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Illinois Beach State Park (IBSP): Determination of Asbestos Contamination in Beach Nourishment Sand

Final Report of Findings

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Executive Summary

Asbestos containing materials (ACM) washing onto the beaches at Illinois Beach State Park (IBSP) has been a concern since 1997. Records of materials collected during beach sweeps in 2004 indicated that most of the ACM was housing or construction related material. There are several possible sources of ACM in the general area, and some available store of ACM may be present on the feeder beach, which was originally created to reduce beach erosion at IBSP. The feeder beach was depleted to about 1% of its original volume from 1989 to 2004. Additional ACM may be present in beach sand, lake-bottom sand in shallow water, or in the remains of former housing in the area.

This study was performed to evaluate two potential lake-bottom sources of beach replenishment sand. The study design utilized very sensitive sampling and analytical methods to determine whether asbestos structure concentrations in the sand were elevated. Background area concentrations were considered because of the sampling method's analytical sensitivity and because inadequate information existed about ambient concentrations of asbestos in soil or sand with the use of this method.

In order to characterize background concentrations, beach sand was sampled at Grant Park Beach in South Milwaukee, Highland Park Beach in Highland Park, and Oak Street Beach in Chicago. The Oak Street Beach results were excluded as background because the sand sampling results indicated greater concentrations than other beaches, which would have masked the analyses that are fundamental to this study. The sand sampling results indicate that the concentration of asbestos structures per gram of PM_{10} in the beach sand at the IBSP North Unit, the lake-bottom sand at the Approach Channel to Waukegan Harbor, and the lake-bottom sand at the North Point Marina were significantly different (greater) than background areas. The IBSP South Unit results were not significantly different than background. Very little information is available about typical background and variability of asbestos in soil or sand in urban and non-urban areas.

GLCEEH performed a screening level analysis of potential health effects for the target areas that include IBSP North and South Unit beaches and the two potential lake-bottom sand beach nourishment sources at the North Point Marina and the Approach Channel to Waukegan Harbor. Since air sampling could not be conducted to evaluate the lake-bottom sand, GLCEEH chose to model and predict potential air emissions from likely recreational activities as if the lake bottom sand were placed on a beach. The screening risk assessment indicated that the two lake bottom sand areas tested, if used for beach nourishment, and the IBSP North Unit represent a minimal risk to beach users from asbestos, based on sample results and the emissions model utilized. These estimates indicate that at this time, there is no reason to exclude the use of the two lake-bottom sand sources for beach nourishment. For an extra measure of safety, lake-bottom sand should continue to be deposited off shore, as is the current practice, rather than directly to onshore areas of the beaches.

The screening risk assessment estimates do not address the potential risk from handling ACM. The condition, friability, and handling circumstances for any particular piece of ACM are not predictable. Therefore, the greatest risk to beach users in the targeted areas should be considered to be the potential handling of ACM.

Based on the information collected for this report, GLCEEH provides four recommendations, including:

1) A continuation and expansion of beach surveillance for ACM at IBSP that would include additional surveillance after inclement high wind and wave events and detailed record keeping of ACM findings and descriptions.
2) A review of IBSP visitor education efforts about ACM to determine effectiveness.
3) An ACM survey of areas that are impacted by erosion for the remains of housing infrastructure. If infrastructure that includes ACM is found, it should be remediated in accordance with applicable rules and regulations for asbestos abatement.
4) Alternative options for long-term beach nourishment and erosion management should be explored in full in order to reduce the expense and potential environmental and ecological impacts involved in obtaining sand for beach nourishment.

ATSDR performed an informal review of the interim version of this report and generally agreed with the conclusions that asbestos exposure on the beaches does not appear to pose a public health hazard, assuming that the program to immediately remove visible ACM is implemented. ATSDR also suggested that, given the overall uncertainties of using indirect measures of asbestos exposure, activity-based air sampling (sampling while re-creating common activities) should be performed on some of the beaches that were tested for this study. IBSP stewards are implementing this suggestion under the guidance of ATSDR.

Introduction

Scope of the Report

This project was undertaken in order to answer a fundamental question raised by the Illinois Attorney General's Asbestos Task Force: Whether or not potential sources of nourishment sand, IBSP beaches, and background areas had statistically significant differences in concentrations of asbestos structures in sand and whether these differences represented human health hazards.

Based on a review of sand sampling results obtained from previous reports, GLCEEH concluded that standard bulk sampling methods were not adequate to provide a useful comparison between areas of interest for this study. The concentrations of asbestos structures in IBSP shoreline areas and potential lake-bottom sources of nourishment sand have typically been below quantifiable detection limits for the analytical methods utilized. GLCEEH recommended that additional sampling should be conducted using more sensitive methods and outlined a study design. The Asbestos Task Force supported this recommendation. This report describes the study background and findings.

Study Background

The Great Lakes Center of Excellence in Environmental Health (GLCEEH) at the University of Illinois at Chicago School of Public Health (UIC-SPH) performed a Health Hazard Evaluation (HHE) as part of its role in the Illinois Attorney General's (AG) Asbestos Task Force formed to address asbestos contamination at Illinois Beach State Park (IBSP). Elements of the scope of the HHE were discussed at several Task Force meetings, which led to a consensus on achievable goals for an evaluation of beach sand and potential beach nourishment sources.

The Illinois AG Task Force is composed of representatives from the AG's office, GLCEEH, UIC-SPH, Illinois Department of Public Health (IDPH), Illinois Department of Natural Resources (IDNR), United States Environmental Protection Agency's Region 5 Air and Radiation, Water, and Superfund Divisions (U.S. EPA), Illinois Environmental Protection Agency (IEPA), United States Army Corp of Engineers, Lake County State's Attorney, City of Waukegan, and the Waukegan Park District. All of these agencies are interested in resolving asbestos-related issues at IBSP and the general area in order to protect public health while providing good management of a valuable state resource that includes unique recreational, geological and ecological features.

Problem Statement

IBSP is a major natural and recreational resource in the densely populated Chicago-Milwaukee metropolitan area that is threatened by severe natural erosion due to the coastal dynamics of the 6.5-mile shoreline. Management of IBSP necessitates approximately 80,000 cubic yards of beach nourishment sand per year from local or outside sources in order to maintain the Park shoreline.[1,2] The Park has sustained severe damage from erosion in recent years.

