eating. We also recommend that residents with young children consult with their pediatrician about having their children's blood tested.

EPA is currently developing a feasibility study for permanent remediation of the site. In the future, if soil is dug up at the site, we recommend that workers should prevent access to contaminated soil and implement dust control and air monitoring measures.

BACKGROUND

In this public health assessment, the FDOH (FDOH, formerly known as FHRS, the Florida Department of Health and Rehabilitative Services), under cooperative agreement with the Agency for Toxic Substances and Disease Registry, evaluates the public health threat of the Normandy Park Apartments site. The purpose of the public health assessment is to find out if people were, are, or will be exposed to hazardous substances and, if so, to determine if exposure is harmful and should be stopped or reduced.

A. Site Description and History

The Normandy Park Apartments site is at 11110 North 56th Street in Temple Terrace, Hillsborough County, Florida (Figures 1 and 2, Appendix A). Since 1971, the nine-acre site has been a 144-unit apartment complex with two main groups of buildings: a southern section formerly for adults only, and a northern section formerly for families. The southern section consists of four buildings arranged in a rectangle around a central courtyard. A swimming pool and laundry facility are in the southern courtyard, and an irrigation well used to be in the southwest corner. The northern section consists of eight buildings arranged around two (northern and middle) courtyards. A swimming pool and a tennis court are in the recreational area connecting the two courtyards (Figure 3, Appendix A). The northern courtyard has a playground for children with a sandbox (ATSDR 1992a; OHM 1992a; FHRS 1995e; 1996d). Children live in both the southern and northern sections of the complex (GCR 1992a). Normandy Park residents drink municipal well water (FHRS 1995e).

From 1953-1963, the site was known as Gulf Coast Lead, a battery recycling facility with a secondary smelter. Plant workers removed lead from used car batteries, crushed the battery casings, and smelted the lead and lead salts into pure lead (ATSDR 1992a, FDER 1992f, FHRS 1995d, Taylor 1996). The smelting operation probably took place in the southern section of the complex (FDER 1992f, GCR 1992a, FHRS 1996e).

Site investigators report site soils are a mixture of battery casing chips and dirt (HCEPC 1991b; OHM 1992a; FHRS 1993, 1995e). Ground cover seems to vary seasonally (Table 1, Appendix B), and exposure of battery casing pieces appears to vary with the seasons. FDOH staff has observed areas covered by bare soil are larger in winter than in summer. As Gulf Coast Recycling Inc. (GCR) has made efforts to clean up the site over time, the size of exposed casing pieces seems to have decreased (Table 2, Appendix B). No casings were observed during a site visit made by FDOH staff in November 1998, however a representative from Gulf Coast Recycling stated that battery chips are occasionally observed (FDOH 1998b).

In 1991, the Hillsborough County Environmental Protection Commission (HCEPC) began investigating the site after receiving a complaint about children finding and playing with battery casing chips from the playground area at the apartment complex (HCEPC 1991a, 1991b; FDER 1992f; FHRS 1995b). The major health concerns arising from this complaint were young children (0-6 years old) would accidentally eat lead by placing lead-contaminated battery chips in their mouths, directly eating soil containing lead, or placing hands covered with lead-contaminated dirt or dust into their mouths. These activities were a health concern because young children are particularly sensitive to the harmful effects from eating lead.

After receiving the complaint, HCEPC asked the site owners, GCR, to sample the soils for lead (HCEPC 1991b). Two sampling efforts found a patchy distribution of high lead concentrations in soil. In these initial sample sets, the highest lead concentration in soil 0-6 inches deep was 2,075 mg/kg, and the highest lead concentration in deeper soils was 35,000 mg/kg. The analyses also found lead in shallow groundwater, with the highest concentration at 16.7 mg/L (milligrams per liter). The southern section of the complex, where the battery recycling likely occurred, had the highest lead concentrations for both soil and water (Eagle 199[1], ESSI 1992). After examining the soil data, a toxicologist hired by GCR concluded that the soils in the northern complex, with the possible exception of one point in the middle courtyard, did not pose a significant human health hazard. However, the toxicologist stated the surface soils in the southern courtyard could require further attention (HSWMR 1991).

During a January-February 1992 investigation on behalf of GCR, investigators performed a ground penetrating radar survey primarily on the southern portion of the site, conducted standard penetration tests, installed temporary and permanent monitor wells, and collected both groundwater and soil samples. Two ground penetrating radar surveys identified four areas of possible buried debris in the southern courtyard (OHM 1992a), and one large area of buried debris in the northern courtyard (OHM 1992c). Water analyses confirmed elevated concentrations of lead and other metals in groundwater under the site. The soil investigation confirmed the presence of patchy high concentrations of lead in subsurface soils, with the highest concentration in the southern courtyard of 125,800 mg/kg (two feet deep). Of immediate concern was the finding of 1,200 mg/kg of lead in soil (one foot deep) next to the playground (OHM 1992a), suggesting a possible health threat to young children playing in this area.

Upon learning of the high lead concentrations in playground soils, the Hillsborough County Health Department, HCHD, worked with the site owners to provide free blood lead testing to Normandy Park Apartment residents. Some residents had blood tests performed by private physicians. Between January and April 1992, approximately 65 residents of all ages had their blood tested. About 20 of these residents were young children (six years old or younger). A few young children had marginally elevated blood lead levels in the 10-12 μg/dL (micrograms per deciliter) range. Most of these young children had follow-up blood lead testing, and all follow-up tests results were below 10 μg/dL (FHRS 1992). Throughout the blood testing process, health officials informed the public there was no immediate health risk (Fechter 1992a, 1992b; Huggins 1992). During this time period, ATSDR reviewed the available environmental and blood data. In a health consultation, ATSDR found the surface soil concentrations of lead were at levels of concern. However, they found no evidence of undue human exposure to lead. ATSDR recommended characterizing surface and subsurface soil contamination more fully, identifying other possible lead sources (e.g., paint), restricting access to surface soils in the playground (the other high lead concentration areas had already been fenced off), testing all children living in the complex for blood lead, educating residents, and conducting a survey of occupational and hobby interests of the residents (ATSDR 1992a). ATSDR echoed these findings in their second health consultation, with the additional recommendation of employing air monitoring and appropriate safeguards when EPA or GCR remediated the site (ATSDR 1992c).

The Florida Department of Environmental Protection (FDEP, formerly known as FDER, the Florida Department of Environmental Regulation) worked with HCEPC during all of the preliminary site investigations described above. In January 1992, FDEP referred the Normandy Park site to EPA for assistance in addressing health issues and emergency response actions (FDER 1992a, 1992b). Subsequently, both EPA and contractors for GCR collected more soil and groundwater samples to better characterize contamination at the site and, later, to decide upon appropriate site remediation measures (EPA 1992b, 1992d; OHM 1992b, 1992d; Weston 1992; EEC 1994a, 1994b). New sampling found surface soils (0-3 inches deep) in the northern courtyard had a maximum lead concentration of 4,900 mg/kg, and surface soils in the southern courtyard had a maximum lead concentration of 13,800 mg/kg (Weston 1992). GCR signed an Administrative Order on Consent with EPA on June 3, 1992 (EPA 1992c). GCR began the remediation actions of capping soil areas with more than 500 mg/kg of lead in September 1992 (Lammers 1992a, 1992b; Tampa Tribune, 1992).

To cap the lead contamination areas in the northern complex, GCR placed two concrete pads over soil in the areas immediately north and south of the tennis court (EPA 1993a, GCR 1992b) (Figure 4, Appendix A). This remedial action included modifying the children's sandbox to prevent children from digging into contaminated soil. Old sand was removed and wire and plywood were placed over the bottom of the sandbox. This prevented children from digging into soil beneath it. The sandbox was then filled with clean sand (FHRS 1993, 1995b, 1995d; FDOH 1997d; GCR 1998). GCR completed the remedial actions in the northern complex in December 1992 (EPA 1993a).

Designing the cap for the southern courtyard was more complicated. In March 1992, GCR replaced the snow fencing around the pool with a chain-link fence (GCR 1992a). Eventually, they removed the snow fence and covered all open ground surfaces in the courtyard with a wooden deck (Figure 5, Appendix A), underlain by visqueen, a plastic liner, to prevent contact with the soil. Fascia boards were placed vertically between the decking and the visqueen to prevent access under the deck (GCR 1995a). Because plastic or the existing concrete walkways covered the entire courtyard, storm water runoff is collected and pumped to a lined retention pond (FDEP 1993a). To implement these plans, GCR purchased the vacant lot south of the complex (Figure 6, Appendix A), performed a ground penetrating radar survey to select a suitable site for the storm water retention pond, and obtained the necessary construction permits from FDEP (FDEP 1993, GCR 1995a, OHM 1992b).

During this process, several issues had to be addressed. HCEPC and FDEP officials visited the vacant lot and found battery casing pieces at ground surface (HCEPC 1993a). Later samples found high lead concentrations (up to 2,620 mg/kg) in the soils of the vacant lot, including the area where the pond was to be placed (EEC 1994a). The soil samples were tested using the Toxic Characteristic Leaching Procedure (TCLP). The test determines if the lead in the soil could migrate into ground water that may be below the soil (leachability). One of two soil samples from the vacant lot showed excessive leachability (the ability to migrate) (TCLP lead = 19.1 mg/L), requiring the excavated soils be treated as a hazardous waste (EEC 1994b). Ground penetrating radar identified a disturbed area, possibly of buried debris, as well as probable karst features on the vacant lot (FDEP 1993a, 1993b; OHM 1992b). Karst refers to areas of irregular limestone formations where caverns, underground streams, and sink holes are possible. These findings raised questions about water quality related to the apparent buried debris, as well as the possibility of pond subsidence in a karst area. Of these issues, FDEP considered the water quality issue most important and required the storm water pond be lined (FDEP 1993b, 1993c). GCR completed the decking and storm water pond system in October 1995 (EPA 1996). At that time, EPA considered the immediate health threat abated (EPA 1995b).

In January 1995, EPA assigned the Normandy Park Apartments a Hazard Ranking Score of 49.98 (EPA 1995a). In February 1995, EPA proposed the site be placed on the National Priorities List (NPL). This proposal to the NPL necessitated FDOH's completing a public health assessment for the site. GCR challenged the computation of the Hazard Ranking Score, and actual placement on the NPL is still pending (FHRS 1995d; EPA 1996; FDOH 1997a, 1998).

At the request of FDOH, GCR resampled groundwater and surface soil in 1996. Sample results showed lead levels were below EPA's 400 mg/kg no risk level for lead in soil. The soil samples had detectable levels of four other heavy metals (ATE 1996c). The monitor wells had detectable levels of lead and barium; both were below Florida's maximum contaminant levels for these metals. During the installation of three new wells for this sampling, GCR's consultant found a confining layer of clay between the surficial and Floridan aquifers under the site (ATE 1996a).

In June 1996, the Consumer Product and Safety Commission published a warning about exposure to lead dust from imported vinyl miniblinds that deteriorate in heat and sunlight (CPSC 1996). Normandy Park Apartments had vinyl miniblinds in them. Site owners did not know if these miniblinds were the type with the deterioration problem; nevertheless, they planned to replace all miniblinds in the complex (ATE 1997b). They also cleaned the apartments housing children with a shop vac containing a HEPA filter on the exhaust. This procedure minimized dust suspension in the air and its resettlement in the apartments. Owners collected dust samples from apartments with young children, as identified in a dust sampling plan previously submitted to FDOH (ATE 1996b, FHRS 1996g, FDOH 1997c). Samples collected from window sills and carpet in the second bedroom showed lead levels in the apartments were below federal guidelines (ATE 1997a, HUD 1995).

EPA and GCR have held informational meetings for residents throughout the site investigations and remedial actions. In April 1992, EPA held a public meeting to explain their emergency response plans for the site (EPA 1992a). The HCHD's Environmental Health Director offered the free blood lead testing to the residents during this meeting. In February 1993, EPA held a public availability session to answer questions the residents might have had after the initial emergency response actions, and to discuss future plans. FDOH staff attended both of these meetings (FHRS 1995c). GCR reports that they have held several informational meetings for residents. In August 1995, FDOH staff held a public meeting to discuss the public health assessment process and collect community health concerns. The community health concerns gathered focused on issues of exposure and on health effects of lead (FHRS 1995e). Over time, community concern about the Normandy Park Apartments site appears to have changed from moderate to low. Presently, EPA is working with GCR on developing a Remedial Investigation/Feasibility Study that focuses on permanently abating the lead threat at the site (EPA 1998, FDOH 1998).

HCEPC records indicate former Gulf Coast Lead plant personnel gave away old battery casings to anyone who wanted them. Area residents and property owners reportedly used the casings for filling swampland, constructing walkways, and as planters. An investigation of these allegations at one property on the Hillsborough River confirmed the presence of battery casing pieces in the soil, and found lead concentrations up to 900 mg/kg in surficial aquifer sand (HCEPC 1992, 1993b, 1993c). Another investigator reported plant personnel also gave away soil from the site (FHRS 1995a). These reports suggest site-related contamination may extend beyond the physical boundaries of the Normandy Park Apartments site. FDEP placed one suspected contamination area on the CERCLIS list (a list of Superfund and pre-Superfund sites). It is called the River Hills Drive and 50th Street Battery Dump (FHRS 1995a, FDEP 1996).

B. Site Visits

Mr. Bruce Tuovila, FDOH, first visited the site on April 9, 1992. During this visit, he noted GCR had replaced contaminated soil from the playground area with clean fill (FHRS 1992b). When Mr. Tuovila revisited the site on February 11, 1993, he observed bare patches of soil on the apartment grounds. He also saw exposed battery casings in the soil. In addition, Mr. Tuovila observed there were two cement pads covering the soil near the tennis court, and there was a fence around the grassy area surrounding the southern courtyard's swimming pool. Off-site, he saw what looked like crushed battery casings mixed in with dirt in the undeveloped lot west of the site (Figure 6, Appendix A). Mr. Tuovila noticed well-worn paths crossed this lot and saw children playing there (FHRS 1995a).

Ms. Carolyn Voyles, FDOH, visited the site on August 23, 1995 to observe current site conditions and verify new file information. She observed the site was well-vegetated with grass. There were patches of bare soil, mostly around air conditioning equipment and near building walls. Ms. Voyles saw a couple of pieces of exposed battery casing chips in the bare areas. She also noted there was one large patch of bare soil under the shade of an oak tree in the middle courtyard. Leaf litter from the tree covered this bare patch of soil. Ms. Voyles observed the concrete caps in the northern complex were in good repair, as was the fence around the southern courtyard's pool. Construction materials for the deck over the southern courtyard were on the site. Ms. Voyles also performed a windshield survey of the area surrounding the site. During the evening of August 23, Ms. Voyles met with concerned residents to discuss the public health assessment process, verify site history, and gather community health concerns (FHRS 1995e).

Ms. Julie Smith, FDOH, visited the site on August 14, 1996 to look at the wood decking that had been placed over the southern courtyard. She noted the decking completely covered the ground, up to the concrete entrance areas of the surrounding apartments. She observed the fascia extended to the ground, preventing small children from crawling under the decking (FHRS 1996h).

Mr. Bruce Tuovila, FDOH, visited the site on December 11, 1996 to observe any differences in vegetative ground cover since his previous visit in winter 1993 (Table 1.). Mr. Tuovila also checked on the condition of the fence around the storm water pond and the deck over the southern courtyard. He observed the fence around the storm water pond was intact and in good repair. The deck was also in good repair, and its design prevented small children from crawling underneath it (FHRS 1996i).

On November 3, 1998, Mr. Andy Brastad, FDOH, visited the site to observe maintenance of the decking and ground cover. He found that the decking was in good repair and that ground cover was well maintained. Very few bare areas in the middle and northern courtyards were observed. We estimate the percent of ground cover to be approximately 90 percent. A GCR representative present during the visit stated that grass and other vegetation had been planted on bare areas on numerous occasions but shady conditions prevented plant growth. Fencing around the storm water pond was in good condition. No battery casings were observed at the time of the visit (FDOH 1998b).

C. Demographics, Land Use, and Natural Resource Use

Demographics

According to 1990 census data, the racial makeup of the census tract containing the site is 71% White, 15% Black, and 14% Hispanic. The median age in the census tract is 30 years. Children between 0-4 years make up 8% of the tract's population, and children between 5-9 years make up about 6% of the tract. The median family income for the census tract is $28,779 (BOC 1992). The demographics of the Normandy Park Apartments residents are similar to that of the census tract. Renters predominantly are middle-income Whites or Hispanics, with adult ages ranging from college students to retired people (FHRS 1996d). Usually, there are about 280 people living at the complex, and about 20 of the residents are children under the age of six (FHRS 1992a, EPA 1995a, FDOH 1997d).

Land Use

The Normandy Park Apartments site is in a mixed residential, commercial, and governmental land use area. City Hall is north of the site, other businesses and apartment buildings are east of the site, a shopping center is south and east of the site, and apartments and undeveloped lands are west of the site (Figure 6, Appendix A). There is no new construction in the immediate neighborhood except for construction related to site remediation (OHM 1992a, FHRS 1995e).

The area within a mile of the site is well-established. There is an industrial area about one mile west of the site, and the University of South Florida is about a half mile northwest of the site. The rest of the surrounding area is mostly residential, with commercial businesses along the major roadways. There is a system of storm water ditches and ponds throughout the area (FHRS 1995e).

There are many special facilities in the 33617 zip code encompassing the site. There are eight day care centers and one foster home within a half mile of the Normandy Park Apartments. There are 16 day care centers and four schools between half to one mile from the site. There are no hospitals, mental hospitals, nursing homes, children's group homes, or adult congregate living facilities within a one mile radius of the site (FHRS 1991).

Natural Resource Use

Groundwater in northern Hillsborough County, where the site is located, generally occurs in a two aquifer system. The surficial (or shallow) aquifer is an unconfined system consisting of undifferentiated-fine to medium grained sand on top of clayey sand. Studies at the site indicate that the shallow aquifer is approximately 30 feet deep, and there is a confining unit of clay, approximately 70 feet thick, between the surficial and Floridan aquifers (ATE 1996a). Groundwater in the surficial aquifer flows radially outward from the southwestern corner of the site, with the predominant flow northeastward across the site (FDER 1992f, OHM 1992a, ATE 1996a). Groundwater flow in the upper Floridan appears to be to the northeast under the site (ATE 1996a).