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[1] Foyle, Anthony M., MJ Chrzastowski, and CB Trask, Erosion and Accretion Trends Along the Lake Michigan Shore at North Point Marina and Illinois Beach State Park, Illinois State Geological Survey, March, 1998, p i.
[2] Chrzastowski, M. J., Geology of the Zion Beach-Ridge Plain Field Trip Guidebook for the Great Lakes Section Annual Field Conference, September 14-16, 2001; printed by Illinois State Geological Survey. p 30.

Pieces of asbestos-containing materials (ACM) have been found and recognized as ACM on the Illinois Beach State Park beaches since 1997. ACM has also been found in local sources of sand used for beach nourishment. Most of the debris that was found on the beaches and in other areas was made up of materials in which the asbestos was bound in a matrix, decreasing the likelihood of fiber release. From 1998 through 2000, IDPH, IDNR, and environmental contractors hired by the State of Illinois performed or participated in inquiries relative to these findings. Summaries of the relevant findings are presented in other sections of this report.

In 1998, IDPH concluded that the IBSP beaches were safe for public use. IDNR implemented ACM survey and cleanup procedures along with public education efforts to deter the public from picking up and handling ACM. In June of 2000, the Agency for Toxic Substances and Disease Registry (ATSDR) performed a Public Health Assessment at IBSP and concluded that the asbestos at the park was not a public health hazard for visitors and workers. The Public Health Assessment recommended that source investigation should continue, ACM should continue to be removed, and education and notification of the public should continue.[3]

A feasibility study to test screening techniques for the removal of ACM from sand was subsequently performed by an environmental consulting firm.[4] The consulting firm concluded that the sand screening technique was feasible for removing ACM from the sand, but IDNR apparently stopped seeking permits after regulatory authorities indicated reservations about the technique and because of the presence of an invasive plant species in the targeted sand pile. No alternative techniques have been proposed to remove ACM from IBSP locations where ACM may be mixed with large volumes of sand. Therefore, this report assumes that IDNR is currently limited to beach survey and debris cleanup efforts to remove ACM from IBSP property.

The inquiries performed through the year 2000 were appropriate for the goals that were established for each study. However, the Task Force was formed in response to continuing public concerns about the presence of ACM in the IBSP area. In addition, the issue of environmental exposure to ambient levels of asbestos in a number of areas of the United States has motivated regulatory agencies and researchers to review questions about ambient exposure to asbestos. The AG's Office reached out to UIC-SPH for assistance in determining the potential health risk to visitors at IBSP.

Study Objectives

This report addresses the following questions:

- Has ACM contaminated the sand at IBSP beaches and potential sources of nourishment sand with asbestos structures in unsafe concentrations?
- Could these structures represent an airborne hazard?
- Will potential sources of sand for beach nourishment cause or contribute to beach contamination or risk to IBSP visitors?

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[3] U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment for Illinois Beach State Park, CERCLIS No. ILD984840140, June 16, 2000.

[4] Hanson Engineers, Inc., Report of Findings: Pilot Study for Sand Processing, Illinois Beach State Park, Volumes I and II, February 2000.

No standards exist for asbestos levels in soil or sand and few studies have investigated urban or rural background levels or exposure from asbestos in soil or sand. GLCEEH attempted to quantify the background prevalence of asbestos structures in sand in representative samples from IBSP, comparison area beaches, and lake-bottom sand locations that are potential sources of beach nourishment.

This report briefly summarizes relevant aspects of human exposure, health effects, and environmental sampling for asbestos, highlights areas of uncertainty, and refers readers to the vast amount of literature about these subjects that is readily available on the internet or through library sources. Controversies or differences within the scientific community on important health and exposure issues cannot be fully addressed or resolved in this report.

GLCEEH wishes to thank the many dedicated people who have performed scientific inquiry on asbestos-related issues in the past.

Asbestos Background

I. Physical Characteristics of Asbestos

Asbestos is present in trace amounts in some areas of the natural environment as well as in many areas impacted by human development. Appendix E provides information on ambient levels of asbestos in various environments, including the Great Lakes watershed.

Asbestos is a fibrous mineral that has unique physical and chemical characteristics. Asbestos fibers are flexible and strong and highly resistant to damage from heat, sunlight, water, and physical energy. While these properties make asbestos desirable for use in industrial and commercial products, they also increase its toxicity. Asbestos fibers have a low density and aerodynamic properties that allow them to remain suspended in air for long periods of time. Asbestos fibers and structures can remain intact after the material used to bind them into matrices and/or products has degraded. Asbestos occurs in various physical forms (structures) that can be differentiated by microscopy performed on environmental samples.

Asbestos is divided into two main classes on the basis of crystalline structure: Serpentine (chrysotile) and amphiboles. The amphibole group has several members, including amosite, actinolite, crocidolite, tremolite, and a number of other small groups.

Asbestos is persistent in the environment. Airborne asbestos structures slowly settle out of air and water into soil and sediment.[5] Chrysotile appears to be more susceptible to degradation in acidic environments than amphiboles. There is some limited evidence that chrysotile may degrade in water.[6] In general, asbestos undergoes minimal or no photolysis, volatilization, or

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[5] ATSDR Toxicological Profile for Asbestos, www.atsdr.cdc.gov/asbestos, p. 139, 156

[6] U.S. EPA, Water-Related Environmental Fate of 129 Priority Pollutants, EPA-440/4-79-029a, Vol 1, referencing several studies, pp 7-3, 7-8.

biotransformation. Some chemical speciation and sorption appears to occur. The ultimate fate of asbestos in the aquatic environment is poorly understood.[7]

II. General Sources of Asbestos

There has been limited commercial mining of asbestos in the United States, but asbestos also occurs as an impurity or waste product from other mining operations. Asbestos is also naturally occurring in geological formations in many parts of the country and in runoff waters.[8] The types of asbestos that have been utilized commercially are chrysotile, amosite, and crocidolite. The peak year of asbestos use in the United States was 1973, when approximately 719,000 metric tons was utilized.

In 1989, U.S.EPA attempted to ban most new uses of asbestos in the U.S. by 1997. However, the majority of the rule (40 CFR Part 763, Subpart I) was overturned by federal court in October 1991. It is still legal to manufacture, process, and import many asbestos products.

About 15,000 metric tons of asbestos was used in the United States in 1999, mostly imported from Canada.[9] Several references state that 95% or more of the asbestos that was commercially imported in the US was chrysotile,[10] although some asbestos products were manufactured with several types of asbestos minerals or may contain impurities from other asbestos minerals.[11,12,13]

III. Asbestos Exposure and Health Issues

Asbestos mining, manufacturing, and use have caused a virtual pandemic of fatal and non-fatal illnesses, primarily from workplace exposures to airborne asbestos. Asbestos exposure causes respiratory diseases that may result in respiratory failure, cardiac failure, and death, as well as several forms of aggressive malignancies. The respiratory diseases include asbestosis, lung cancer, mesothelioma, and adverse effects on the pleural (lung) lining, and are discussed briefly below.

Human health outcomes from environmental exposures follow a dose-response relationship, in which the probability of a specific adverse health effect increases with increased exposure levels. The exact relationship between time and level of exposure and adverse health effects for carcinogens such as asbestos is difficult to establish. The period of time between exposure and disease (latency periods or lag time) differs for specific diseases. For asbestos, dose-response relationships have been developed through epidemiologic studies of workers in settings such as

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[7] U.S. EPA, Water-Related Environmental Fate of 129 Priority Pollutants, EPA-440/4-79-029a, Vol 1, referencing several studies, pp 7-13 – 7-14.

[8] ATSDR: Asbestos, Chemical-Specific Health Consultation: Tremolite Asbestos and Other Related Types of Asbestos, www.atsdr.cdc.gov/asbestos/doc_tremolite.html accessed February 4, 2005, dated September, 2001, Section entitled Occurrence of Tremolite Asbestos.

[9] United States Geological Survey Fact Sheet FS-012-01, March 2001.

[10] ATSDR Toxicological Profile for Asbestos, www.atsdr.cdc.gov/asbestos, p. 143

[11] Tossavainen, Antti, et al, Amphibole Fibres in Chinese Chrysotile Asbestos, Ann Occup Hyg, Vol. 45, No.2, pp 145-152, 2001.

[12] McDonald, AD, et al, Mesothelioma in Quebec Chrysotile Miners and Millers: Epidemiology and Etiology, Ann Occup Hyg, Vol. 41, No.6, pp 707-719, 1997.

[13] ATSDR: Asbestos, Chemical-Specific Health Consultation: Tremolite Asbestos and Other Related Types of Asbestos, www.atsdr.cdc.gov/asbestos/doc_tremolite.html accessed February 4, 2005, dated September, 2001, Section entitled Occurrence in Chrysotile.

manufacturing, ship repair, and construction, where airborne exposure to asbestos was historically extremely high (dust concentrations high enough to prevent reading a newspaper held at arms length are described). Asbestos was not recognized as a carcinogen until the mid-twentieth century because these high concentrations of airborne asbestos caused death from lung fibrosis (asbestosis) within as little as fifteen years, and the latency period for the development of asbestos-related cancer is longer than that, generally 20 years or more from the time of first exposure. Workers in the last half of the century were exposed to progressively lower levels as workplace exposure controls became more common and adverse outcomes decreased. Asbestos exposures required to produce increased rates of lung fibrosis response are higher than those that produce increased rates of cancer. As with any carcinogenic substance, exposure should be minimized to the extent possible.

Both amphibole and serpentine forms of asbestos have produced lethal outcomes in non-occupational as well as occupational exposure settings. There is discussion in the scientific community about the relative importance of asbestos mineral types and size in producing adverse health outcomes.[14,15] It is beyond the scope of this report to attempt to resolve these issues.

The ability of workplace epidemiologic studies to provide precise answers to questions about the relative importance of mineral type and fiber size are limited by changes in manufacturing processes over time, limited environmental sampling data, differences in sampling and analytical methods, and limited descriptions of variables such as fiber size and purity of asbestos mineral type used in the manufacturing process.

The route of exposure for known adverse human health effects is inhalation. Fibers must be airborne to be inhaled, and penetration into the lungs depends on fiber size and shape. Evidence for adverse effects from ingestion is mixed, and the U.S. EPA currently provides no quantitative estimate of carcinogenic risk from oral exposure (ingestion).[16] Transdermal (skin) absorption does not occur. This report focuses on inhalation as the exposure route of interest.

The following health effects discussion is drawn from several Agency for Toxic Substances and Disease Registry (ATSDR) and supporting documents as cited.[17,18]

The risk of adverse health outcomes from inhalation of asbestos is increased for the health effects described below:

- *Malignant mesothelioma* is a cancer of the lining of the lungs (pleura) and abdominal organs (peritoneum). Mesothelioma causes death by local aggressive spread to tissues surrounding the lungs or other organs. The background rate of occurrence may be on the order of 1 - 4 in

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[14] Omowunwi, YO Osinubi, Michael Gochfeld, and Howard M. Kipen, Health Effects of Asbestos and Non-asbestos Fibers, Environmental Health Perspectives, Vol 108, Supplement 4, August 2000, pp 665-674.
[15] Valic, Fedor, The Asbestos Dilemma: 1. Assessment of Risk, www.asbestos-institute.ca/special reports/valic_1_risk_assessment.pdf
[16] U.S. EPA Integrated Risk Information System (IRIS), www.epa.gov/iris/subst/0371.htm, accessed 3/17/05, Section II.A.2. and II.B.
[17] ATSDR Health Consultation, W.R. Grace & Company, Santa Ana Plant and supporting references http://www.atsdr.cdc.gov/naer/santaanaca/hc.html, accessed 4/8/05.
[18] ATSDR Toxicological Profile for Asbestos, www.atsdr.cdc.gov/asbestos

1,000,000 for persons with no known asbestos exposure,[19] but rates as high as 1 in 10 have been reported in insulation workers who were heavily exposed for 20 years or more.[20] Most mesothelioma cases have been attributed to asbestos exposure. Lag time between first exposure and disease averages 20 - 40 years. The disease is invariably fatal, although research into new therapies continues.