The Floridan aquifer is the principal source of potable groundwater in the Temple Terrace vicinity (FDER 1992f). The City of Temple Terrace has four municipal wells one quarter to one-half mile east-northeast of the site (FDER 1992c, 1992d, 1992e). Regional groundwater flow in the Floridan aquifer is southwestward in the Temple Terrace vicinity (FDER 1992f, OHM 1992a).

D. Health Outcome Data

FDOH epidemiologists evaluated cancer incidence near the site as recorded in the Florida Cancer Data System (FCDS). FCDS is a FDOH program operated under contract by the University of Miami School of Medicine that covers all cancers reported in Florida from 1981 - present. We discuss the results of the FCDS search in the Public Health Implications, Health Outcome Data Evaluation section.

COMMUNITY HEALTH CONCERNS

During the April 1992 and February 1993 public meetings, EPA and HCHD officials talked to the residents of Normandy Park Apartments about the health effects of lead. In general, residents are concerned about how they might be exposed to lead, and how likely they are to become ill from incidental exposures. In FDOH's August 23, 1995 public meeting, residents asked the following questions:

How am I likely to be exposed to lead?

2. If the lead recycling operation took place 30 years ago, can there still be enough lead in the soil to affect my health?

3. Is it safe to dig/garden in the soil?

4. Can walking across the site make someone sick?

5. Are pets affected by lead in the same way people are?

We address these health concerns in the Public Health Implications section.

Environmental Contamination and Other Hazards

In this section, FDOH identifies "contaminants of concern" for further evaluation in the public health assessment.

In summary, we compared the environmental concentrations of the 43 detected contaminants (Table 3, Appendix B) with ATSDR screening values. We eliminated those contaminants from further consideration that were below their applicable ATSDR screening values (Table 4, Appendix B). We found that five contaminants (calcium, iron, magnesium, potassium, and sodium) are essential nutrients, three are ubiquitous in soil (aluminum, copper, and tin) and were found in low levels and the remaining contaminants, with the exception of lead, were not expected to cause health problems for the following reasons:

The contaminants were found at low concentrations that do not present a health threat; or
The contaminants were found in media where human exposure is not likely (an incomplete pathway).

For each of the contaminants, we reviewed the environmental data collected from water, soil, and air, listed the maximum concentration and detection frequency, and evaluated the sampling adequacy. Upon further evaluation we determined that lead was the only chemical of concern. We describe the method for selecting contaminants of concern in detail in Appendix C.

A. On-site Contamination

For the purposes of this evaluation, we defined "on-site" as the curb to curb area between 53rd and 56th Streets which encompasses the Normandy Park Apartments. On-site includes the vacant lot south of the original apartment complex property where the storm water pond is now located (Figure 7, Appendix A).

We compiled data in this subsection from contractors hired by the site owners (Eagle Remediation 199[1]; EEC 1994b; ESSI 1992; OHM 1992a, 1992b, 1992d; ATE 1996a, 1996c, 1997) and from various government agencies investigating the site (EPA 1992b, 1992d; Weston 1992). We reviewed data found in other reports, memos, and letters (ATSDR 1992b; EEC 1994a; EPA 1992c, 1993a, 1995a; FDEP 1994a; GCR 1995a; HSWMR 1991; OHM 1993), but determined these data had already been presented and counted earlier. When we were able to identify duplicate information among the many reports we reviewed, we counted the samples only once. In counting the number of analyses for a contaminant, we used raw data whenever these data were available to us. We did not have maps of all EPA sample locations, but we did have descriptions for all unmapped sample points. We could not obtain a map of the sample points for one GCR document (OHM 1992d). However, we determined GCR took the samples on-site from the description in the cover letter. Because we did not have maps of the latter EPA and GCR sample point locations, we could not plot all on-site sample locations on the site maps for this subsection.

<u>On-site Surface Soil (0-3 Inches Deep)</u>

In 1992 and 1996, EPA and GCR collected on-site surface soil samples at more than 34 locations (Figure 8, Appendix A). No one collected any background surface soil samples.

The analytical results identified ten contaminants in on-site surface soils. Although some contaminants are above screening values, our findings are that only lead presents a health threat.

Concentrations in On-site Surface Soil (0-3 Inches Deep)

Contaminants of Concern	Detected Range (mg/kg)	Total # Detected/ Total # Samples	Total # Exceeding Comparison Value/ Total # Samples	Back-ground Concen-tration Range (mg/kg)	Comparison Value	
					(mg/kg)	Source
Aluminum	690-2500	9/9	--	NA	--	--
Antimony	1.2-170	6/9	6/9	NA	0.8	RMEG
Arsenic	0.73-22J	9/21	9/21	NA	0.5	CREG
Barium	2.1-21	21/21	0/21	NA	100	RMEG
Benzo(a)Pyrene	0.290J	1/2	1/2	NA	0.1	CREG
Chromium	2-24	20/21	--	NA	--	Carcinogen
Copper	1.1-30	7/9	--	NA	--	--
Lead	1.4-13,800	47/47	--	NA	--	Carcinogen
Tin	26	2/7	--	NA	--	--
Vanadium	9	7/9	2/9	NA	6	EMEG

mg/kg - milligrams per kilogram (parts per million)
NA - not analyzed
ND - not detected
J - estimated value
RMEG - Reference Dose Media Evaluation Guide
CREG - Cancer Risk Evaluation Guide
EMEG - Environmental Media Evaluation Guide
Carcinogen -potential or known cancer-causing agent

For the purposes of this public health assessment, there were enough samples taken to fully characterize on-site surface soil quality for metals in the northern and middle courtyards. Because the southern courtyard is now covered, there is no current need to collect more on-site surface soil samples in that area as long as the southern courtyard's cover remains intact and in good repair. However, if future site cleanup efforts disturb the soil, or if the present ground cover changes, a comprehensive study of all contaminants of concern in the southern courtyard should be conducted to allow evaluation of the potential health effects from exposure to these metals.

<u>On-site Shallow Subsurface Soil (0-6 Inches Deep)</u>

In 1992 and 1994, EPA and GCR collected on-site shallow subsurface soil samples at more than 86 locations (Figure 9, Appendix A). No one collected any background surface soil samples.

Lead was the only contaminant analyzed for in on-site shallow subsurface soils. The concentration of lead found in these soil samples ranged from 21 to 3700 mg/kg.

On-site Deep Subsurface Soil (More Than 6 Inches Deep)

In 1992 and 1994, EPA and GCR collected on-site deep subsurface soil samples at more than 114 locations (Figure 10, Appendix A). In February 1992, EPA's contractor collected a background sample on the northeast corner of the site.

The analytical results identified eleven contaminants in on-site deep subsurface soils. Although some contaminants are above screening values, our findings are that only lead presents a health threat.

Concentrations in On-site Deep Subsurface Soil (More Than 6 Inches Deep)

Contaminants of Concern	Detected Range (mg/kg)	Total # Detected/ Total # Samples	Total # Exceeding Comparison Value/ Total # Samples	Back-ground Concen-tration Range (mg/kg)	Comparison Value	
					(mg/kg)	Source
Aluminum	58-2800	18/18	--	2400	--	--
Antimony	7.8-880	8/18	8/18	ND	0.8	RMEG
Arsenic	0.6-130J	6/18	6/18	ND	0.5	CREG
Barium	1.1-200	13/18	1/18	2.1	100	RMEG
Cadmium	1.6	1/19	--	ND	--	Carcinogen
Chromium	1.5-86	11/18	--	2.1	--	Carcinogen
Copper	1.2-26	6/18	--	ND	--	--
Lead	1-125,800	266/301	--	1.3	--	Carcinogen
Nickel	3.4	1/19	--	ND	--	Carcinogen
Tin	3.4-93	5/14	--	ND	--	--
Vanadium	1.3-8.2	11/18	1/18	2.6	6	EMEG

mg/kg - milligrams per kilogram (parts per million)
NA - not analyzed
ND - not detected
J - estimated value

RMEG - Reference Dose Media Evaluation Guide
CREG - Cancer Risk Evaluation Guide
EMEG - Environmental Media Evaluation Guide
Carcinogen -potential or known cancer-causing agent

For the purposes of this public health assessment, there were enough samples taken to fully characterize on-site deep subsurface soil quality.

On-site Indoor Dust

In 1996, GCR collected on-site indoor dust samples from 16 apartments with children (ATE 1997a, 1997b). GCR collected these dust samples in conjunction with sampling and removal of lead-containing miniblinds in the apartments. After the samples were taken, the apartments were specially cleaned to remove indoor dust. The cleaning method included use of a vacuum fitted with a HEPA filter to minimize suspension of lead-containing dust in the air and its resettlement in the apartments (ATE 1996b, FHRS 1996g, FDOH 1997c, FDOH 1998b).

The dust samples were analyzed only for lead. The analytical results confirmed the plastic miniblinds in the apartments contained lead. The results also showed lead levels on sills and carpets were below US Department of Housing and Urban Development (HUD) guidelines

Lead Concentrations in Indoor Dust

Sample Location	Detected Range ($\mu g/ft^2$)	Total # Detected/ Total # Samples	Total # Exceeding Comparison Value/ Total # Samples	Comparison Value	
				($\mu g/ft^2$)	Source
Blinds	60-310	3/3	--	--	--
Sill	110-170	2/3	0/3	500	HUD, EPA
Carpet	11-19	3/19	0/19	100	HUD, EPA

$\mu g/ft^2$ - micrograms per square foot
HUD - US Department of Housing and Urban Development
EPA - US Environmental Protection Agency.

For the purposes of this public health assessment, there were enough samples taken to fully characterize on-site indoor dust levels in apartments that were sampled. We do not know what the lead levels in dust are in apartments that have not had miniblind replacement and the thorough cleaning. In 1997, GCR told FDOH they had ordered new blinds for the remaining apartments (without children) and planned to replace the old miniblinds upon receipt of the new ones (ATE 1997b). In 1998, GCR stated that all lead-containing miniblinds in the complex had been replaced (FDOH 1998b). We also recommend that GCR perform the special cleaning on each apartment in the complex as residents move out or children move in, whichever comes first.

On-site Shallow Groundwater - Temporary and Monitor Wells

In 1991, 1992, and 1996, EPA and GCR collected on-site shallow groundwater samples at more than 13 locations (Figure 11, Appendix A). GCR collected a background sample (TW-1) for lead on-site (OHM 1992a). FDOH does not consider this to be a proper location for a background sample. First, ground penetrating radar and soil borings have established the presence of buried debris throughout the apartment complex grounds (OHM 1992a, 1992c), and buried debris may also lie near the background well location. Tests have shown lead in this debris to be leachable (OHM 1992a, EEC 1994b) with the potential to contaminate groundwater below. Second, even though the predominant direction of groundwater flow is to the northeast across the site, there is a localized outward radial movement under the southern courtyard from a point (TW-2) east of the background sample (TW-2) location (OHM 1992a). Water contamination in the eastern well might affect water quality in OHM's background well. Finally, the lead concentration in shallow groundwater at GCR's background location is 720 micrograms per liter (µg/L) (OHM 1992a), higher than lead concentrations found in an off-site shallow private well sample (EPA 1992b). For this public health assessment, we considered the GCR background sample to be a regular shallow groundwater sample point. The analytical results identified seven contaminants in on-site shallow groundwater:

Concentrations in On-site Shallow Temporary and Monitor Wells

Contaminants of Concern	Detected Range (µg/L)	Total # Detected/ Total # Samples	Total # Exceeding Comparison Value/ Total # Samples	Back-ground Concen-tration Range (µg/L)	Comparison Value	
					(µg/L)	Source
Aluminum	570-10,000	3/5	--	NA	--	--
Antimony	63-784	2/5	2/5	NA	4	RMEG
Arsenic	46-150J	2/9	2/9	NA	0.02	CREG
Barium	18-190	2/8	0/8	NA	700	RMEG
Chromium	25	1/9	--	NA	--	Carcinogen
Di(2-ethylhexyl) Phthalate	38	1/3	1/3	NA	3	CREG
Lead	5-22,000	22/28	--	NA	--	Carcinogen

µg/L - micrograms per liter (parts per billion)
NA - not analyzed
ND - not detected
J - estimated value

RMEG - Reference Dose Media Evaluation Guide
CREG - Cancer Risk Evaluation Guide
EMEG - Environmental Media Evaluation Guide
Carcinogen -potential or known cancer-causing agent

Data Sources: EPA 1992b, ESSI 1992, OHM 1992a, ATE 1996a.

For the purposes of this public health assessment, there were enough samples taken to generally characterize on-site shallow groundwater quality for lead and other metals.

On-site Shallow Groundwater - Irrigation Wells

In 1991, GCR collected one groundwater sample from the site's irrigation well and tested it for lead. The well depth was unknown. The analysis did not detect lead in this well. GCR has plugged this well to allow decking to be placed over the southern courtyard (FHRS 1996d).

On-site Deep Groundwater - Piezometer and Monitor Wells

In 1996, GCR collected on-site deep groundwater samples from three newly installed wells (one monitor well and two piezometers) at different locations (Figure 12, Appendix A). None of the piezometers was down gradient from the southern courtyard, the most contaminated portion of the site.

The analytical results identified one contaminant, barium, in on-site deep groundwater. The barium was present in all three wells at concentrations below its comparison value. Lead was not detected in any of the three deep wells.

For the purposes of this public health assessment, there were enough samples taken to generally characterize on-site deep groundwater quality for lead and other metals.

On-site TCLP Waste

In 1992 and 1994, GCR performed Toxicity Characteristic Leaching Procedure (TCLP) tests on-site shallow and deep subsurface soils, showing lead and barium could leach out of them. The lead leachate values were high enough to classify the on-site subsurface soils as a hazardous waste, and to require that they be handled as such if they are excavated (OHM 1992a, EEC 1994b).

TCLP Waste

Contaminants of Concern	Detected Range (μg/L)	Total # Detected/ Total # Samples	Comparison Value	
			(μg/L)	Source
Lead (old property)	295,000-333,500	2/2	500	FDEP
Lead (new property)	250-19,100	2/2-	500	FDEP

μg/L - micrograms per liter (parts per billion)
FDEP - Florida Department of Environmental Protection

Data Sources: OHM 1992a, EEC 1994b.

Other On-site Media (Sediments, Surface Water, Air, Biota)

There is no record of sediments, surface water, air, or biota samples being collected on-site. However, due to the nature of the soils, the land use (residential apartments) and the contaminant of concern (lead is not volatile), these pathways are of little concern.

B. Off-site Contamination

For the purposes of this evaluation, FDOH defined "off-site" as the area within a 1 mile radius of the Normandy Park Apartments site. Most off-site sampling occurred on land areas adjacent to the site; however, EPA collected a few samples at private residences about ¼-½ mile away. Since the site used to have a smelter, and since the recycling facility reportedly gave battery casings and soil away to people who wanted them (HCEPC 1992, 1993b, 1993c; FHRS 1995a), the off-site area potentially affected by site-related contaminants may be quite large.

FDOH compiled data in this subsection from EPA (EPA 1992b, Weston 1992). In counting the number of analyses for a contaminant, we used raw data whenever these data were available to us. We did not have maps showing the locations of all sample points; however, EPA provided sample point descriptions that allowed us to determine sample type and general location of the off-site sample points. Because we did not have maps of off-site sample point locations, we could not create maps for this subsection.

We found the number of off-site samples too few to fully characterize the nature and extent of potential site-related contamination in off-site soil and water. We recommend further sampling for lead in the vacant lot west of the apartment complex. There is some evidence that the former lead recycling facility at the site gave away battery casings for construction fill. At least two residences near the Hillsborough River reportedly have buried battery casings on their property (HCEPC 1992, 1993b, 1993c). Local, state or federal environmental agencies may want to further investigate these allegations.

Off-site Surface Soil (0-3 deep)

In 1992, EPA collected off-site surface soil samples (0-3 inches deep) at two locations. One sample point was a vacant lot east of the site, and the other was a residence south of the site. There is no record of shallow subsurface soil samples (0-6 inches deep) being collected off-site.

The analytical results identified six contaminants in off-site surface soils. None of the contaminants were found at levels of concern.

Concentrations in Off-site Surface Soil (0-3 Inches Deep)

Contaminants of Concern	Detected Range (mg/kg)	Total # Detected/ Total # Samples	Total # Exceeding Comparison Value/ Total # Samples	Back-ground Concen-tration Range (mg/kg)	Comparison Value	
					(mg/kg)	Source
Aluminum	980-1200	2/2	--	NA	--	--
Barium	2.4-9.3	2/2	0/2	NA	100	RMEG
Chromium	1.7-4.6J	2/2	--	NA	--	Carcinogen
Copper	1.1	½	--	NA	--	--
Lead	29-68	2/2	--	NA	--	Carcinogen
Vanadium	2.5	½	0/2	NA	6	EMEG

mg/kg - milligrams per kilogram (parts per million)
NA - not analyzed
ND - not detected
J - estimated value

RMEG - Reference Dose Media Evaluation Guide
CREG - Cancer Risk Evaluation Guide
EMEG - Environmental Media Evaluation Guide
Carcinogen -potential or known cancer-causing agent

No one has sampled the vacant lot west of the site. During one site visit, FDOH staff observed particles that might have been shredded battery casings on this lot where children were playing (FHRS 1995c). During a later site visit, FDOH staff noted the lot was fairly well-vegetated with wild grasses. There were numerous bare areas, but staff did not observe battery casing pieces in the bare spots during that visit (FHRS 1995e). Still, because of its proximity to the site, there may be site-related contaminants in the western vacant lot's surface soils.

Off-site Deep Subsurface Soil (More Than 6 Inches Deep)

In 1992, EPA collected off-site deep subsurface soil samples at five locations. The sample points were at a vacant lot east of the site, a bank adjacent to the site, City Hall (two points) north of the site (Figure 6, Appendix A), and a residence southwest of the site.

The analytical results identified five contaminants in off-site subsurface soils: aluminum, barium, chromium, lead, and vanadium. None were found in high concentrations and are of minimal concern.

Off-site Shallow Groundwater - Temporary Wells

In 1992, EPA collected one off-site shallow groundwater sample from a temporary well at a private residence southwest of the site. Residents use this well for irrigation only (EPA 1996).

The analytical results identified four contaminants in the off-site shallow groundwater.