- *Lung cancer* or bronchogenic carcinoma is a cancer of the lung airways that also carries a high mortality rate. The mechanism is not completely understood. The risk of lung cancer from smoking and asbestos exposure is more than additive. It has been postulated that smoking inhibits the body's defenses to foreign material in the lungs.[21] Lag time averages 25 – 30 years. While some progress has been made in treatment, lung cancer remains a predominantly fatal disease.
- *Noncancer effects* include asbestosis, scarring and reduced lung function caused by asbestos fibers lodged in the lung; pleural plaques, localized or diffuse areas of thickening of the pleura (lining of the lung); pleural thickening, extensive thickening of the pleura which may restrict breathing; pleural calcification, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and pleural effusions, fluid buildup in the pleural space between the lungs and the chest cavity.[22]

Although several studies have identified increases in cancer of the larynx and various sites in the gastrointestinal tract among heavily-exposed asbestos workers, at this time, the evidence is considered inconclusive.

Some animal toxicology studies indicate that longer asbestos structures (greater than 8-10 μm in length) and amphibole structures may be more potent toxicologically than short structures and serpentine (chrysotile) structures in general.[23] An ATSDR-assembled expert panel has concluded that asbestos structures shorter than 5 μm in length are unlikely to cause cancer in humans.[24]

The most accessible information on health effects from asbestos exposure and many other asbestos issues are available at ATSDR, International Programme on Chemical Safety (IPSC INCHEM), U.S. EPA, and Health Effects Institute (HEI) web sites.[25,26,27,28]

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[19] National Institute for Occupational Safety and Health (NIOSH) Work-Related Lung Disease Surveillance Report, 2002, Table 7.2 estimates for female population, p 161.

[20] Selikoff, Irving J., and E. Cuyler Hammond, editors, "Health Hazards of Asbestos Exposure", Annals of the New York Academy of Sciences, Volume 330, 1979, p. 303.

[21] ATSDR Toxicological Profile for Asbestos, www.atsdr.cdc.gov/asbestos , pp 111-113.

[22] ATSDR Health Consultation, W.R. Grace & Company, Santa Ana Plant and supporting references http://www.atsdr.cdc.gov/naer/santaanaca/hc.html, accessed 4/8/05.

[23] ATSDR Health Consultation, W.R. Grace & Company, Santa Ana Plant and supporting references http://www.atsdr.cdc.gov/naer/santaanaca/hc.html, accessed 4/8/05.

[24] Report on the Expert Panel on Health Effects of Asbestos and Synthetic Vitreous Fibers: The Influence of Fiber Length, http://www.atsdr.cdc.gov/HAC/asbestospanel/index.html , p v-vi., accessed April 8, 2005.

[25] ATSDR Toxicological Profile for Asbestos, www.atsdr.cdc.gov/asbestos

[26] HEI, www.healtheffects.org

[27] IPCS INCHEM, www.inchem.org

[28] U.S. EPA Integrated Risk Information System (IRIS), www.epa.gov/iris/subst/0371.htm

IV. General Information on Asbestos Sample Collection, Preparation and Analysis

Any type of environmental sampling attempts to provide insight into a larger picture of site characterization. Sampling is designed to represent the target area or media of concern by providing information needed to estimate the true distribution of the contaminant in the environment.

Asbestos does not dissolve in most solvents. Therefore, the most practical and accurate way to detect asbestos in environmental samples is by visually inspecting the sample under a microscope. It is tedious, expensive, and introduces potential error through limitations in sampling and analysis. An excess of non-asbestos fibers or other materials may interfere with sample analysis. Early studies carried on in asbestos mining or manufacturing facilities used sample collection and analytical techniques that differ from current practice. Phase contrast light microscopy (PCM) techniques were used for air sample analysis, whereas today, electron microscopy techniques are commonly used. Sampling results from PCM may differ from results analyzed by transmission electron microscopy (TEM). Some air sampling strategies include a combination of PCM and TEM analysis. PCM concentrations are usually expressed as fibers per cubic centimeter (or milliliter) of air (f/cc) and TEM concentrations are usually expressed as structures per cubic centimeter (s/cc) of air.

Transmission electron microscopy (TEM) can detect smaller fibers (less than 0.01 μm in diameter) than PCM, so more thorough data can be collected on fiber length and diameter distribution. PCM cannot reliably differentiate between asbestos and non-asbestos fibers. TEM microscopes equipped with selected area electron diffraction (SAED) and energy dispersive x-ray analysis (EDXA), techniques that analyze crystal structure, can reliably distinguish between asbestos and non-asbestos fibers as well as between different asbestos mineral classes. However, TEM fiber counting accuracy is statistically different from PCM because TEM scans smaller areas at high magnifications. TEM methods are relatively slow and expensive compared to PCM, but may be more useful in samples that are expected to have low concentrations of asbestos relative to non-asbestos fibers.

PCM is generally used to monitor asbestos worker exposures for Occupational Safety and Health Administration (OSHA) compliance purposes.

Polarized light microscopy (PLM) can be used for analysis of bulk materials. Material with 1% asbestos content (expressed as a percentage of asbestos estimated in the visual field) or greater is defined as asbestos containing material (ACM).[29] TEM or PLM can be used to evaluate soil or sand samples in similar manners, although PLM is much more limited in identifying small fibers. Bulk sampling methods are specifically intended for analysis of building materials.