Concentrations in Off-site Shallow Temporary Wells

Contaminants of Concern	Detected Range (μg/L)	Total # Detected/ Total # Samples	Total # Exceeding Comparison Value/ Total # Samples	Back-ground Concen-tration Range (μg/L)	Comparison Value	
					(μg/L)	Source
Aluminum	58,000	1/1	--	NA	--	--
Barium	56	1/1	0/1	NA	700	RMEG
Chromium	47	1/1	--	NA	--	Carcinogen
Lead	17	1/1	--	NA	--	Carcinogen

μg/L - micrograms per liter (parts per billion)
NA - not analyzed

RMEG - Reference Dose Media Evaluation Guide
Carcinogen -potential or known cancer-causing agent

Off-site Deep Groundwater - Private Wells

In 1992, EPA collected three off-site deep groundwater samples from private wells east, west, and southwest of the site. No chemicals were found at elevated levels. Residents use these wells for irrigation only (EPA 1996).

Other Off-site Media (Sediments, Surface Water, Air, Biota)

As with on-site findings, there is no record of off-site sediments, surface water, air, or biota samples being collected. Again, due to the nature of the soils, the land use (residential apartments) and contaminant of concern (lead is not volatile), these pathways are also of little concern.

Off-site Industries or NPL Sites

There are ten NPL sites in Hillsborough County. The closest NPL site to Normandy Park Apartments is Tri-City Oil, just over a mile away. From 1960-1975, Tri-City Oil was a heating oil business. From 1978-1983, it operated as a waste oil storage and distribution center. EPA cleaned up the heavy metal contamination of soil at Tri-City Oil, and removed the site from the NPL in 1988 (EPA 1992e). It is unlikely that activities at Tri-City Oil affected the Normandy Park Apartments site.

Our search of the Toxics Release Inventory database between 1987-1993 for the 33617 zip code area found only one facility reporting emissions to the environment. This facility is about 0.8 miles away from the site. The chemicals released from this facility are different from contaminants found at the site (TRI 1995).

C. Quality Assurance and Quality Control

We had quality assurance/quality control (QA/QC) information for seven of the 13 data sets we used in the public health assessment. The QA/QC results we had for two EPA data sets indicated their analytical results were reliable. The QA/QC results we had for GCR data suggested there might be problems with some of their analytical results. However, the GCR results for the range of lead concentrations in the two data sets were consistent with the range of lead data from other reports. A detailed QA/QC analysis can be found in Appendix C.

D. Physical and Other Hazards

FDOH staff did not observe any physical hazards on the old portion of the site (FHRS 1992b, 1993, 1995c, 1995e). The storm water pond on the lot south of the southern complex is deep and has steep sides (FHRS 1995e). Drowning could be a potential physical hazard if someone were to accidentally fall into the pond. However, as long as the fence around the pond is kept in good repair, and the gate locked, the possibility of someone drowning in the pond seems remote.

PATHWAYS ANALYSES

Contact with hazardous substances is a critical component to assessing the public health significance of a site. Exposure is another name for contact with a substance. Chemical contaminants in the environment may have the potential to harm human health. However, human health can only be affected if people are exposed to the contaminants. Exposure to chemicals can occur in three ways: by ingestion (eating or drinking a substance); by inhalation (breathing in a contaminant); or by skin contact including absorption of a chemical through the skin. These ways of being exposed are called exposure routes.

To determine if people have been, are, or might be exposed to contaminants found at a site, FDOH evaluates the environmental and human components of exposure pathways. An exposure pathway consists of five elements: a source of contamination, a mode of transport through an environmental medium (that is, soil, water or air), a point of exposure, a route of human exposure, and an exposed population.

We categorize exposure pathways as completed, potential, or eliminated. We call a pathway completed if all five elements exist and exposure to a contaminant has occurred, is occurring, or will occur. We call a pathway potential if at least one of the five elements is missing, but could exist. We eliminate an exposure pathway if at least one of the five elements is missing and will never be present.

Chemical contaminants in the environment at Normandy Park Apartments have the potential to harm the residents' health. However, the residents may not be exposed to all contaminants found at this site. For Normandy Park residents, ingestion (intentionally or unintentionally eating soil) and inhalation (breathing contaminated dust) are the most likely exposure routes. Lead, the contaminant of concern, is not known to penetrate intact skin.

The following sections describe various pathways that existed in the past, are currently present, or may be present in the future. For the purposes of this health assessment, only surface soils, battery casing chips, and dust are completed pathways. Currently, residents have little contact with soils deeper than six inches. Drinking water for the apartment complex is supplied by the City of Temple Terrace so residents are not exposed to contaminants found in shallow ground water.

In the past, through their daily work activities, former plant workers at the site were probably exposed to contaminants found in lead-acid batteries through incidental (accidental) ingestion. Because the plant had a smelter, workers also may have been exposed to lead vapors. Although several exposure pathways are likely to have been completed for former workers, we do not have the environmental information necessary to estimate exposure concentrations or evaluate their health significance. Therefore, we restrict the focus of this public health assessment to the exposure pathways affecting residents of the apartments.

A. Completed Exposure Pathways

For a summary of the completed exposure pathways at this site, refer to Table 6, Appendix B.

Surface Soil Pathway (0-3 and 0-6 Inches Deep)

In the past, apartment residents were exposed to lead in surface soils at the site. Young children (0-6 years), in particular, were potentially exposed to lead in surface soils as they played outside and dug in and around the old playground area. Exposure to lead in the surface soil may have occurred via incidental ingestion and dust inhalation.

Exposure to soils as deep as six inches probably occurred while digging. In a recent site visit, there was no evidence that residents were digging in the soil (FHRS 1995e, FDOH 1998b). Site owners inform the residents about lead in the soil when they rent apartments at the site (FHRS 1995e, GCR 1995b). Residents have asked about using site soils for gardening (FHRS 1995e) and have been advised about the potential health risks. Residents should be discouraged from digging or gardening in the soil because we do not know if contaminants in deeper soil could accumulate in vegetables.

In the future, if on-site digging were to occur, residents could be exposed to lead and other contaminants.

Presently, the areas with the highest lead concentrations in soil are covered by concrete, asphalt, or decking. Exposure to these soils is very unlikely. Areas of low lead concentration are well vegetated.

Therefore, exposure to these surface soils is significantly reduced. There are some bare soil areas, however, we do not expect that the levels of lead in these areas present a health threat.

Accessible Battery Casing Chip Waste Pathway

In the past, apartment residents had contact with battery casing chips that were on or near the ground surface. Young children dug battery casing pieces out of the ground and played with them (HCEPC 1991, FDER 1992f, FHRS 1995b). Through this play, young children were exposed to lead on the chips via incidental ingestion. Because the battery casing chips have been mixed with the soil, exposure to this material is possible for residents playing in bare, nonremediated areas in the present or future. No battery chips were observed during our last on-site visit (FDOH 1998b).

Dust (Indoor and Outdoor) Pathway

Site soils are sandy with a mixture of organic matter (FHRS 1995e). Lead may adhere to the organic portion of the soil and form dust. This seems particularly likely if residents or pets track soil particles into their homes from outside. Dust samples collected from 16 apartments showed measurable levels (range <10 to 170 micro grams per square foot) of lead on some window sills and carpets tested (ATE 1997a, 1997b). The indoor lead testing was done in conjunction with lead analysis of miniblinds in each of the 16 apartments. The testing did not differentiate between lead dust tracked into the apartment or lead dust from the miniblinds. In the past, residents may have been exposed to contaminated dust via inhalation prior to removal of lead-containing miniblinds. It is possible that residents are exposed to low levels of contaminated dust from tracking soil into the apartment. However, dust sampling indicated that the lead levels in the apartments tested were within federal guidelines. Exposure to contaminated dust may increase if contaminated soils are uncovered, disturbed, or removed during clean up activities at the site.

Although all lead-containing miniblinds have been removed (GCR 1998), apartments, especially carpets and floors should be throughly cleaned on a regular basis. To reduce the amount of dust in the homes from exterior soils, parents should restrict the play activities of their children to areas covered with grass, or capped by cement pads or wood decking, or to the playground where casing chips and contaminated soils are less accessible. Residents should remove their shoes before entering the apartment and wash their hands and faces after playing on apartment grounds, and especially before eating. Parents should ensure that young children follow these clean up practices.

B. Potential Exposure Pathways

We categorize the following exposure pathways as potential because there is no existing point of exposure or no environmental data measuring contaminant amounts. Without these data, we cannot fully evaluate the contribution of each potential pathway to the residents' total exposure. For a summary of the potential exposure pathways at this site, refer to Table 7, Appendix B.

Deep Subsurface Soil Pathway (More than 6 Inches Deep)

Eleven contaminants exist in soils and battery chip casings found in subsurface soils. Nine of the 11 contaminants have their highest measured concentrations in deep subsurface soils. Ground penetrating radar has identified buried debris (probably battery casing chips) at depths greater than one foot across the site (OHM 1992a, 1992c). Currently, apartment residents are not exposed to these contaminants. Apartment residents may be exposed to contaminants in deep subsurface soils if future site remediation activities involve digging up buried soils. Should excavation occur, residents may be exposed to these contaminants via incidental ingestion and dust inhalation.

Biota Pathway

FDOH staff did not observe residents growing vegetables in porch gardens (FHRS 1995e, FDOH 1998b). However, if residents were to grow vegetables using on-site soils, they could be exposed to the contaminants in deeper soil that accumulate in plants, especially arsenic, cadmium (if present), and vanadium (ATSDR 1992f, 1993b, 1993c). Plant uptakes of these metals depends on the soil type, soil pH (a measure of acidity and alkalinity), and plant species grown.

To avoid this potential exposure, apartment residents should not use on-site soils for growing vegetables or other edible foods.

C. Eliminated Pathways

We eliminated the following exposure pathways from consideration:

Shallow Groundwater Pathway

People in Temple Terrace use municipal water from the deep Floridan aquifer for potable purposes (drinking, cooking, bathing, etc.). Some Temple Terrace residents may use shallow wells for irrigation, but exposure to contaminants from this use is unlikely to be significant. Di(2-ethylhexyl)phthalate was only found in shallow groundwater and there is no past or current exposure point for this substance.

Site owners currently use municipal water to irrigate the complex's vegetation. In the past, site owners used an on-site irrigation well of unknown depth for this purpose. However, since the contaminants found in the shallow ground water are not absorbed through the skin, it seems unlikely apartment residents were exposed to significant amounts from this well when it was in use.

Deep Groundwater

Studies show that lead can move from sites' subsurface soils and enter the ground water (OHM 1992a, EEC 1994b). This is presumably how the shallow ground water became contaminated. If a connection between the shallow and the deep aquifer exists, contaminants from the shallow aquifer could migrate to the deeper aquifer. However, the most recent ground water investigations beneath the site found the presence of a confining unit (clay) between the shallow and deep aquifer systems (AT&E 1996a). The confining unit prevents contaminants from moving from the shallow to the deep aquifer. The City of Temple Terrace has municipal wells ¼-½ miles east-northeast of the site in the Floridan aquifer (FDER 1992c, 1992d, 1993e). To ensure that the quality of the drinking water remains safe, the City of Temple Terrace should continue to meet the regulatory standards for drinking water monitoring and quality.

Sediment and Surface Water Pathway

Because site soils are very sandy, storm water is likely to percolate through the ground rather than carrying sediment to a surface water body. During two site visits, FHRS staff observed little storm water ponding on site after a rain (FHRS 1995c, 1995e). The storm water falling on the remediated southern courtyard is diverted to a storm water pond designed specifically for this site. There is a well-maintained fence around this storm water pond which is kept locked (FHRS 1995e, GCR 1998). Residents are unlikely to have contact with significant quantities of on-site sediment.

PUBLIC HEALTH IMPLICATIONS

In this section, we discuss the risk of illness and possible health effects for persons exposed to specific contaminants, evaluate state and local health databases, and address specific community health concerns. For this discussion, it is helpful to understand the contaminant selection process (see Appendix C), toxicological evaluation methods (see Appendix D), and concepts of risk of illness, dose-response, threshold values, and uncertainty (see Appendix E) that were used to select lead as the contaminant of concern.

A. Toxicological Evaluation For Lead

Methodology

In this subsection, we examine exposure levels and discuss possible health effects that might occur in people exposed to lead at the site. To evaluate exposure, we estimated the daily dose of lead that children and adult residents at the site might experience.

Children and adults differ in the amount of exposure and physiological reactions to a chemical because some body functions work differently in adults and children. Also, young children may be more exposed to soils and battery chips through play and hand to mouth behavior. Because of these differences, we estimated contaminant doses for two hypothetical individuals: a young child (0-6 years old) and an adult. To calculate the daily dose of lead, we used standard assumptions about body weight, ingestion and inhalation rates, exposure time length, and other factors needed for dose calculations for adults and young children (Table 9, Appendix B). In our dose estimates for adults and children, we used the maximum measured concentrations in the environment to estimate past exposure.

The southern courtyard decking now covers the soil with the maximum measured lead concentration. Therefore, as an estimate of present-day exposure, we calculated lead exposure for adults and children at the maximum measured concentration in surface soil in the area of the middle and northern courtyard. We also included indoor and outdoor dust exposures. We could not use the indoor air sampling data in our calculations. The air data was not comparable with the soil data so we used the maximum measured lead concentrations in the surface soils found in the northern and middle courtyards. By using this worst case scenario exposure, we are over-estimating the likelihood of the lead in dust exposure.

We evaluated potential noncancer and cancer health effects separately. To evaluate possible noncancerous health effects from our dose estimates, we compared our estimated doses to contaminant-specific health values, when those existed. When health values did not exist, we compared our estimated doses to experimental doses used in animal studies or to estimated doses observed in human studies. There is not enough information to determine an individual's additional risk of developing cancer over a lifetime after exposure to lead.

There is uncertainty in our risk estimates, meaning, most calculations are over-estimates of real exposure levels. We've incorporated uncertainties into this public health assessment by using worst-case assumptions when estimating or interpreting health risks, and by using health values with wide safety margins. For lead, this means the actual risk of illness may be lower than we suggest, but is unlikely to be higher.

Health effects are influenced not only by exposure dose (how much), but also by exposure duration (how long), and exposure route (breathing, eating and drinking, or skin contact). Also, individual characteristics such as age, sex, diet, general health, life style, chemical exposure history and genetics can influence how a specific individual absorbs, distributes, and metabolizes a chemical. All of these factors must be considered in estimating possible health effects from a contaminant.

We present a summary of our findings regarding lead exposure at Normandy Park Apartments site. General information about lead can be found in Appendix F.

Lead Exposure

Summary - As indicated in the exposure pathway section, residents have been exposed to lead in surface soil and, to a lesser extent, indoor and outdoor dust. Exposure is still possible in the present, but the risk of adverse health effects from lead is greatly reduced. The concrete, decking, and vegetative cover greatly reduce the areas where residents may be exposed to contaminated soil. The soil that is not covered by decking or concrete has lower lead concentration levels that do not appear to be a risk to public health.

Toxicological studies indicate residents' past exposure to lead by inhalation and ingestion could have affected their health. However, the blood lead levels of residents, including about 20 young children, indicate adverse noncancer health effects from past exposures were unlikely. This discrepancy could be caused by our over-estimating the exposure doses, or by residents' changing their behavior to reduce their lead exposure prior to blood testing, or by both. We do not know what blood lead levels in young children were prior to the publicity about lead at the site. Currently, the areas where the highest lead levels in the soil were found are now covered by concrete and wood decking. Areas of lower lead concentration are covered by grass and mulch. We believe that the concrete, decking, grass, and mulch provide a barrier between people and contaminated soil to the extent that there is no apparent public health threat at this time. However, there are some bare, un-remediated areas which may present a source of lead contamination. Soil sampling data suggest that there are some areas slightly above EPA's standard of 400 mg/kg no risk lead concentration (EPA 1992 and Weston reports). Nevertheless, past testing of some of the apartment resident's blood-lead levels and indoor dust sampling indicate that the residents do not appear to be at risk at this time from surface soil and dust provided that the ground cover (concrete, deck, grass, and mulch) remain in place.

Although there is extensive information on noncancer illnesses caused by lead exposure, there is little information regarding lead's ability to cause cancer in humans. Information is not available, at this time, to estimate the potential cancer risk from past or present exposure to lead at the site.

Site-specific Noncancer Health Effects

Residents may have been exposed to lead through incidental ingestion and inhalation of dust. The areas with highest lead concentrations are now covered. However, lead exposure may continue at lower levels in the present and future. Below, we discuss the possible health effects from past and present exposure to lead, based on studies in the toxicological literature

Past Exposures

For past exposure to lead in dust, the inhalation doses we estimated for residents of all ages are close to doses found to affect blood formation in a group of test volunteers. In a 1975 study, adult males suffered a 20% decrease in an enzyme (ALAD) necessary to make normal red blood cells, but were otherwise healthy (ATSDR 1993e). The use of adult males in this study places important limitations on our interpretations because young children are more sensitive than adults to the lead they absorb, and lead can cross the placenta in pregnant women and affect unborn babies (ATSDR 1993e). The health effects on these subgroups have the potential to have been more serious than the effects found in the 1975 study.

For past exposure to lead in surface soil, the incidental ingestion doses we estimated for adults and young children may have reduced the level of an enzyme (ALAD) necessary to make normal red blood cells. The ingestion dose of lead we estimated for adults is similar to the doses female and male adult volunteers ingested in 1974 and 1976 studies. These volunteers suffered decreases in the ALAD enzyme, but were otherwise healthy (ATSDR 1993e). It is not known if pregnant women participated in these studies. The past ingestion doses we estimated for young children are ten times greater than the doses affecting the ALAD enzyme of adult volunteers in the studies. The use of adults only in the studies is important because children absorb more lead from the intestinal tract than adults, and children are more sensitive than adults to the lead that is absorbed. In addition, lead in the bloodstream of pregnant women can cross the placenta and affect developing babies (ATSDR 19933e). Consequently, the effects on these subgroups may have been more serious.

Present Day Exposure

For present-day exposure to lead in dust, the inhalation doses we estimated for adults and young children are far below the doses found to affect blood formation in studies of adult males (ATSDR 1993e). However, our present-day dose estimates consider outside surface soil as the only source of dust. We do not know how much lead-contaminated dirt or dust may have remained in residents' homes from past activities when the lead concentrations were higher. Furthermore, because the apartments were built prior to 1978, dust inhalation from lead-based paint may be an additional source of lead exposure as well as lead-containing miniblinds which were reported to have been removed in 1996 (ATE 1997a, ATE 1997b, FDOH 1998b).

For present-day exposure, we reviewed the distribution of lead in surface soil in uncapped areas. We found that average concentration of lead in the upper six inches of soil in these areas is 246 ppm, significantly less than EPA's 400 ppm no risk level. However, while there are some elevated levels, because contamination is not uniform across the site, exposures to levels above 400 ppm are unlikely to occur every time a person is exposed.

Children and Other Sensitive Populations

We also consider that children are more sensitive to the effects of lead than adults. Children may be exposed to lead when playing or digging in these soils, but the majority of the surface soils are below

400 mg/kg and mainly covered by grass and mulch. Because the lead concentrations are low and most of the area is vegetated, we do not expect exposures will cause adverse health effects.

At high lead exposures, lead can cause premature birth, smaller babies, decreased intelligent quotient and damage to the male reproductive system in adults, and brain and kidney damage in both children and adults (ATSDR 1993e). We do not know how much lead will cause these effects, but the Centers for Disease Control and Prevention (CDC) recommends that children's blood lead levels not exceed 10 micrograms per deciliter.

Through their hand-to-mouth behavior, young children may ingest lead from sources such as lead-based paint and lead in dirt or dust on the floor. For this reason, we recommend blood lead testing in young children to confirm that lead ingestion is not a problem.

Pregnant women, the elderly, smokers, alcoholics, and people with diseases affecting blood formation, nutrient uptake, and nerve or kidney function may be more susceptible to the toxic effects of lead exposure. We do not expect that these sensitive populations will be affected by the low lead concentrations found in the unremediated soils.

Site-specific Blood Lead Monitoring - In 1992, the Hillsborough County Public Health Unit and private physicians tested the blood lead levels in about 45 adults and 20 children (six years old or younger) living in the Normandy Park Apartments. Most of the blood lead levels were less than 10 micrograms of lead per deciliter of blood (FHRS 1992a). These people were tested before GCR capped areas with the highest lead contamination. Based on these blood lead levels, noncancerous health effects are unlikely. Blood lead levels before 1992, however, may have been higher.

There was a discrepancy between what we expected to find in the blood lead levels and in the actual results. The toxicological literature suggests adverse health effects may be associated with lead exposure in the past at the site, yet the measured blood lead levels indicate there were no undue exposures to this contaminant. There are two possible reasons why the blood lead levels may have been lower than predicted. First, we may have overestimated the exposure doses for lead. To calculate our doses, we used the maximum surface soil lead concentration measured and assumed all residents were exposed to this maximum concentration. Residents may have been exposed to a lower dose, giving lower blood lead levels than estimated. Similarly, the pre-1992 residents may have behaved in ways on their own to reduce their exposure to surface soil or dust. For example, they may have had less hand-to-mouth behavior than assumed, and consequently ingested less soil, leading to lower exposure doses than we estimated. Second, residents may have behaved and been exposed as assumed in the dose calculations, but changed their behaviors to reduce exposure before the blood lead testing began. HCEPC received the initial complaint in August 1991 (HCEPC 1991a), and the blood testing began in January 1992 (FHRS 1992a). Since the half-life of lead in the blood is about a month (ATSDR 1993e), there could have been up to a 96% decrease in the amount of lead in residents' blood in the intervening five months. We do not know what blood lead levels in young children were prior to the publicity about lead at the site. Results from blood lead tests only provide information about a person's lead uptake for a short time prior to the test. The tests cannot determine past exposures or what future exposure might be.

B. Health Outcome Data Evaluation

For this study period, none of the four race-gender groups had significantly higher cancer incidence, indicating there is not an unusual cancer incidence in the area around the site (FHRS 1995f).

To evaluate cancer incidence near the site, FDOH epidemiologists evaluated cancer incidence recorded in the Florida Cancer Data System (FCDS). FCDS is an FDOH program operated under contract by the University of Miami School of Medicine. FCDS records all cancer occurrences, except basal cell and squamous cell skin cancers, reported by Florida hospitals from 1981 - present. However, the time required for FCDS data verification procedures cause delays in the availability of reliable data. Consequently, FDOH epidemiologists analyzed FCDS data for 1981 -1990 for this public health assessment.
The following is a brief explanation of the process used in making the no increased cancer incidence determination:

Because the site is on the eastern boundary of its census tract and is close to three other census tracts, FDOH epidemiologists examined the cancer incidence in the following four census tracts in FCDS: 1 (the tract containing the site), 107, 108.04, and 109 (Figure 13, Appendix A). We assumed people in these census tracts were at risk of exposure to site contaminants; this most likely occurred when the former recycling facility operated the lead smelter. However, we do not know the exposure concentrations or durations because there are no environmental data from the time of facility operation.

FCDS records cancer incidence by cancer site, the place in the human body where cancer occurs. To identify the cancer sites relevant for study, we selected cancer sites in human and animal studies associated with the contaminants of concern considered known or suspected cancer-causing agents (ATSDR 1993b, 1993d, 1993e; IRIS 1995). These cancer sites were: stomach; liver; nasal cavity, ear and sinuses; lung and bronchus; bladder; and kidney and renal pelvis.

The FDOH analysis used the standardized incidence ratio (SIR) to examine these six cancer sites for four race-gender groups (white female, white male, nonwhite female and nonwhite male). The analysis compared reported cases of cancer in the four census tracts of interest (the observed population) with reported cancer cases for all census tracts in Florida (the reference population) in each group. The ratio of (the observed cases X 100) to (the reference population) is the SIR number used in the analysis. From the SIR numbers, FDOH epidemiologists calculated a 95% confidence interval for the distribution of SIR numbers at each cancer site. When the SIR number and the lower bound of the 95% confidence are both greater than 100, the cancer incidence is significantly higher in the observed population than in the reference population.

C. Community Health Concerns Evaluation

In this subsection, we address the community health concerns in terms of our findings presented in the Toxicological Evaluation subsection above. In general, residents are concerned about how they might be exposed to lead, and how likely they are to become ill from incidental exposures.

We address each community health concern as follows:

1. **How am I likely to be exposed to lead?**

   There are three ways residents are likely to be exposed to lead. First, residents may be exposed to lead by incidental ingestion of surface soil. Residents who play on bare ground or dig up site soils are more likely to be exposed to contaminants of concern (including lead) than residents who play in grassy areas, on the capped areas, or in the playground. Second, residents or pets can accidentally track site soils into their apartments, where children may ingest contaminants of concern in dirt on the floor through hand-to-mouth behavior. Some soil particles may become airborne, and residents may be exposed to contaminants through inhalation or incidental ingestion of household dust. Third, since the apartment complex was built in the early 1970s, there may be lead-based paint in the buildings. Children can be exposed to lead by eating lead-based paint chips directly. All residents may be exposed to lead in lead-based paint dust by inhalation or incidental ingestion, especially in areas where the paint is peeling or where the paint has been abraded.

2. **If the lead recycling operation took place 30 years ago, can there still be enough lead in the soil to affect my health?**

   It is unlikely that the levels of lead in the soil will cause a problem. The areas that are not covered by asphalt, concrete, or decking have levels of lead that are not expected to cause health concerns. If the ground is dug up, or the concrete is removed, residents could be exposed to soils with higher concentrations of lead that could be a health concern.

3. **Is it safe to dig/garden in the soil?**

   Residents should not dig or garden in the soil. Children who wish to dig should do so only in the sandbox, which is designed to prevent contact with site soils. Currently, lead tends to occur in higher concentrations as one digs deeper into the ground. Exposure to deeper soils probably would increase the amount of lead a person incidentally ingests. In addition, arsenic, cadmium, and vanadium may accumulate in vegetables grown in site soils.

4. **Can walking across the site make someone sick?**

   No. A person must have direct contact with significant quantities of hazardous substances to become ill from walking across a site. Exposure to significant quantities of contaminants of concern is unlikely for residents walking across the Normandy Park Apartments site because most of the site is covered with vegetation, concrete, asphalt, or wood decking. Also, none of the contaminants of concern form a gas that residents will breathe (volatile).

5. **Are pets affected by lead in the same ways that people are?**

Experimental studies show animals can be adversely affected by inhalation or ingestion of lead in ways similar to humans. We did not find any references to studies of cats. However, one study of dogs found long-term lead ingestion adversely affected this animal's kidneys and blood formation abilities (ATSDR 1993e).

CONCLUSIONS

Based on the information currently available, we classify this site as a public health hazard in the past, but no apparent public health hazard in the present. This judgement is made on the basis that areas of high lead concentration (the southern courtyard) are covered by either concrete, asphalt, or wood decking. Areas of lower lead concentration (the middle and northern courtyard) have grass or mulch covering most of the area. Provided the mulch and grass cover, concrete and decking remain in place and there is no digging in the soil, the site is unlikely to be a future public health hazard. Specific reasons for our classification are:

1 In the past, apartment residents were exposed to lead on battery chips and contaminated soils. Young children (0-6 years), in particular, were exposed as they played and dug in and around the old playground area. Residents were exposed via incidental ingestion and dust inhalation.

2 Current exposures are not likely to cause health effects because levels of contaminants are relatively low and access to the contaminated soil has been restricted by vegetation, concrete and decking. As long as site conditions remain unaltered, we do not expect exposure to surface soil and dust will present a health threat.

3 In the future, workers or residents have the potential to be exposed to contaminants found in deeper soils if the dirt is dug up or the concrete or decking is removed. Future exposure is possible through gardening/planting activities as well if soil is disturbed at depths greater than six inches. Additional information may be needed in order to determine if vegetables or fruits can be safely grown at the site.

4. During one site visit, FDOH staff observed particles that might have been shredded battery casings in the vacant lot west of the site. Because of its proximity to the site, there may be site-related contaminants in the soils. There is insufficient information to evaluate this lot.

5 Movement of contamination from the site into the deeper drinking water aquifer does not appear likely. The shallow ground water aquifer beneath the site, though contaminated, does not pose a health threat because it is not used as a potable water supply or for irrigation purposes.

6. There is some evidence Gulf Coast Lead gave away battery casings from the site for construction uses, and may have given away lead-contaminated soil. At least two residences on the Hillsborough River reportedly have buried battery casings on their property. This suggests that contamination from the old battery recycling activities may not be confined to the site.

RECOMMENDATIONS

<u>Cease/Reduce Exposure Recommendations</u>

1 Consider permanently remediating the contaminated soil (under the decking) to reduce the possibility of exposure.

Maintain grass cover, concrete pads, asphalt and wooden decking to prevent exposure to contaminated soils.

3 Inform apartment residents about the health effects of lead and how to reduce exposure to it. Parents should only allow their children to dig in the sandbox, which is constructed to prevent contact with contaminated soils. Apartment residents should remove their shoes before entering their apartment to reduce the amount of dust brought into the apartment. Residents should also wash their hands and faces after working on the apartment grounds, especially before eating. Parents should frequently wash toys and pacifiers.

4. Encourage residents not to dig up on-site soils deeper than six inches, and not to grow vegetables or fruits in the on-site soils.

5. Develop and implement a dust control and air monitoring plan during remediation of the site. Prevent access to deep subsurface soils and solid waste.

6. Periodically check the fence around the storm water pond on the south lot to ensure it remains in good repair.

<u>Biological Monitoring</u>

7 Normandy Park Apartment residents with small children (12 months to 24 months of age) should consult with their pediatricians about blood lead testing.

Site Characterization Recommendations

8. Conduct a comprehensive study of all heavy metals in the soil to evaluate the potential health effects from exposure if future site cleanup efforts disturb the soil, or if the present ground cover changes.

9. Collect surface soil in the vacant lot west of the site and analyze for lead. If lead is present at levels of concern, the site should be fully characterized and remediated if necessary.

10. Investigate the allegation that there is widespread contamination related to the former lead recycling facility. This is especially true for the vacant lot west of the site.

PUBLIC HEALTH ACTION PLAN

The purpose of a Public Health Action Plan is to ensure that any existing health hazards are reduced and any future health hazards are prevented. FDOH and ATSDR agree to review new information as it becomes available regarding site remediation.

2. There should be a continual public education program for residents at the apartment complex. Apartment residents need to be informed concerning contaminants found at the site and the possible health risks from lead exposure and how to prevent exposure. This is especially important to new residents, parents of young children, and pregnant women. FDOH will work with GCR to provide educational materials to the residents.

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CERTIFICATION

This Normandy Park Apartments Public Health Assessment was prepared by the Florida Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment, and concurs with its findings.

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Appendix A

Figures

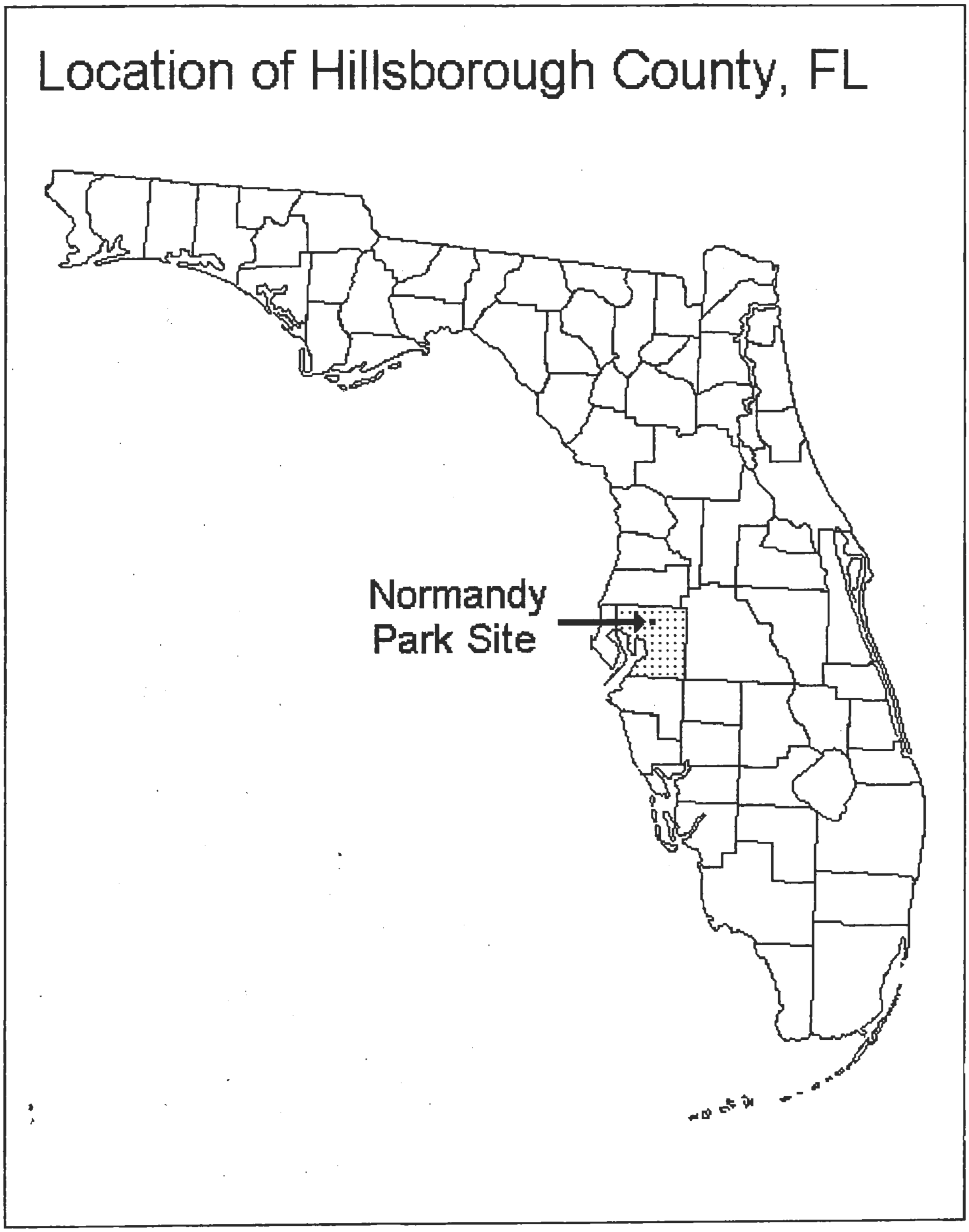

Figure 1 Normandy Park Apartments Location in Hillsborough County, FL.

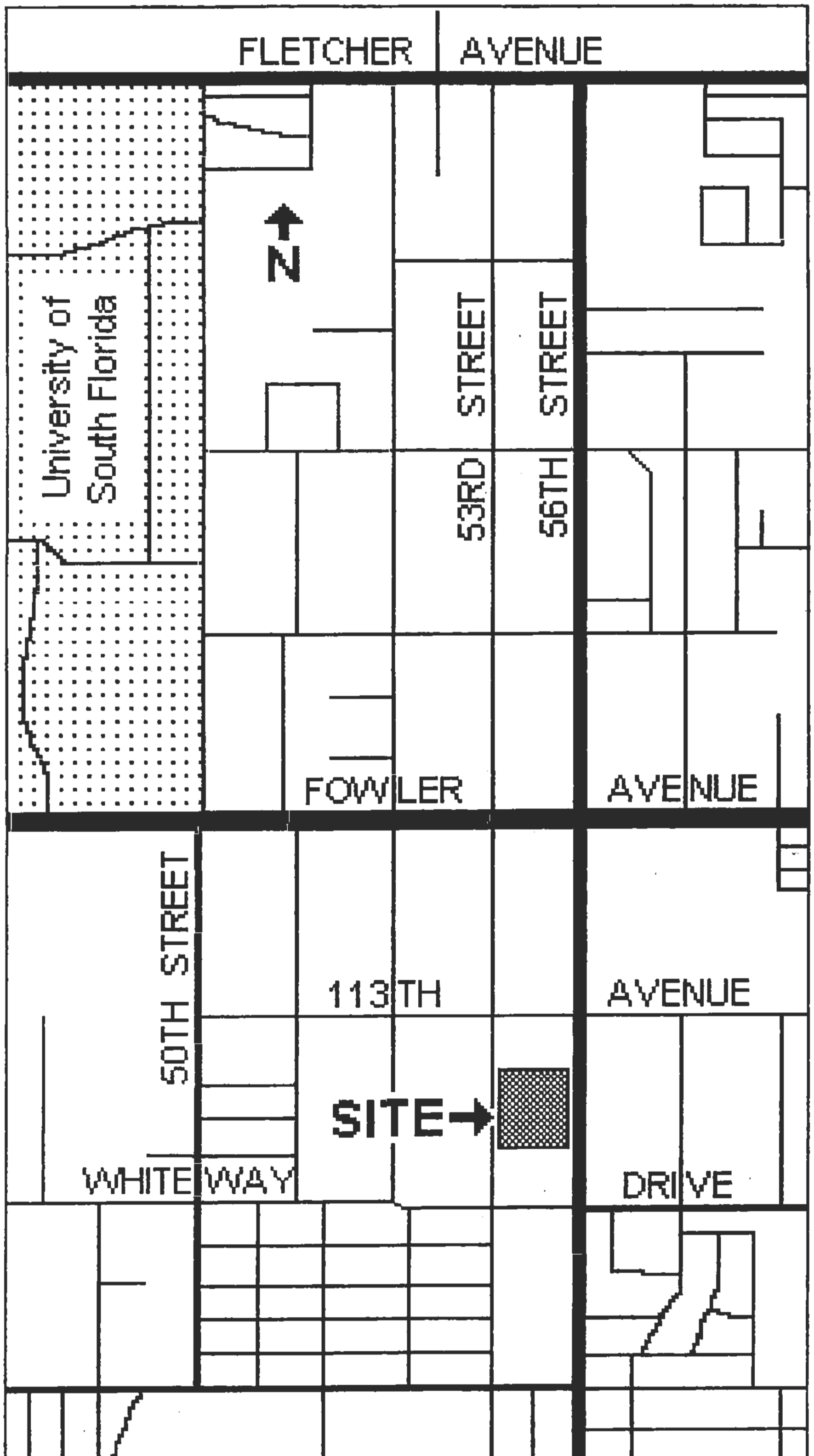

Figure 2. Normandy Park Apts. Location in Temple Terrace, FL.