The definition of ACM according to the 1% visual estimation threshold applies to U.S. EPA and Occupational Safety and Health Administration (OSHA) regulations. However, the U.S. EPA Office of Solid Waste and Emergency Response (OSWER) has issued a memorandum that states that risk-based, site-specific action levels should be developed to determine whether or not response actions should be taken when materials containing less than 1% asbestos are found on a

[29] U.S. EPA Method for Determination of Asbestos in Bulk Building Materials, U.S. EPA/600/R-93-116 (7/93 Edition).

site. This is based on data from various sites that suggests that soil/debris containing significantly less than 1 % asbestos can release unacceptable air concentrations of asbestos fibers.[30]

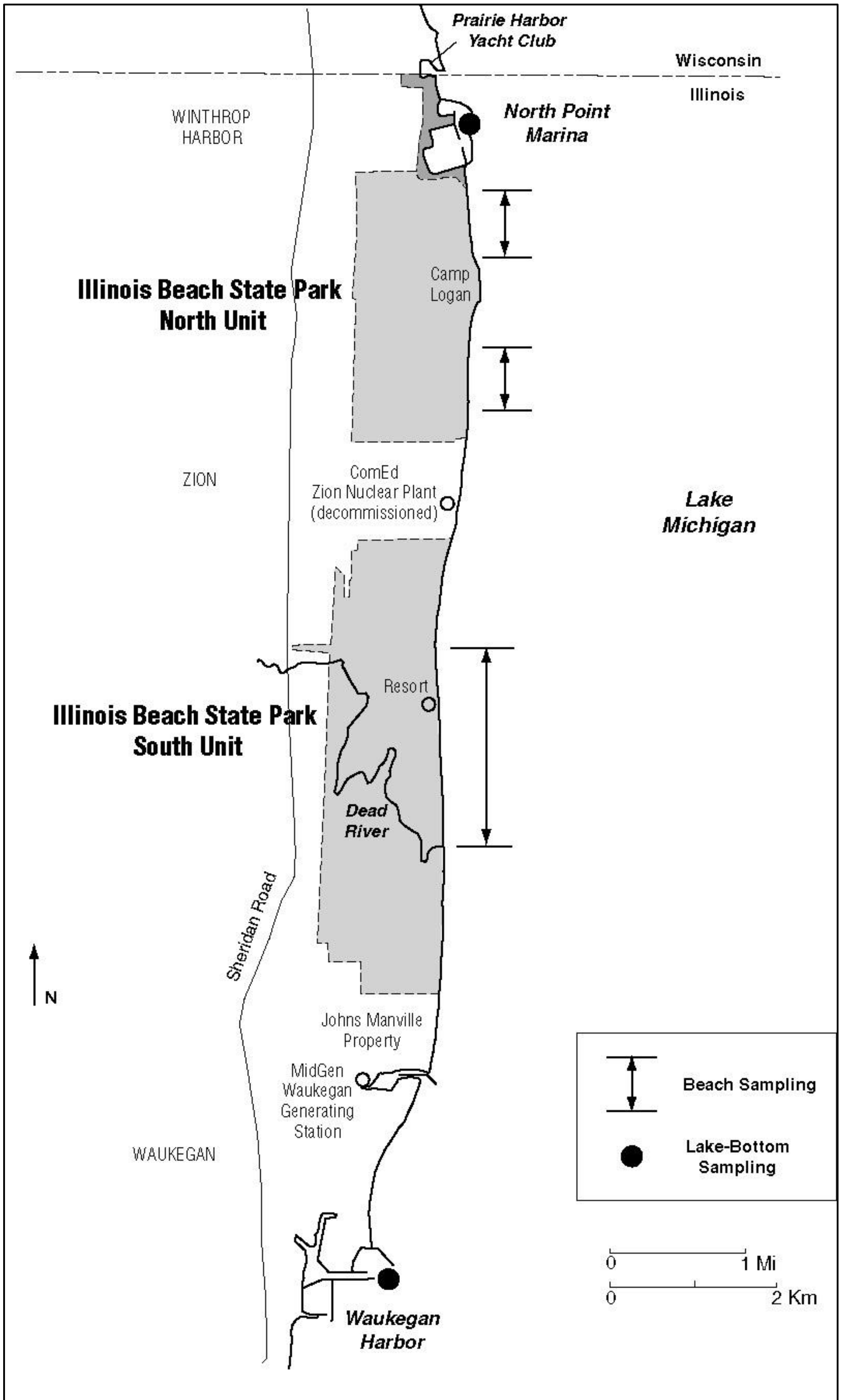
U.S.EPA plans to develop improved sampling and analytical techniques for evaluating asbestos contaminated bulk materials and Superfund sites in order to provide better information about exposure and risk.[31] GLCEEH presumes that a version of the sampling and analytical techniques utilized for this report may be considered for these purposes.[32]

Historic Review of Occurrence of Asbestos Containing Materials (ACM) at IBSP

This section is a review of the important coastal processes at work on the IBSP shoreline and a history of the area relative to the movement of sand and ACM by natural and anthropogenic influences. This section provides insight into potential past and current sources of ACM at IBSP, as well as considerations about potential sources of nourishment sand. Figure 1 provides a visual overview of the vicinity of IBSP to help the reader visualize the locations described in the text of the historic review.

[30] U.S.EPA OSWER 9345.4-05 Memorandum to Superfund National Policy Managers, Regions 1-10, August 10, 2004, p 1-2.
[31] U.S.EPA "Asbestos Project Plan", November, 2005, http://www.epa.gov/asbestos/pubs/asbestosprojectplan.pdf , p 6-7, accessed March 30, 2006.
[32] Superfund Method for the Determination of Releasable Asbestos in Soils and Bulk Materials (US EPA 540-R-97-028, 1997)

Figure 1: Illinois Beach State Park and Vicinity and Sampled Sites



Sampling locations at Illinois Beach State Park and entrances to North Point Marina and Waukegan Harbor.