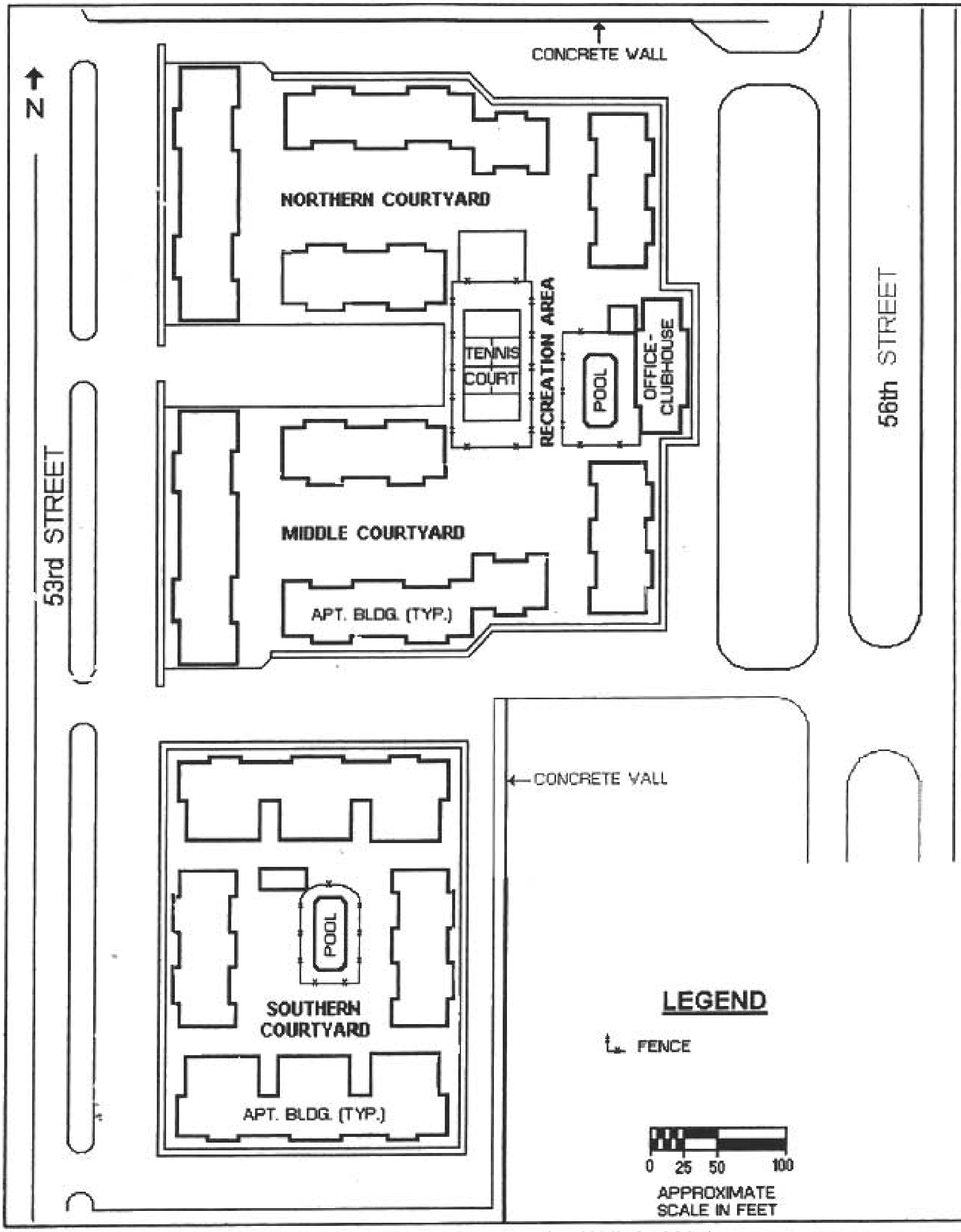

Figure 3. Layout of the Normandy Park Apartments Site (OHM 1992a).

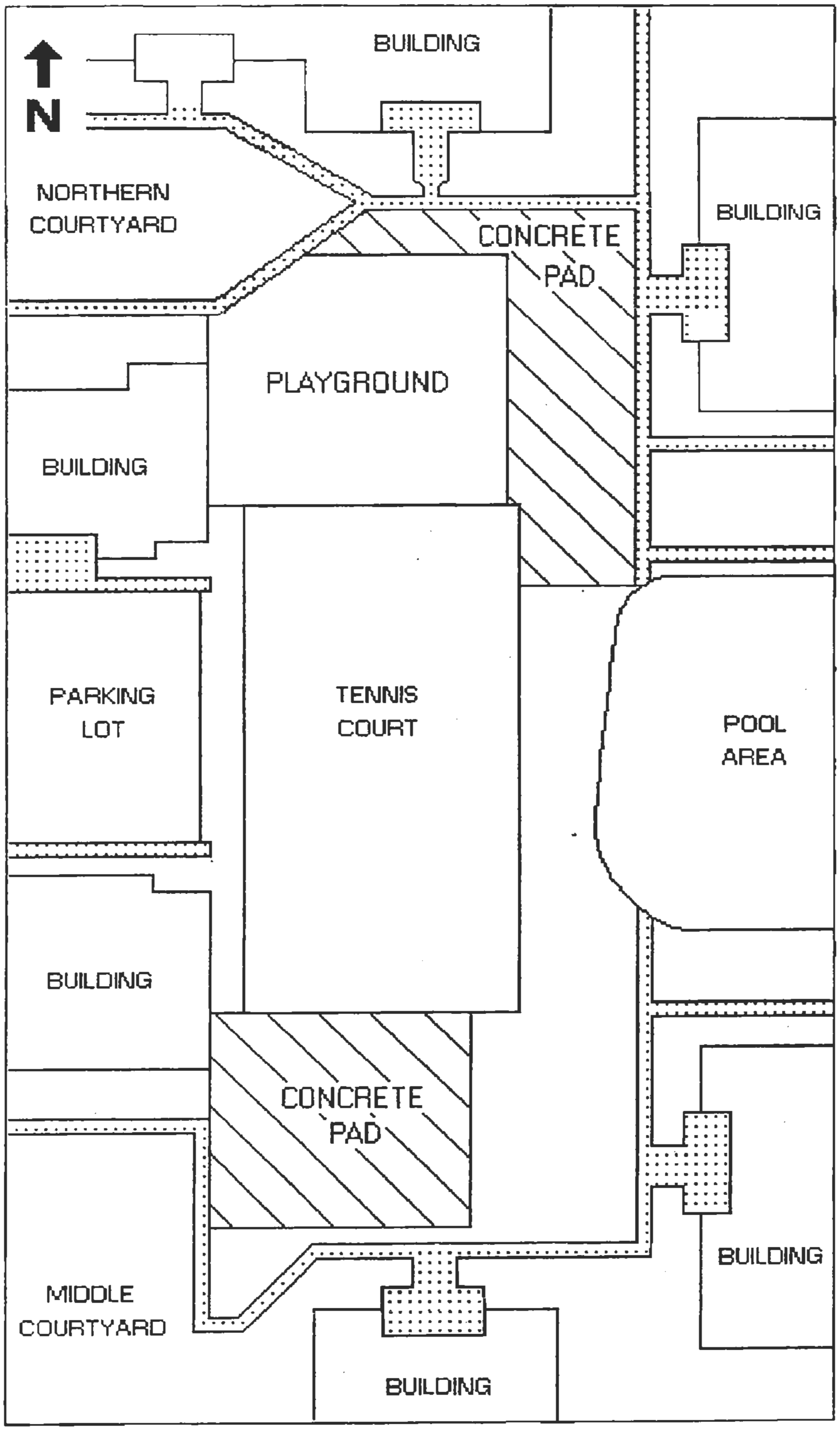

Figure 4. Concrete Pads in the Northern Complex (Beach 1992).

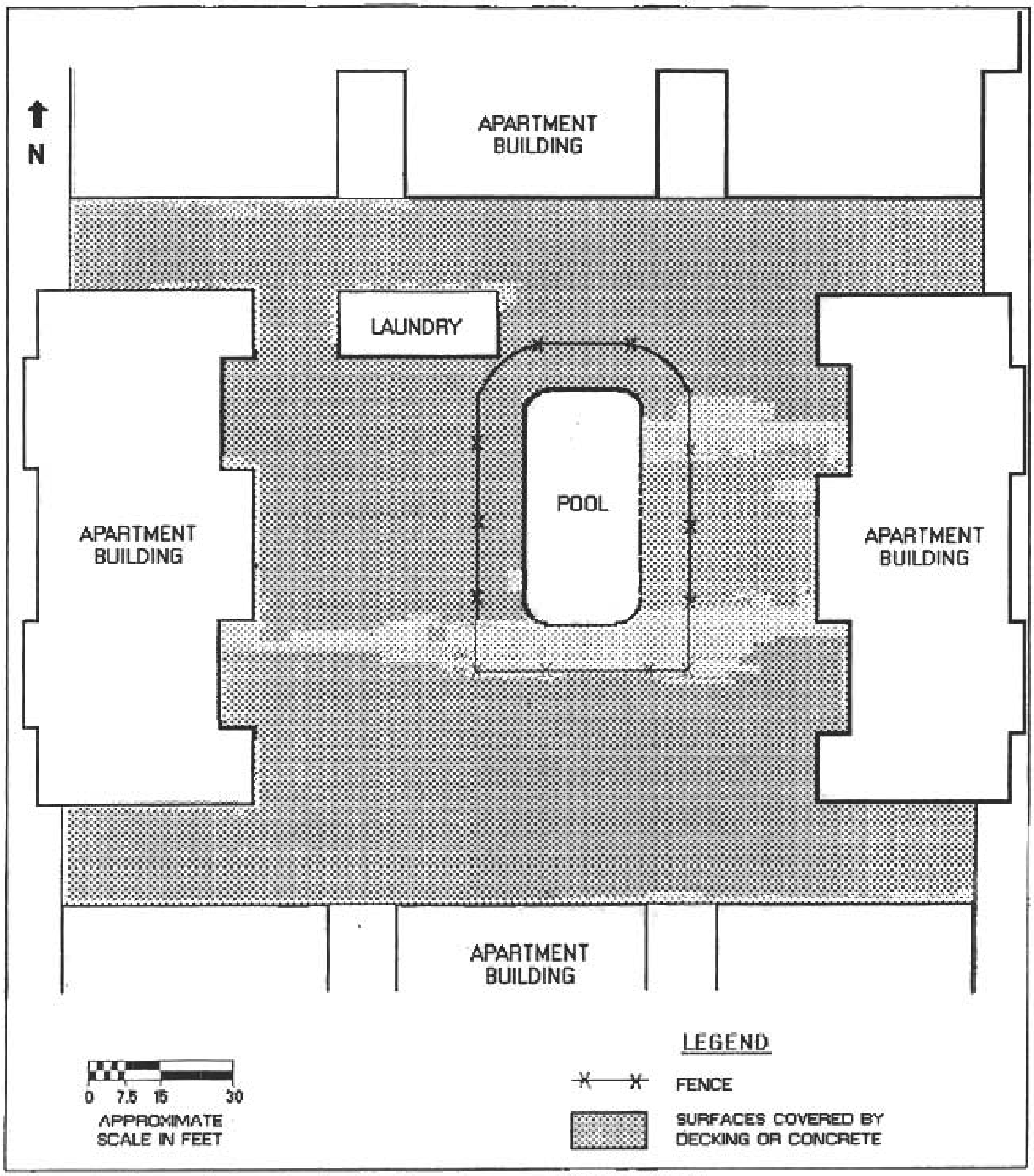

Figure 5. Covered Areas in the Southern Courtyard (GCR 1992b).

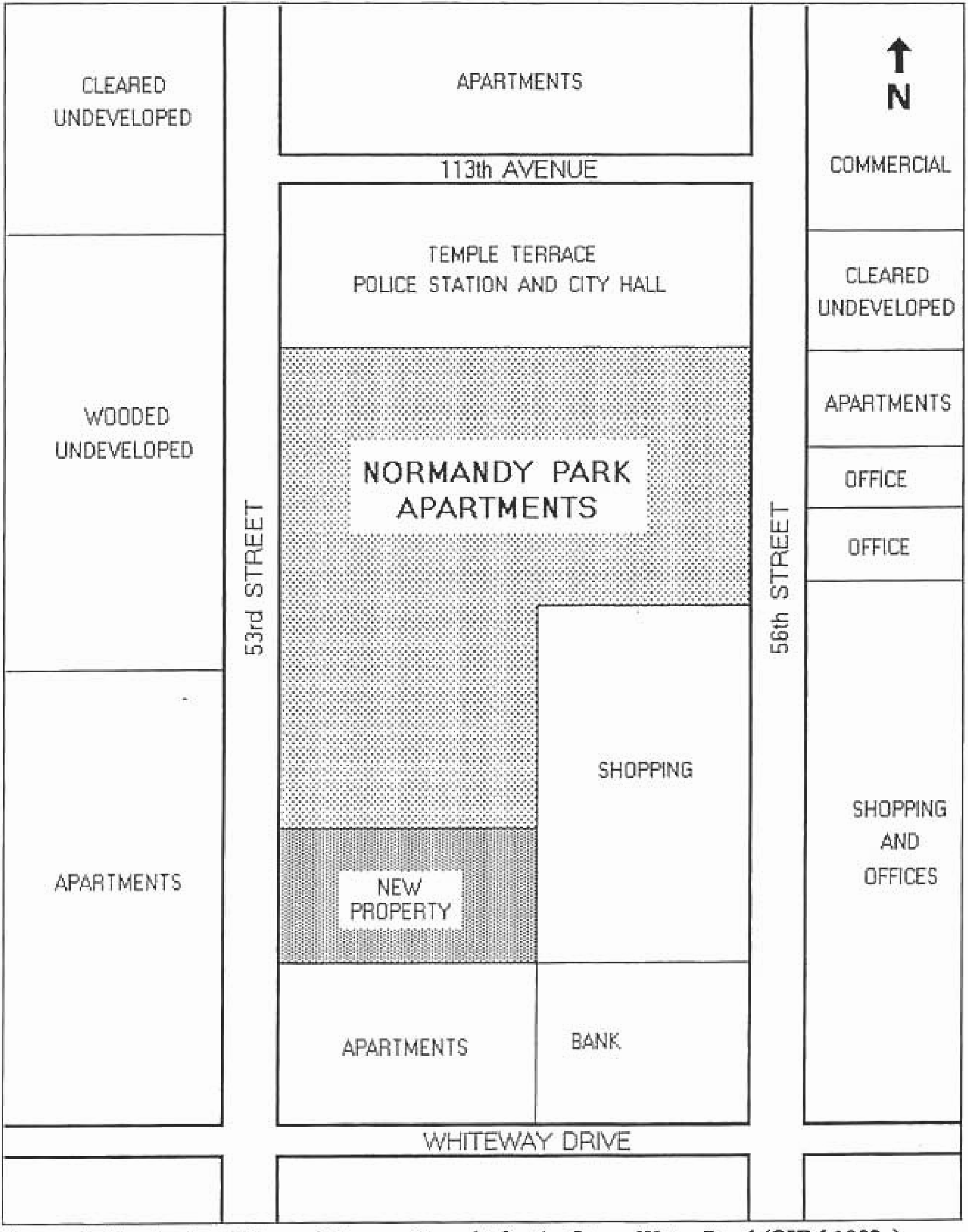

Figure 6. Nearby Land Use and Property Bought for the Storm Water Pond (OHM 1992a).