I. Illinois Coastal Processes

- Waves and Littoral Transport: Waves along the Illinois coast are the primary force for the erosion, transport and redistribution of beach and nearshore sediment (*nearshore* refers to the zone from the shoreline to limit of breaking waves, about 18-foot water depth). For any given year, average wave height is 1.5 to 2 feet, average maximum wave height is 8 feet, and largest storm waves rarely exceed 10 to 12 feet.[33] Because of the overall north-south orientation of the Illinois coast, waves can move beach and nearshore materials either northward or southward along this shore. However, because the northeast quadrant has the greatest fetch (*i.e.*, distance over water that wind can blow and generate waves), northeasterly waves have the greatest influence along the Illinois coast and result in a net littoral transport from north to south. The greatest volume of sediment transport occurs during times of high wave events during fall, winter and spring storms. Minimal transport occurs in summer.[34]
- Beach and Nearshore Ice: Ice forms along the Illinois beaches and nearshore to varying degrees from winter to winter. Typically there are multiple cycles of ice formation, break up, and reformation. Ice along the shore can protect the beach from wave action and any gain or loss of beach sediment. However, waves impacting the lakeward edge of the nearshore ice can cause local lake-bottom erosion. Beach and nearshore sediment that is incorporated into the ice can be transported offshore or along shore if the ice breaks up and begins to drift. Such rafted sediment can have transport pathways very different from typical wave-induced transport. For example, ice-rafted sediment can get around jetties, breakwaters or other coastal obstructions that might not be possible by normal wave-induced transport.[35,36]
- Lake-level Changes: Lake Michigan water level varies annually about one foot due to the annual water budget of the lake. High water occurs in summer and low water in winter. This annual change is superimposed on long-term changes related to meteorological variations in the Great Lakes region. The historical monthly mean lake level has varied as much as 6.3 feet from record high in October 1986 to record low in March 1964.[37] The yearly and multi-year lake-level changes result in shifting of the shoreline and the submergence or emergence of beach area.

II. IBSP History

The IBSP North Unit and South Units are the areas separated by the decommissioned ComEd Zion Nuclear Power Plant. The area now known as IBSP South Unit existed since the 1940s as an undeveloped natural area that was of interest to land conservationists because of its unique natural features. The State of Illinois began purchasing parcels of land in the South Unit in 1948. The Illinois Dunesland Preservation Society was established in 1950 to protect the area. In

[33] U.S. Army Corps of Engineers, 1953, Illinois shore of Lake Michigan, beach erosion control study: 83rd U.S. Congress, 1st Session, House Doc. No. 28, 137 p. plus 21 sheets.
[34] Chrzastowski, Michael J., Coastal geology and coastal engineering of the Illinois Shore of Lake Michigan, Field Trip #6 text, 34th Annual Meeting, Association of Engineering Geologists, Sep 29 – Oct 5, 1991, p 3.
[35] Barnes, Peter, W., Edward W. Kempema, Erik Reimnitz, and Michael McCormick, The influence of ice on southern Lake Michigan coastal erosion: Journal of Great Lakes Research, v. 20, no. 1, pp. 179-195.
[36] Chrzastowski, Michael J., Coastal geology and coastal engineering of the Illinois Shore of Lake Michigan, Field Trip #6 text, 34th Annual Meeting , Association of Engineering Geologists, Sep 29 – Oct 5, 1991, p 5.
[37] U.S. Army Corps of Engineers, 2005, Long-Term Average Min-Max Water Levels: http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/historicdata/longtermaveragemin-maxwaterlevels/ Accessed March 17, 2005.

conjunction with the Department of Conservation (now IDNR), the area south of the Dead River was dedicated in 1964 as the first Illinois nature preserve. The area was not completely free of previous human impact. Beach erosion in 1997 exposed the remains of railroad tracks in the IBSP South Unit that were used in the late 1800s for transporting excavated sand and gravel.[38] The IBSP North Unit, from the Commonwealth Edison Zion Nuclear Power Plant to the Wisconsin border, was acquired by the State of Illinois between 1971 and 1982.[39]

Some or all of the parcels of land in what is now the IBSP North Unit were acquired after erosion of private land caused damage to homes in the 1960s and 1970s. Approximately 140 homes had been constructed after 1954 in a subdivision named Sherman Shores on or near the lakeshore in the Zion and Winthrop Harbor areas. The total number of homes in the general area appears to be somewhat greater. A history of the park suggests that there were at least 400 homes in the acquisition area of the IBSP North Unit, and that there had been several industrial facilities built in the same areas in the early 1900s.[40] A 1958 topographic map highlighted some 175 homes in existence in the general area from the Wisconsin state line to the Camp Logan headland and inland some 3000-4000 feet.[41] Rising lake levels and erosion caused severe damage to some homes. Riprap from various sources was used to protect the shoreline from erosion since at least the 1930s.[42] Attempts to stem the erosion with shore protection had limited success, as evidenced by shore protection still visible in an aerial photograph made in May 2000.[43] One estimate indicated that 129 homes were ultimately destroyed by erosion.[44]

Parts of some of the homes may have subsided into the lake. Apparently, many of these homes had municipal water and sewer connections. It appears that the infrastructure and foundations of some of these homes were not completely removed when the land was acquired or demolition was performed. The remains of foundations, sewer lines, water pipes, sidewalks and building materials including siding, roofing, and floor tile, have been exposed by erosion over the years or have washed onto the shore.[45]

In 1987, IDNR began the development of the North Point Marina in the area where some of the homes had been located. It was understood at the time that the marina would change the erosion

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[38] Chrzastowski, M. J. and W. T. Frankie, 2000, Guide to the geology of Illinois Beach State Park and the Zion beach-ridge plain, Lake County, Illinois: Illinois State Geological Survey, Field Trip Guidebook 2000C, Champaign, photograph, p 56.
[39] www.dnr.state.il.us/lands/landmgt/PARKS/R2/ILBEACH.HTM#History, accessed March 1, 2005.
[40] Bannon-Nilles, Phyllis L., A Park in the Making: the History of the Development of Illinois Beach State Park, Illinois Department of Natural Resources, Open File Series 2003-8, page 7.
[41] Chrzastowski, M. J., Geology of the Zion Beach-Ridge Plain Field Trip Guidebook for the Great Lakes Section Annual Field Conference, September 14-16, 2001; printed by Illinois State Geological Survey. p 27.
[42] Bannon-Nilles, Phyllis L., A Park in the Making: the History of the Development of Illinois Beach State Park, Illinois Department of Natural Resources, Open File Series 2003-8, page 6-7.
[43] Chrzastowski, M. J. and W. T. Frankie, 2000, Guide to the geology of Illinois Beach State Park and the Zion beach-ridge plain, Lake County, Illinois: Illinois State Geological Survey, Field Trip Guidebook 2000C, Champaign, photographs, p 42 and 44.
[44] Bauer, Robert A., presentation to IDNR on March 18, 1998.
[45] Chrzastowski, M. J., Geology of the Zion Beach-Ridge Plain Field Trip Guidebook for the Great Lakes Section Annual Field Conference, September 14-16, 2001; printed by Illinois State Geological Survey. p 27-28.

dynamics and concentrate erosion just south of the marina.[46] Plans were made to place material from the marina excavation into a ‘feeder beach’ area just south of the marina. Between 1987 and 1989, the excavation and dredging of the 72-acre basin for North Point Marina involved removal of an estimated 1.5 million cubic yards (yds^3) of sand and gravelly sand by slurry-pipe discharge.[47]

The sand and gravelly sand from the dredging of the North Point Marina was placed on the shore immediately south of the marina. By taking advantage of the naturally occurring net southward transport of littoral sand, the sand eroded and was transported to nourish the state park shoreline to the south. This feeder beach subsequently became known as the “North Unit” feeder beach because an additional feeder beach was established at the north end of the IBSP South Unit. The purpose of the South Unit feeder beach was to provide nourishment to the state park’s main swimming beach. The South Unit feeder beach was short-lived. All imported sand at the South Unit site was dispersed within a year of placement.

Table 1 details the estimated North Unit Feeder Beach sand volume from 1987 to the present.

Table 1: Feeder Beach Sand Volume[48]

Year	Added (yd3)	Source	Lost (yd3)	Lost to	Balance (yd3)
1987-89	1,500,000	NPM Dredging	295,100	NPM parking[a]	1,204,900
1987-89			35,400	Emergency pile[b]	1,169,500
1988-89			168,600	2 years of erosion	1,000,900
1990	150,000	Prairie Harbor[c]			1,150,900
1990-93			337,200	4 years of erosion	813,700
1994	32,000	Quarry pea gravel[d]			845,700
1995	46,000	Waukegan Generating Station sand pile[e]			891,700
1994-95			168,600	2 years of erosion	723,100
1997	20,000	Quarry pea gravel[f]			743,100
1996-2001			505,800	6 years of erosion	237,300
2001	40,000	Approach Channel, Waukegan Harbor[g]			277,300
2002	40,000	Approach Channel, Waukegan Harbor[g]			317,300
2002-2004			252,900	3 years of erosion	64,400
2005			50,000	1 year of erosion	14,400
2005	25,000	Quarry sand (projected)			39,400
2005		Balance			39,400

[46] Moffatt & Nichol, Engineers, 250 W. Wardlow Road, Long Beach, CA 90807, Potential impacts of the Illinois Beach State Park Marina on littoral processes, report prepared for Epstein Civil Engineering, Inc., 600 W. Fulton St., Chicago, IL 60606-1199, p E-15 – E-16.
[47] Chrzastowski, Michael J., Coastal geology and coastal engineering of the Illinois Shore of Lake Michigan, Field Trip #6 text, 34th Annual Meeting , Association of Engineering Geologists, Sep 29 – Oct 5, 1991, p 10, Figure 4.
[48] Foyle, Anthony M., MJ Chrzastowski, and CB Trask, Erosion and Accretion Trends Along the Lake Michigan Shore at North Point Marina and Illinois Beach State Park, Illinois State Geological Survey, March, 1998, adapted from Table G-1, p 88 and current information.

[a] 295,100 yds^3 was used for construction of the Marina south parking area after a change in project plan. This necessitated the defense of the parking area from any shore erosion and eliminating it from the extent of the feeder beach.
[b] 35,400 yds^3 was piled further west to serve as an available source of emergency sand if storms or other natural occurrences caused large erosion events to occur.
[c] By late 1989 there was a recognized need to obtain additional sand for this feeder beach. In the summer of 1990, 150,000 yds^3 was obtained from dredging at the Prairie Harbor Yacht Club, which is on the Wisconsin shore immediately north of North Point Marina. That marina was then under new management and had dredged to expand its basin.
[d] In the summer of 1994, 32,000 yds^3 of pea gravel purchased from a Lake County sand/gravel pit was placed on the Feeder Beach. Pea gravel was used to provide a slightly coarser material to the beach and thus provide a longer residence time.
[e] In July and December 1995, a total of approximately 46,000 yds^3 was supplied from the stockpile of dredged sand at the Waukegan Generating Station owned by Commonwealth Edison Company (presently owned by Midwest Generation Co.). The 1995 nourishment was the only documented use of sand obtained from the power plant dredging on the North Unit feeder beach.
[f] 20,000 yds^3 of pea gravel was purchased from a Lake County sand/gravel pit in 1997. This was last time that pea gravel was supplied to the feeder beach, because it was later determined to be detrimental to some of the plant communities on the beach.
[g] There is no record on file at the Illinois State Geological Survey of sand supplied directly to the feeder beach since 1997. Sand has been supplied to the nearshore area by slurry pipe from dredging at the entrance to North Point Marina. The most recent major source of nourishment sand in recent years (2001-2002) is dredged sand from the Advanced Maintenance Area and Approach Channel for Waukegan Harbor that was placed just off shore at IBSP through an arrangement between IDNR, IEPA, and US Army Corp of Engineers Chicago District. Although some of the sand from these two sources probably washed ashore for a short amount of time, as with all of the sand along this beach and across the shallow lake bottom, residence time is short. Wave action quickly moves it southward. There was additional loss of sand from across the shallow lake bottom in front of the feeder beach.