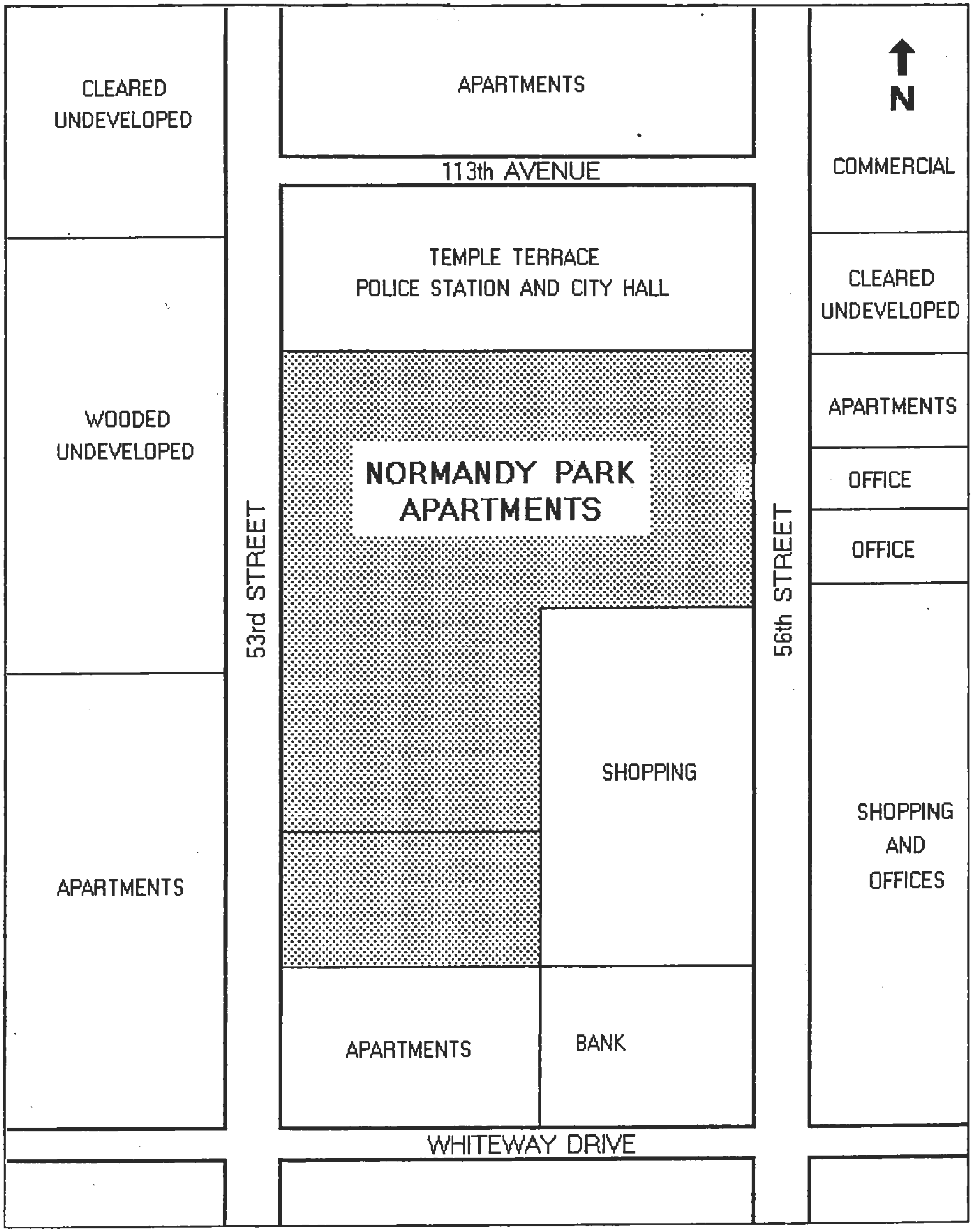

Figure 7. On-site Area (Shaded) for the Normandy Park Apartments (OHM 1992a).

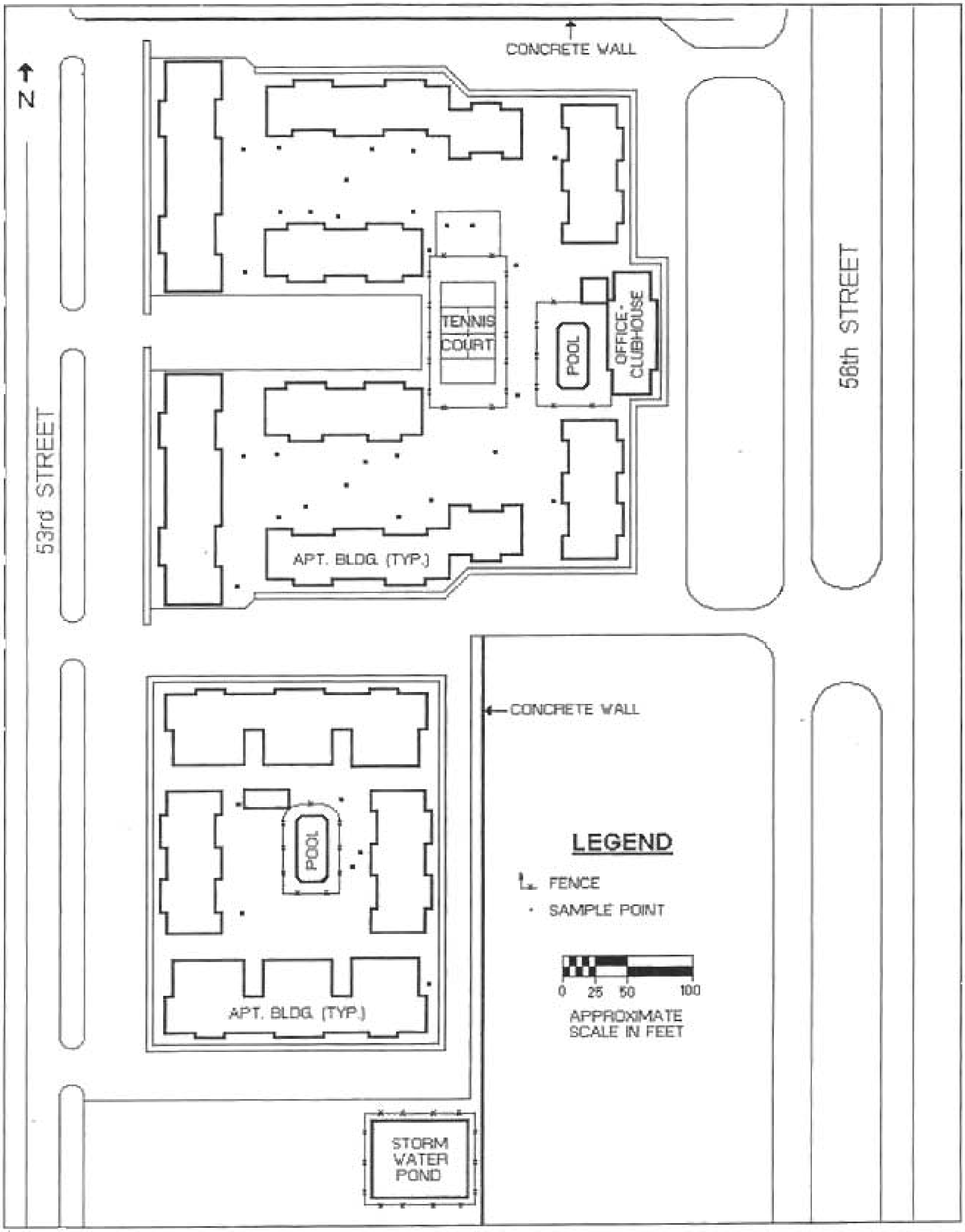

Figure 8. On-site Surface Soil (0-3" Deep) Sample Locations (re: Table 6).

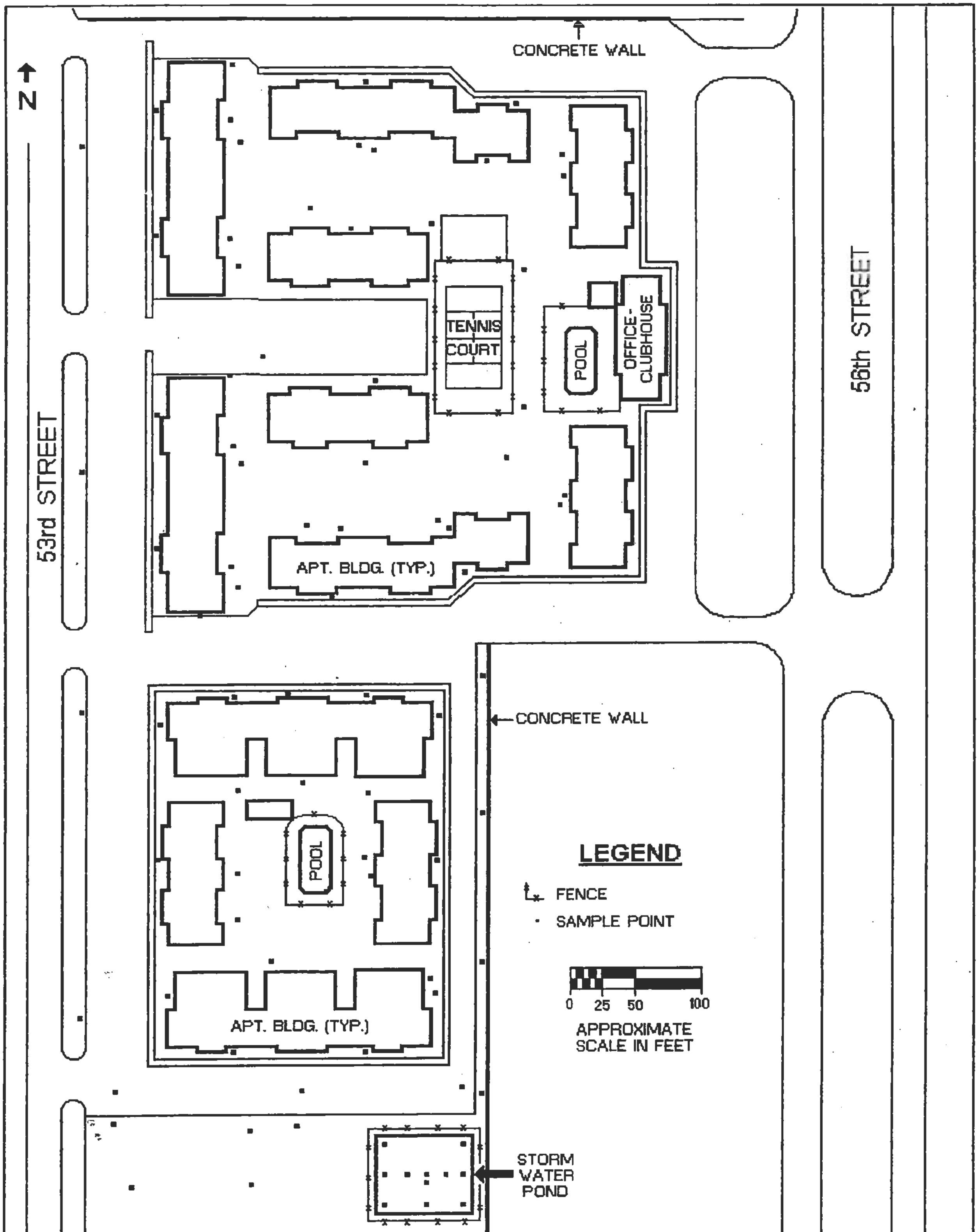

Figure 9. On-site Shallow Subsurface Soil (0-6" Deep) Sample Locations (re: Table 7).

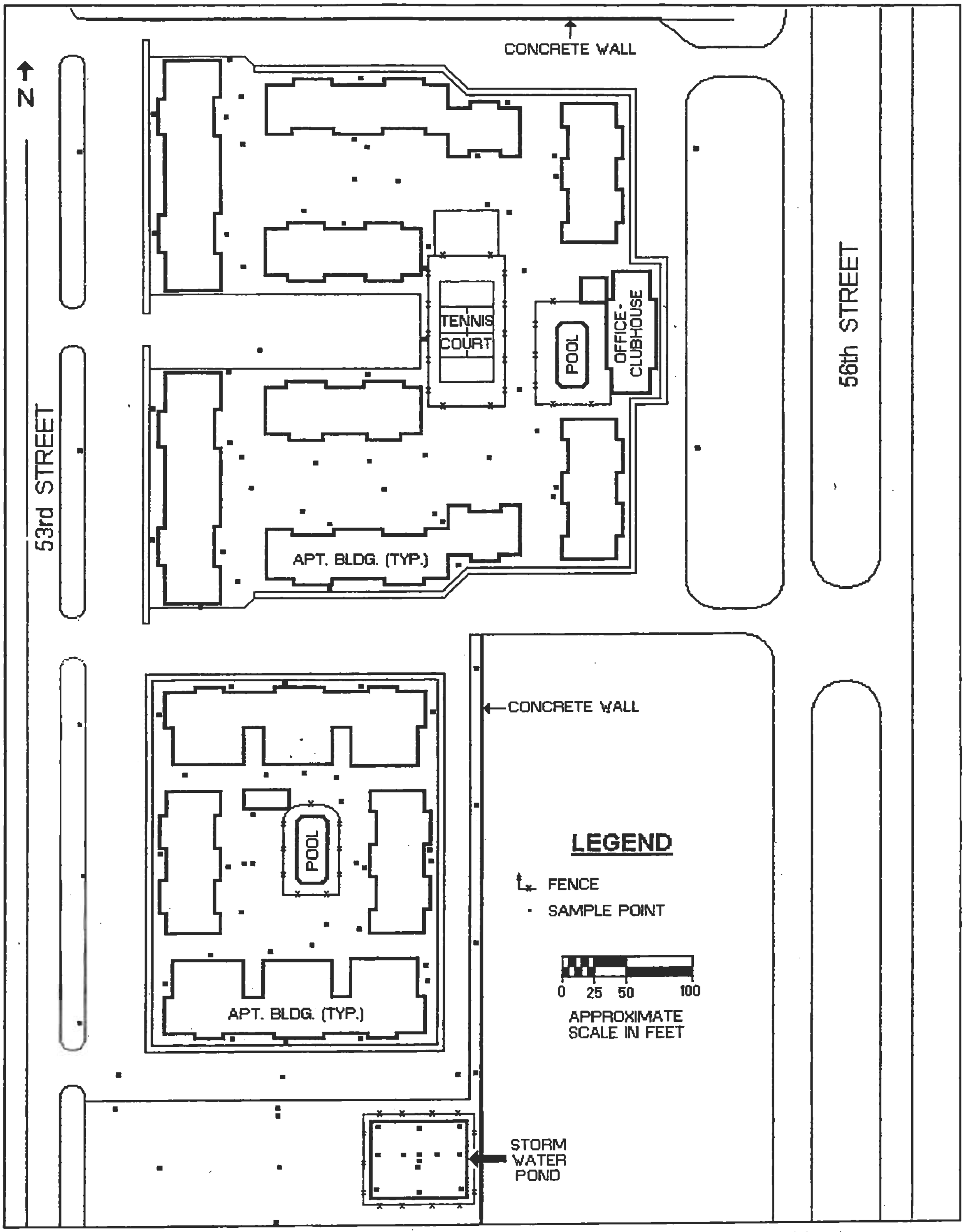

Figure 10. On-site Deep Subsurface Soil (> 6" Deep) Sample Locations (re: Table 8).

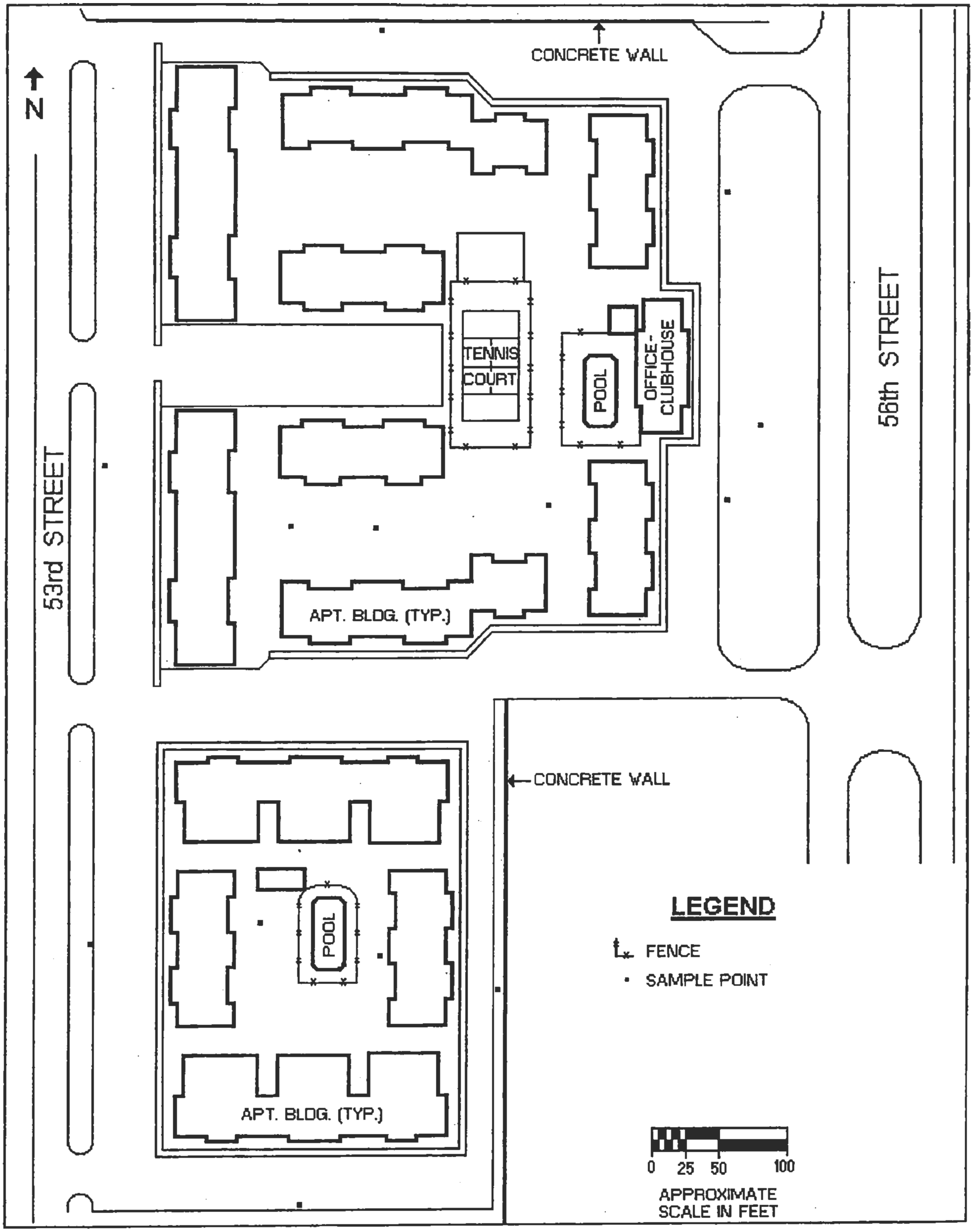

Figure 11. On-site Shallow Well Sample Locations.

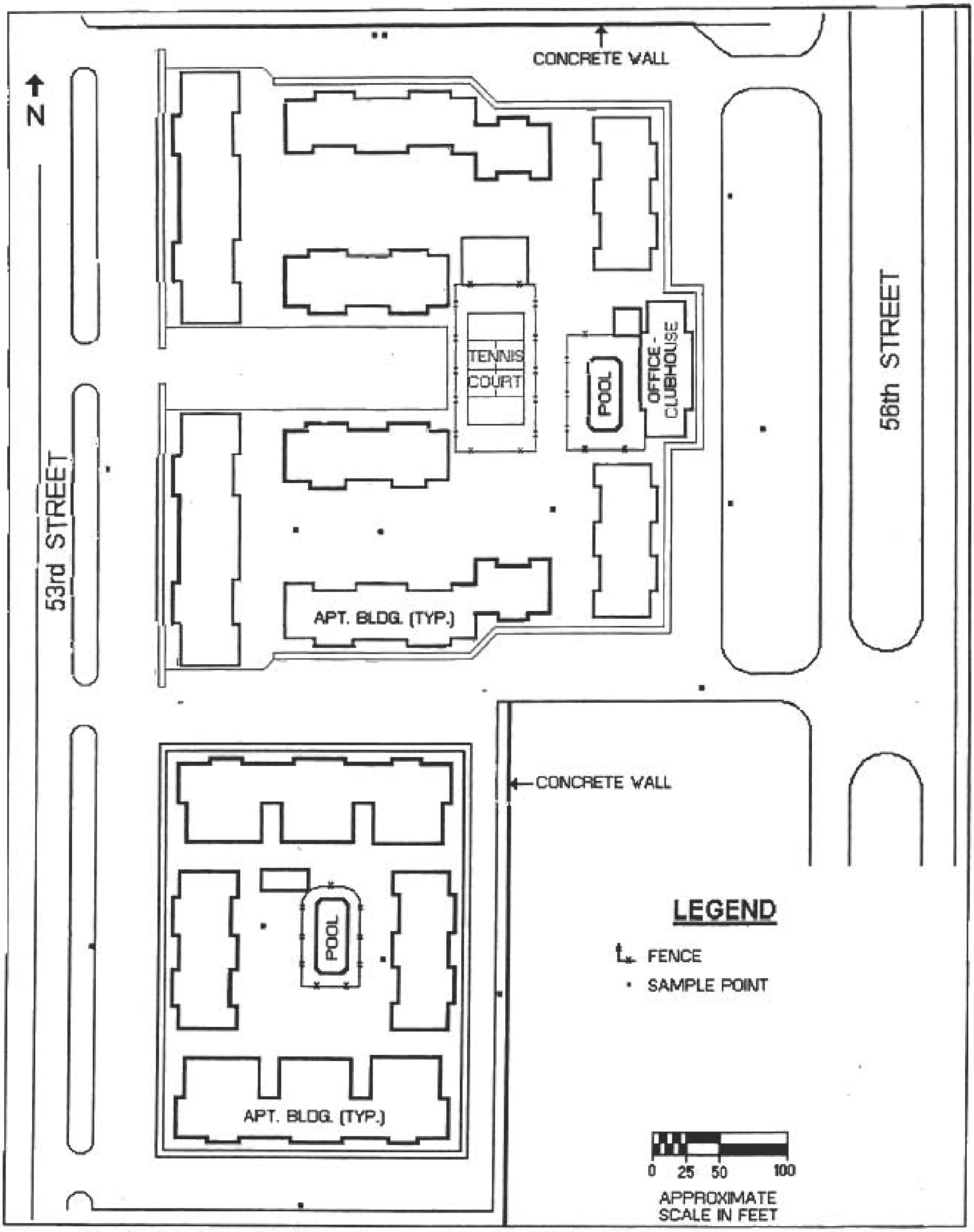

Figure 12. On-site Deep Well Sample Locations (re: Table 12)

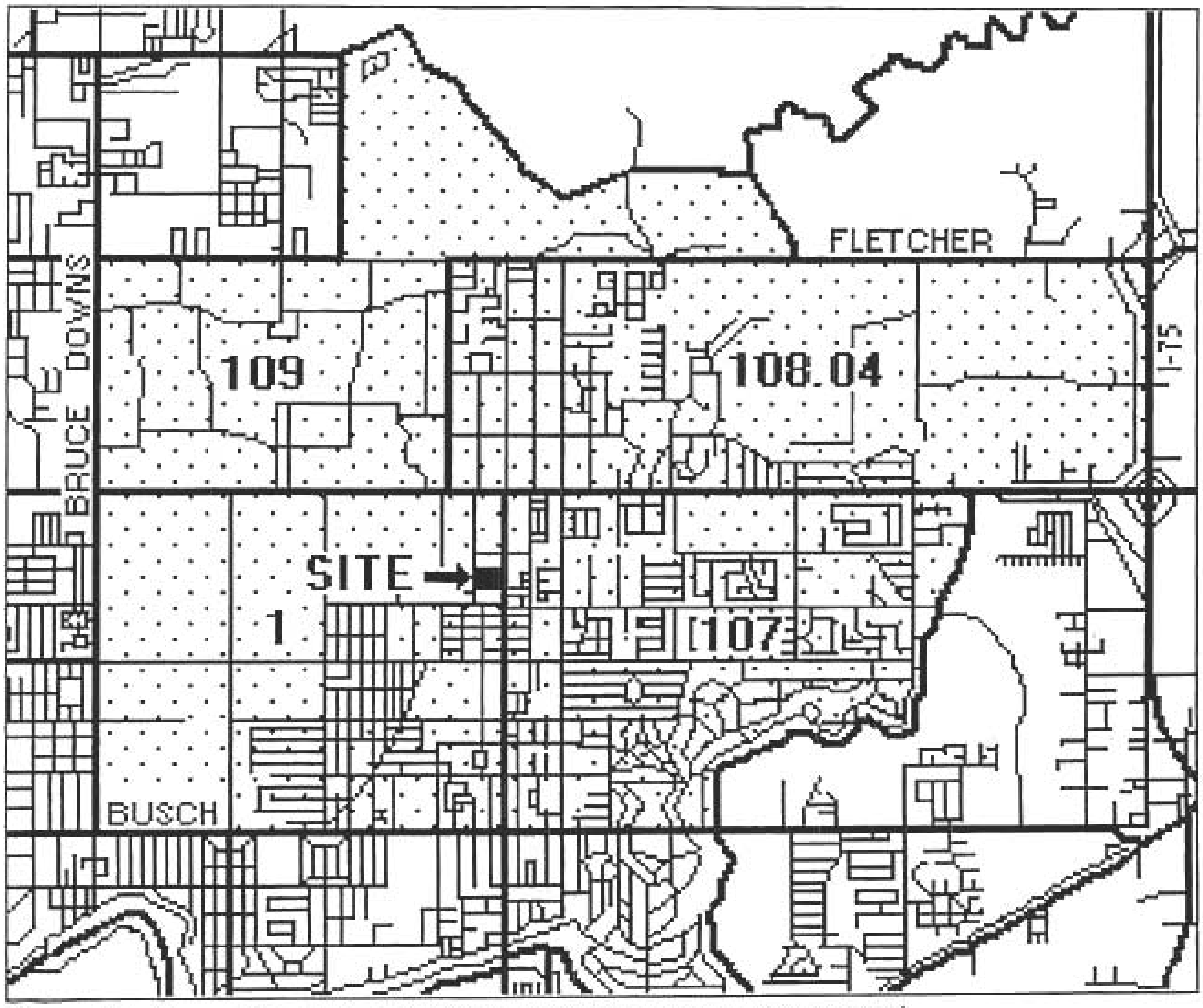

Figure 13. Census Tracts Examined in the FCDS Evaluation (BOC 1992).

B. Tables

Table 1. Estimated Vegetative Ground Coverage

Area	Estimated Vegetative Ground Cover (Percent)		
	February 1993	August 1995	December 1996
Northern Courtyard	70	95	90
Middle Courtyard	45	60	45
Southern Courtyard	80	95	--*
Recreation Area	95	95	95
Outside of Buildings, Exterior to the Courtyards	65	75	65

Data Sources: FHRS 1993, 1995e, 1996i; FDOH 1997b.

* In October 1995, site owners had the southern courtyard covered with decking.

Table 2. Description of Exposed Casing Pieces

Casing Piece	February 1993	August 1995	December 1996
Average Size (in^2)	2	1	<1
Largest Size (in^2)	4	2	1
Number of Pieces Seen	many	3	a few

Data Sources: FHRS 1993, 1995e, 1996i; FDOH 1997b.

* In October 1995, site owners had the southern courtyard covered with decking

Table 3. Detected Contaminants

Contaminant Name	
Aluminum	Lead
Antimony	Magnesium
Arsenic	Manganese
Barium	Mercury
Benzo(a)Anthracene (PAH)	Nickel
Benzo(a)Pyrene (PAH)	4-Nitroaniline
Benzo(b and/or k)Fluoranthene (PAH)	Petroleum Products (unspecified)
Benzo(g,h,i)Perylene (PAH)	Phenanthrene (PAH)
Calcium	Potassium
Cadmium	Pyrene (PAH)
Carbon Disulfide	Selenium
Chromium	Sodium
Chrysene (PAH)	Strontium
Copper	Tetradecanoic Acid
DDE	Tin
DDT	Titanium
Dieldrin	Toluene
Di(2-ethylhexyl)Phthalate	Trichloroethene
Fluoranthene (PAH)	Vanadium
Hexadecanoic Acid	Yttrium
Ideno(1,2,3-c,d)Pyrene (PAH)	Zinc
Iron	

PAH - Polynuclear Aromatic Hydrocarbon

Table 4. Contaminants Below ATSDR Screening Values in All Media in Which They Were Detected

Contaminant Name	
Carbon Disulfide	Selenium
Fluoranthene (PAH)	Strontium
Manganese*	Toluene
Mercury	Trichloroethene
Pyrene (PAH)	Zinc

PAH - Polynuclear Aromatic Hydrocarbon
* Used screening values discussed in ATSDR 1997b.

Table 5. Contaminants Without ATSDR Screening Values

Contaminant Name	
Aluminum*	Magnesium
Benzo(a)Anthracene (PAH)	4-Nitroaniline
Benzo(b and/or k)Fluoranthene (PAH)	Petroleum Products (unspecified)
Benzo(g,h,i)Perylene (PAH)	Phenanthrene (PAH)
Calcium	Potassium
Chrysene (PAH)	Sodium
Copper*	Tetradecanoic Acid
Hexadecanoic Acid	Tin*
Ideno(1,2,3-c,d)Pyrene (PAH)	Titanium
Iron	Yttrium

*Human health data are available for this contaminant
PAH - Polynuclear Aromatic Hydrocarbon; limited health information available

Table 6. Completed Exposure Pathways - On Site

Pathway	Source	Environmental Media	Exposure Point	Exposure Route	Exposed Population	Time of Exposure	Exposure Activities	Estimated Number Exposed	Chemicals
Surface Soil	Normandy Park Apartments	Surface Soils (0"-6"Deep) and battery chips	Play Areas, Bare Soil in Yard Areas, Soil Tracked into Apartments	Ingestion, Dust Inhalation	Residents - Especially Children,	Past, Present, Future	Play, Digging, Indoor Activities	280	Lead
Dust	Normandy Park Apartments	Dust	Indoor and Outdoor Dust	Inhalation, Ingestion	Residents - Especially Children	Past, Present, Future	Play, Digging, Housework	280	Lead

N.B. We did not identify completed exposure pathways off site.

Table 7. Potential Exposure Pathways - On Site

Pathway Name	Source	Environmental Media	Exposure Point	Exposure Route	Exposed Population	Time of Exposure	Exposure Activities	Estimated Number Exposed	Chemicals
Deep Subsurface Soil	Normandy Park Apartments	Subsurface Soils (More Than 6" Deep)	Exposed Soils in Remediated Areas	Ingestion, Inhalation	Residents - Especially Children	Future	Site Cleanup, Play, Digging	60	Lead
Buried Solid Waste	Normandy Park Apartments	Subsurface Soils (More Than 6" Deep)	Exposed Battery Casings, Other Lead Waste in Remediated Areas	Ingestion	Residents - Especially Children	Future	Site Cleanup, Play, Digging	60	Lead
Biota	Normandy Park Apartments	Plant Tissue	Vegetables Grown in Site Soils	Ingestion	Residents	Past, Future	Gardening	30	Lead

No off-site potential exppsure pathways were identified.

Table 8. Population Estimates Table

Pathway Name	Unknown	Estimated Population in Pathway (Average)	Estimated Population in Pathway (Range Minimum)	Estimated Population in Pathway (Range Maximum)
Potential Pathways On-site			55	280
Potential Pathways Off-site				
Total Potential On and Off-site			55	
Completed Pathways On-site			30	280
Completed Pathways Off-site	X		--	--
Total Completed On and Off-site			30	280
Potential and Completed Pathways On-site			30	280
Potential and Completed Pathways Off-site				
Total Potential and Completed On and Off-site			30	

Data Sources: BOC 1992, FHRS 1992a, EPA 1995b, FDOH 1997d.

Table 9. Parameters Used for Ingestion Dose Calculations for Hypothetical Individuals

Parameter	Hypothetical Individual	
	Adult Resident	Young Child
Age	Over 18 y	0-6 y
Body Weight	70 kg	13 kg
Lifetime Expectancy	70 y	70 y
Ingestion/Inhalation Frequency	350 d/y	350 d/y
Exposure Period	25 y	6 y
Soil Ingestion Rate	100 mg/d	200 mg/d
Contaminated Fraction of Soil	1.00	1.00
Respirable Fraction of Dust	0.73	0.73
Inhalation Rate - Inside	0.71 m^3/h	0.60 m^3/h
Inhalation Duration - Inside	21 h/d	21 h/d
Proportion of Contaminated Dust - Inside	0.80	0.80
Dust Concentration - Inside	56 $\mu g/m^3$	56 $\mu g/m^3$
Inhalation Rate - Outside	1.67 m^3/h	1.60 m^3/h
Inhalation Duration - Outside	3 h/d	3 h/d
Proportion of Contaminated Dust - Outside	1.00	1.00
Dust Concentration - Outside	75 $\mu g/m^3$	75 $\mu g/m^3$

y - year
kg - kilogram
mg/d - milligrams per day
d/y - days per year
m^3/h - cubic meters per hour
h/d - hours per day
$\mu g/m^3$ - micrograms per cubic meter

Appendix C

Contaminants of Concern Seletion Method

Contaminants of Concern Selection Method

The public health assessment focuses on contaminants identified as contaminants of concern. We select contaminants of concern based on the following factors:

1 Concentrations of contaminants on and off site. Although background concentrations are useful in determining if contaminants are site-related, contaminants are only eliminated from further consideration if both the background and on-site concentrations are below standard screening values. This is necessary to assess the public health risk to all contaminants detected, whether site-related or not.

2. Field data quality, laboratory data quality, and sample design.

3. Community health concerns.

4. Comparison of maximum on and off site concentrations with published ATSDR standard screening values. ATSDR's published standard screening values are media-specific concentrations used to select contaminants for further evaluation. They are not used to predict health effects or to set clean-up levels. Contaminants with media concentrations above an ATSDR standard screening value do not necessarily represent a health threat, but are selected for further evaluation in the public health assessment. Contaminants with media concentrations below an ATSDR standard screening value are unlikely to be associated with illness and are not evaluated further.

   We used the following ATSDR standard screening values (ATSDR 1997a), in order of priority, to select contaminants of concern:

   A. CREG - Cancer Risk Evaluation Guide - calculated from EPA's cancer slope factors, is the contaminant concentration that is estimated to result in no more than one excess cancer per one million persons exposed over a lifetime.

   B. EMEG - Environmental Media Evaluation Guide - derived from ATSDR's Minimal Risk Level (MRL) using standard exposure assumptions, such as ingestion of two liters of water per day and body weight of 70 kg for adults. MRLs are an estimate of daily human exposure to a chemical likely to be without an appreciable risk of noncancerous illnesses.

C. RMEG - Reference Dose Media Evaluation Guide - derived from EPA's Reference Dose (RfD) using standard exposure assumptions. RfDs are an estimate of daily human exposure to a chemical likely to be without an appreciable risk of noncancerous illnesses.

D. LTHA - Lifetime Health Advisory for Drinking Water - EPA's estimate of the concentration of a contaminant in drinking water at which illnesses are not expected to occur over a lifetime of exposure. LTHAs provide a safety margin to protect sensitive members of the population.

E. MCL - Maximum Contaminant Level - FDEP's regulatory standards for contaminants in public water systems. FDEP often adopts MCLs from federal drinking water standards; however, some FDEP MCLs are stricter than federal standards. MCLs consider the economic feasibility of attaining the standard as well as the potential health effects from drinking water at the standard.

5. Contaminants without ATSDR standard screening values, but which have toxicological information published in documents called ATSDR toxicological profiles. These profiles are chemical-specific and contain a variety of toxicological information found in the scientific literature.

Sample analyses detected 43 contaminants in various environmental media (water, soil, air) near the site (Table 3, Appendix B). Using the methodology described above, we eliminated 10 chemicals detected in various media from further consideration because their concentrations were below their standard screening values (Table 4, Appendix B). For manganese, we sought ATSDR's advice on possible screening values and eliminated this contaminant from further consideration based on that advice (ATSDR 1997b).

Contaminants Below ATSDR Screening Values in All Media

Carbon Disulfide	Selenium
Fluoranthene	Strontium
Manganese	Toluene
Mercury	Trichloroethene
Pyrene (PAH)	Zinc

Twenty chemicals had no standard screening values (Table 5, Appendix B). Of these 20, titanium, yttrium, tetradecanoic acid, hexadecanoic acid, 4-nitroaniline, and the six PAHs have very little human health data to determine their public health significance. Based on limited information, we determined that the low concentrations of these chemicals found in the soil should not pose a public health threat and so we eliminated them from further consideration. Since there was no information identifying the chemicals classified as "petroleum products," we could not evaluate this category, and we eliminated it from evaluation.

Because calcium, iron, magnesium, potassium, and sodium are common soil nutrients, they are unlikely to have adverse health effects on people exposed to them. We eliminated these five nutrients from further evaluation. Investigators found the three pesticides (DDT, DDE and dieldrin) in one off-site surface soil sample from a residential yard. Although site investigators sampled for these pesticides on site in six soil and three well samples, the analyses did not detect these compounds. These findings suggest the pesticides found in the off-site residential yard are not likely to be site-related. We also determined that the trace concentrations found should not pose a health problem; consequently, we eliminated the them from subsequent consideration. In the Pathways section, we eliminated barium, cadmium, nickel, and di(2-ethylhexyl)phthalate as past or present contaminants of concern.

By the end of this process, we had the following 9 contaminants to further evaluate:

Aluminum	Benzo(a)Pyrene	Lead
Antimony	Chromium	Tin
Arsenic	Copper	Vanadium

D. Toxicological Evaluation Methods

Toxicological Evaluation Methods

To calculate the daily dose of each contaminant, we used standard assumptions about body weight, ingestion and inhalation rates, exposure time length, and other factors needed for dose calculation (Table 22, Appendix B). The standard values and dose-related equations we used originated from ATSDR and EPA guidance manuals (ATSDR 1992b, 1995a; EPA 1990a). In calculating the dose, we assumed residents were exposed to the maximum concentration measured for each contaminant in each medium (Tables 6-17, Appendix B). To calculate daily doses, we used the computer software, Risk*Assistant™ (1995). Using this software enabled us to model dose estimates for dust inhalation.

Because some body functions work differently in adults and children, we estimated contaminant doses for two hypothetical individuals: a young child (0-6 years old), and an adult. We assumed young children did not exhibit pica behavior, the abnormal ingestion of large amounts of non-food substances including soil. Although all children inadvertently ingest soil as a part of normal mouthing behavior, this activity usually stops around 18 months of age. Pica behavior is rare. However, when it occurs, pica behavior is usually established by 18 months of age and may persist until a child is six years old (EPA 1990a). In terms of exposure, pica children are likely to ingest abnormally large amounts (up to 5000 mg) of soil, making their daily dose of a soil-borne contaminant much higher than that of other children or adults. In the August 1995 public meeting, residents and apartment managers said they did not know of any children living in the complex with pica behavior (FHRS 1995e). In 1998 GCR staff again reported that, to their knowledge, no children at the apartments exhibited pica behavior (FDOH 1998c). For the hypothetical young child and adult, we estimated human exposure from incidental (accidental) ingestion of contaminated surface and subsurface soil and from modeled dust inhalation data both inside and outside the home.

To evaluate possible noncancerous health effects at these doses, we compared our estimated dose to contaminant-specific MRLs or RfDs, when they existed, for each type of exposure route (inhalation, ingestion, and skin contact) and length of exposure (chronic - greater than 364 days of exposure, intermediate - 15 to 364 days of exposure, and acute - less than 15 days of exposure). An MRL is an estimate of the daily dose of a contaminant below which non-cancer illnesses are unlikely to occur. ATSDR develops MRLs from scientific studies found in the toxicological literature, and publishes them in a series of chemical-specific documents called toxicological profiles. These documents contain not only MRLs, but also information on possible health effects, environmental transport, human exposure, and regulatory status of contaminants. EPA publishes similar minimal risk doses, called RfDs, below which non-cancer illnesses are unlikely to occur. In evaluating the dose data for contaminants at this site, we used the MRL for comparison when both an MRL and a RfD were available. In some cases, there are no MRLs or RFDs for comparison. In these cases, we compared the estimated doses we calculated to doses in published human or animal studies in order to estimate possible health effects. Our conclusions from these comparisons are judgements based on: what we know about the quality of the study, natural disease rates in the test organisms, and how close our estimated doses are to published experimental doses. These judgements always contain some uncertainty because of natural variation within human and animal populations, and because of species differences among humans and animals. Humans and animal differences are particularly important because a given test animal species may be either more or less sensitive to a particular contaminant than humans, and often the direction of this sensitivity difference is unknown.

To evaluate possible cancerous health effects, we used standard equations to calculate an individual's additional risk of developing cancer over a lifetime after exposure to a potentially cancer-causing contaminant. This calculated probability is known as the cancer risk, the number of excess cancer cases that could develop per unit of population if the exposure assumptions are met for a specific contaminant. Usually, an excess cancer risk of 1 in 10,000 to 1 in 1,000,000 is considered a negligible increase in cancer risk. There are three things to consider when evaluating cancer risk. First, when examining the numeric cancer risk value, it is important to recognize there is a background cancer rate of around 25% in the United States (ATSDR 1993a). This means that in a group of a million people, 250,000 people can be expected to develop cancer in their lifetime without exposure to contaminants at a particular site. Within the negligible cancer risk range of 1 in 1,000,000 to 1 in 10,000 excess cancer cases for a specific contaminant, 250,001 - 250,100 people in this same group might develop cancer in their lifetime if they are exposed to that contaminant at the specified dose and exposure period. Because these cancer risk calculations are made for a lifetime, and because some cancers don't develop until many years after exposure, we do not calculate a separate cancer risk for children. Second, when interpreting the associated cancer information, it is important to note whether or not the associated cancers have been looked for and found to occur in humans. This is because a given test animal species can be more or less likely to develop cancer than humans. When only animal studies of cancer are available, we present the suggestive evidence from the animal studies, but cannot necessarily conclude human exposure will be linked to cancer. Third, there is much scientific controversy about the validity of adding cancer risks from different exposure routes together. Some scientists believe exposure to a cancer-causing chemical via multiple pathways seems likely to increase the overall cancer risk. Other scientists believe cancer risks can be added only if the cancer-causing agent affects the same cell type within the same organ, and works through the same cellular mechanism within the common cell type. In this document, we support the principle that a common mechanism is required. Often, cellular mechanisms of action are not known; in these cases, the suitability of adding estimated cancer risks together cannot be determined. In this subsection, we present the estimated cancer risks from different exposure pathways separately. After examining the dose-related calculations for the nine remaining contaminants of concern and making the appropriate comparisons, we divided the contaminants among two categories: a minimal risk category and a possible risk category.

The minimal risk category identifies those contaminants whose dose-related value is very close to or below the applicable MRL, RfD, or within the negligible cancer risk range for a medium (soil, water, or air); or significantly below exposure levels associated with noncancer illnesses in a medium; or both (ATSDR 1990, 1992d, 1992f, 1992g, 1992h, 1993b, 1993d). In defining "close to" values, we included contaminant doses that slightly exceeded a health value in this group for three reasons. First, the estimated dose values are not known with great precision due to the uncertainty inherent in exposure parameter estimation. Second, the conservative assumptions behind our calculations are likely to cause us to overestimate contaminant doses, and consequently to overestimate the public health risk. Third, our evaluation of the toxicological literature used to estimate the RfDs or MRLs for these specific contaminants supports this categorization. Therefore, we consider the actual risk of becoming ill from exposure to these contaminants to be minimal. The eight minimal risk contaminants for the Normandy Park Apartments are:

Minimal Risk Contaminants

Aluminum	Benzo(a)Pyrene	Tin
Antimony	Chromium	Vanadium
Arsenic	Copper	

Possible risk contaminants have estimated doses above the MRL, RfD, or negligible cancer risk range; have estimated doses relatively close to doses associated with health effects in humans or animals; or do not have enough information for evaluation. Being above a health value does not necessarily mean exposure to a contaminant will cause illnesses; it simply means the contaminant needs further evaluation. We perform this evaluation by comparing the doses we estimated for different age groups of residents with doses found in human or animal studies published in the toxicological literature. In examining this literature, we relied heavily on the study summaries presented in the ATSDR toxicological profiles and in EPA's IRIS (Integrated Risk Information System) database (IRIS 1995). IRIS contains toxicological information for many contaminants commonly found at hazardous waste sites.

The possible risk contaminant for the Normandy Park Apartments is:

Lead

Contaminants in the possible risk category are not necessarily threats to public health; they are simply selected for further evaluation. Possible risk contaminants are the focus of a public health assessment. We discuss the possible risk contaminants in more detail in the Toxicological Evaluation subsection of the Public Health Implications section.

E. Concepts for Public Health Implications

Concepts for Public Health Implications

Risk of Illness

In this health assessment, the risk of illness is the chance that exposure to a hazardous contaminant is associated with a harmful health effect or illness. The risk of illness is not a measure of cause and effect; only an in-depth health study may identify a cause and effect relationship. Instead, we use the risk of illness to indicate whether or not a follow-up health study *should be considered*, and to provide possible associations to be addressed in a follow-up health if needed.

In general, the greater the exposure to a hazardous contaminant, the greater the risk of illness. However, the risk of illness is also determined by the amount of a substance that is required to harm a person's health. In theory, everyone who is exposed to a hazardous contaminant above a minimum level has an increased risk of illness, but only in unusual circumstances do many people actually become ill. Individual risks of illness usually are measured and reported as an expression of chance. Consequently, scientists discuss the likelihood of becoming ill, and may express the chance of becoming ill as a fraction. For example, in the 1930's and 1940's, some workers exposed to very high levels of asbestos in asbestos factories had an estimated cancer risk of one chance in one hundred (1/100). However, the estimated cancer risk from exposure to the lower levels of asbestos in air outside of these plants was one chance in ten thousand (1 in 10,000). Sometimes, scientists compare the likelihood of different risks by looking at the expected occurrences of an illness for the total exposed population. For example, in 100,000 workers exposed to high levels of asbestos in the 1930's and 1940's, scientists would expect to see 1,000 (= 100,000 x 1/100) extra cancer cases. If 100,000 people were exposed only to the low levels of asbestos, scientists would expect to see 10 (= 100,000 x 1/10,000) extra cases of cancer (EPA 1990b).

Information from human studies provides the strongest evidence that exposure to a hazardous contaminant is related to a particular illness. Some of this evidence comes from doctors reporting unusual incidences of a specific illness in exposed individuals. More formal studies compare illnesses in people with different levels of exposure. However, human information is very limited for most hazardous contaminants, and scientists frequently must depend upon data from animal studies. Animal studies are used to estimate risk of illness in humans because hazardous contaminants that are associated with harmful health effects in humans often also are associated with harmful health effects in other animal species. There are limits to relying only on animal studies, however. For example, scientists have found some hazardous contaminants are associated with cancer in mammals, but lack evidence of a similar association in humans. In addition, human and animals have differing abilities to protect themselves against low levels of contaminants. Furthermore, most animal studies test the possible health effects of high exposure levels only. Consequently, the possible effects of a hazardous contaminant on humans is uncertain when there is information only from animal experiments (EPA 1990b).

Dose-Response and Threshold Concepts

The focus of toxicological studies in humans or animals is identification of the relationship between exposure to different doses of a specific contaminant and the chance of having a health effect from each exposure level. This dose-response relationship provides a mathematical formula or graph that is used to estimate a person's risk of illness. The actual shape of the dose-response curve requires scientific knowledge of how a hazardous substance affects different cells in the human body. There is one important difference between the dose-response curves used to estimate the risk of noncancer illnesses and those used to estimate the risk of cancer: the existence of a threshold dose. The threshold dose is the highest exposure dose at which there is no risk of illness. The dose-response curves for noncancer illnesses include a threshold dose that is greater than zero. Scientists include a threshold dose in these models because of the observation that the human body is capable of adjusting to varying amounts of other types of cell damage without showing signs of illness. The threshold dose differs for different contaminants and different exposure routes, and is estimated from information gathered in human and animal studies. In contrast, the dose-response curves used to estimate the risk of cancer assume there is no threshold dose (or, the cancer threshold dose is zero). This assumes a single cancer cell may be sufficient to cause a clinical case of cancer (EPA 1990b). This assumption is very conservative, and many scientists believe a threshold dose greater than zero also exists for the development of cancer.

Uncertainty in Health Assessments

Health assessments are developed to be conservative and protective of public health. However, health assessments require the use of assumptions, judgements, and incomplete data to varying degrees. These contribute to the uncertainty of the final risk estimates. Some of the more important sources of uncertainty in this public health assessment include environmental sampling and analysis, exposure parameter estimation, use of modeled data, and present toxicological knowledge. These uncertainties may cause risk to be overestimated or underestimated to different extents (EPA 1993b). As a result of the uncertainties described below, this public health assessment should not be construed as representing an absolute estimate of risk to persons potentially exposed to chemicals at or near the Normandy Park Apartments site.

There are uncertainties inherent in the public health assessment process. In general, these uncertainties fall into four categories: 1) the uncertainty of science in general (that is, science is never 100% certain), 2) the inexactness of the health assessment process, 3) the incompleteness of the information collected thus far, and 4) differences in opinion as to the implications of the information (NJDEP 1990). In general, scientists and public health officials incorporate uncertainties into health assessments by using worst-case assumptions when estimating or interpreting health risks, and by using wide safety margins when setting health-related threshold values. Because of these actions, health assessments tend to err on the side of protecting public health. In accordance with this practice, the assumptions, interpretations, and recommendations we make throughout this public health assessment tend to err in the direction of protecting public health.

Environmental chemistry analysis errors can arise from random errors in the sampling and analytical processes, resulting in either an over- or under-estimation of risk. These errors can be controlled to some extent by increasing the number of samples collected and analyses performed, and by sampling the same locations over several different time periods. These actions tend to make uncertainty contributed from random sampling errors small (EPA 1993b). However, only a small number of samples were collected for some contaminants, and many sample locations were not sampled more than once. The limited data from these areas may not be representative of the presence or concentrations of contaminants across the entire area. Consequently, the risk of illness for these contaminants may be over- or under-estimated.

There are two areas of uncertainty related to exposure parameter estimation. The first is related to exposure point concentration estimation. The second is related to the parameter values used to estimate chemical exposures (EPA 1993b). In this assessment we used maximum detected concentrations as the exposure point concentration. We believe using the maximum measured value to be appropriate because we cannot be certain what the peak contaminant concentrations are, and we cannot statistically predict peak values because the sample numbers and distribution are unsuitable for this type of analysis. Nevertheless, this assumption introduces uncertainty into the health assessment that may over- or under-estimate the actual risk of illness. When selecting parameter values to estimate exposure dose, we used default assumptions and values within the ranges recommended by ATSDR or EPA. These default assumptions and values are designed to be conservative and may contribute to the over-estimation of risk of illness. Similarly, we assumed residents of Normandy Park were exposured to contaminants on a regular basis for each selected pathway. Both of these assumptions are likely to contribute to the over-estimation of risk of illness

There are also data gaps and uncertainties in the design, extrapolation, and interpretation of toxicological experimental studies (EPA 1993b). Data gaps contribute uncertainty because information is either not available or must be addressed qualitatively. In addition, there are great uncertainties in extrapolating from high to low doses, and from animal to human populations. Extrapolating from animals to humans is uncertain because of the differences in the uptake, metabolism, distribution, and body organ susceptibility between different species. Human populations are also variable because of differences in genetic constitution, diet, home and occupational environment, activity patterns, and other factors. These uncertainties can result in an over- or under-estimation of risk of illness. Finally, there are great uncertainties in extrapolating from high to low doses, and controversy in interpreting these results. Because the models used to estimate dose-response relationships in experimental studies are conservative, the risk estimates resulting from these models tend to be over-estimated. Currently, there is much debate in the scientific community as to how much the actual risks are over-estimated and what the risk estimates really mean.

Appendix F

General Information on Lead

LEAD

Use and Human Exposure - Lead is a naturally occurring bluish-gray metal found in small quantities in the earth's crust. Most lead used by industry comes from mined ores or from recycled scrap metal. Lead is used to produce some types of batteries, ammunition, and electronic devices. It is used as radiation shields (from x-rays, for example), and is found in sheet lead, solder, pipes, caulking, paints, ceramic glazes, and gasoline. In recent years, the amount of lead added to solder, paints, ceramic products, caulking, and gasoline has been reduced because of its harmful health effects; however, its use in ammunition and roofing has increased. Human activities, particularly the use of leaded gasoline, have spread lead to all parts of the environment.

People can be exposed to lead by breathing air, drinking water, eating foods, or ingesting dirt or dust containing lead. Foods such as fruits, vegetables, meats, grains, seafood, soft drinks, and wine may have lead in them. This lead can come from deposition of lead-containing dust on crops or during food processing, plant uptake of lead from soil, use of improperly glazed ceramics or leaded-crystal glassware, lead-soldered cans containing acidic foods, or lead-soldered kettles used to boil water. Communities with acidic water may have increased lead levels in water as the metal leaches out of lead pipes, lead-based solder, and brass faucets. Children can ingest lead-based paint chips. Lead enters the air from industrial releases, the weathering or burning of lead-based paints, or the burning of leaded gasoline, solid wastes, or tobacco. Consequently, tobacco smokers can be exposed to more lead than nonsmokers. Although skin contact with lead-containing dust and dirt occurs every day, not much lead passes through intact skin.

Most lead enters the body through ingestion. The amount of lead entering the body after ingestion depends upon when the last meal was eaten, as well as the person's age and how well the lead particles are dissolved in the stomach juices. Children tend to absorb more lead than adults, and more is absorbed from an empty stomach than from a full stomach. Frequent skin contact with lead in soil and dust can result in young children's swallowing high lead through hand-to-mouth behavior. In adults, only a small amount of lead can enter the body through intact skin if it is not washed off after skin contact. Lead can also enter the body through breathing in dust or chemicals containing lead, or through smoking tobacco products. Once in the body, lead first travels to body organs such as the liver, kidneys, lungs, brain, spleen, muscles, and heart. In adults, almost all of the lead entering the body leaves within a couple of weeks through urination or defecation. However, in children, only about a third of ingested lead leaves the body in waste. Lead that does not leave the body will, after several weeks, move to the bones and teeth where it can stay for decades. Some of the lead stored in bones and teeth may leave these tissues and reenter the blood and body organs at a later date. In adults, 94% of the total body lead is stored in bones and teeth. In children, only 73% is stored in bones and teeth; the rest is in body organs and blood (ATSDR 1993e).

General Health Effects - At high levels of exposure, lead can damage the brain or kidneys of adults or children. Unborn children are particularly sensitive to lead exposure during development. Exposure during pregnancy can lead to premature birth, smaller babies, and decreased mental abilities in the infant. Young children are also more sensitive to lead exposure than are adults. Lead exposure can decrease IQ scores and reduce the growth of young children.

These effects are more often seen after exposure to high lead levels rather than low lead levels. In adults, high levels of lead exposure may decrease reaction time; affect the memory; cause weakness in the fingers, wrists, or ankles; increase blood pressure in men; cause anemia; cause miscarriages; or damage the male reproductive system. It is not known if lead exposure causes cancer in humans. Some studies show rats and mice given very large doses of lead develop kidney tumors. However, the results of these animal studies are questionable because of the study methods used. Still, lead is classified as a suspected cancer-causing agent via ingestion (ATSDR 1993e).

Interactions with Other Chemicals - A number of studies of humans have found undernourished individuals are more susceptible to the effects of lead exposure because deficiencies in calcium, phosphorus, copper, iron, and zinc can increase lead absorption. Several animal studies have supported these findings by showing that sufficient dietary intake of calcium, magnesium, phosphorus, copper, iron, and zinc protects against the harmful effects of various lead compounds. A few animal studies show cadmium increases lead's toxic effects on mortality, behavior, and the male reproductive system. In addition, lead may worsen mercury's effects on the kidneys and liver. Another animal study indicates lead blocks intestinal responses to vitamin D and its by-products. In a different study, coexposure of lead and ethanol (drinking alcohol) in rats increased the rat's susceptibility to lead's toxic effects on the liver, brain, and nervous system. However, another study investigating the interactive effects of lead and ethanol during pregnancy found no interaction between these substances on reproduction or learning in rats (ATSDR 1993e).