III. Potential Sources of ACM at IBSP

Potential sources of ACM at IBSP beaches were listed in the June, 2000 ATSDR Public Health Assessment of Illinois Beach State Park,[49] and are included in this report along with supplementary information. The potential sources include:

1. The remains of residential homes and infrastructure in and around the IBSP North Unit as described in the IBSP history section above. Some components of these homes and infrastructure may have contained ACM.
2. The former Johns-Manville asbestos-product manufacturing site.[50] The plant is closed and has been demolished. There is a Superfund site located within the former Johns-Manville property, and this site is located on the south border of IBSP's Nature Preserve. Johns-Manville manufactured roofing, flooring, insulation, and other building materials, some of which contained asbestos, between 1922 and 1986.[51] Transite pipe was also manufactured at

[49] U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment for Illinois Beach State Park, CERCLIS No. ILD984840140, June 16, 2000.
[50] U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment for Illinois Beach State Park, CERCLIS No. ILD984840140, June 16, 2000.
[51] Answer to Second Amended Complaint for Injunctive and Other Relief in People vs. Johns Manville, filed October 30, 2001, Count 1, Item 5.

the facility.[52] The Superfund site covers some 120 acres within the property. A section of the site includes waste materials that are capped by 24 inches of soil cover, and a 33-acre settling basin that contains manufacturing waste products. The U.S. EPA is responsible for inspecting the integrity of the soil cover and has made plans for remediation of the settling basin. U.S. EPA is monitoring the site and verified the integrity of the site after the 1998 discoveries of ACM in the area. The U.S. EPA has also sent divers offshore of the property to ascertain whether offshore ACM pockets were present near the site.[53,54] No offshore pockets of ACM were found. ACM has been found in seven onshore pockets that were partially or wholly outside of and adjacent to the property line of the facility.[55]

3. Several former rifle range berms for the Pan-American Games of 1959 were built on City of Waukegan property between the Johns-Manville property the Midwest Generation property. Factory waste material was apparently donated by Johns-Manville to the U.S. Army for the construction of the berms.[56,57] Aerial photographs indicate that two of the berms were located near the shore where subsequent shore erosion occurred.[58] Lake forces may have transported the materials to other nearby areas.
4. Sand dredged from the cooling water channel at the Midwest Generation coal-fired power plant and stockpiled on the property. The cooling water channel, which is located just south of the Johns-Manville and Waukegan property described above, may have intercepted ACM from other sources. This sand was used for beach nourishment sand when it was deposited on the IBSP North Unit feeder beach in 1995. ACM products have been found on Midwest Generation property and in the sand dredged from the cooling water channel.[59] The beach nourishment sand from this sand pile may have contained ACM.[60] Manufactured materials, including a large brake shoe, were visible in the dredged sand stockpile during a September 18, 2003 Task Force site visit.
5. Miscellaneous other local sources. An unconfirmed source was part of a sand stockpile at the Prairie Harbor Yacht Club, used in 1990 for beach nourishment. Subsequent visual examination of the stockpile by IDNR indicated that transite-like materials were mixed with the stockpile and rocks used to armor the beach against erosion.[61] Sampling results for these materials are unavailable. There have been other reports of ACM (transite-like pipe) being found along the lakeshore north of Kenosha Harbor.[62] During sampling performed for this study in 2004, a small (approximately 2 inch square) piece of transite-like material was found

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[52] Monthly Johns-Manville newsletter to employees, circa 1953, pp 13-21.
[53] Comments by William Muno, U.S. EPA Director Superfund Division, at a meeting hosted by the Illinois Attorney General's Office on July 11, 2003.
[54] Chicago Tribune article, July 23, 1999, Sec. 2, p 7.
[55] First Amended Consent Decree entered in US and State of Illinois v. Johns Manville entered in federal district court on December 17, 2004, page 7 and Exhibit 4.
[56] U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment for Illinois Beach State Park, CERCLIS No. ILD984840140, June 16, 2000.
[57] Chicago Tribune article, Sec 2, July 10, 2002.
[58] Aerial photographs provided by Illinois State Geological Survey, #1-7, dated May, 1956 through June, 1970.
[59] Chicago Tribune article, July 23, 1999, Sec. 2, p 7.
[60] U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment for Illinois Beach State Park, CERCLIS No. ILD984840140, June 16, 2000.
[61] Davis, Steve, IDNR and Chrzastowski, Michael J., ISGS, presentation for the Task Force on September 5, 2003.
[62] Waukegan News Sun article, February 10, 1998.

at Grant Park Beach in South Milwaukee. This item was tested by UAS, Inc. and was positive for asbestos content > 1% (analytical results included in Appendix C).

IV. Specific ACM Occurrences at IBSP

IDNR provided GLCEEH with copies of several reports generated in 1998 and 2000 by consultants to IDNR. Photographs and descriptions from one report illustrate several findings of large diameter (approximately 6 - 12 inch) ACM pipes several feet in length with transite-like aspects.[63] A subsequent report indicates approximately 3.5 - 4 cubic yards of ACM was removed during eight site visits from May 8 through September 21, 1998,[64] a span of about 20 weeks.

IDNR also provided GLCEEH with reports from an IDNR environmental consulting firm that was hired to perform beach surveys and pickup of ACM from IBSP and nearby beaches at the former Zion power plant and Johns-Manville, in the summer of 2004. In the approximately 11-week period from July 2, 2004 through September 10, 2004, 308 pieces of material were picked up. Most of these pieces were small, on the order of a few square inches. Of the 308 pieces of material, 63 pieces were tested for asbestos and 23 were positive. 245 pieces were assumed positive, apparently based on experience or prior testing of similar materials.

If the untested pieces were all positive, there were 268 pieces of ACM, or an average of about 24 pieces of ACM found per week along the 7-mile shoreline extending from the North Point Marina to the beach adjacent to Johns-Manville property. Based on descriptions of locations where items were found, the pieces (including non-asbestos materials) were distributed relatively evenly from north to south along the shore. Excluding 22 pieces of non-asbestos fireworks wrapping paper, 80 pieces of material were found from the Feeder Beach to the Sailing Beach, 73 in the vicinity of the former Zion Power Plant, 59 from the IBSP South Unit park office up to the Dead River, and 62 from the Dead River south through the beach adjacent to Johns-Manville property. The location descriptions of a few pieces were not specific enough to add to this total.

230 pieces (74.3%) of all materials found were listed as transite or transite-like material, mostly gray in color, but including pieces that were white, black, green, beige and red.[65] The breakdown of materials is listed in Table 2.

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[63] Hanson Engineers, Inc., Sampling for Asbestos Material, Oversight of Asbestos Removal Activities at Illinois Beach State Park, Volume II, May, 1998, Appendix B.
[64] Hanson Engineers, Inc., Asbestos Removal and Abatement Activities at Illinois Beach State Park, October 21, 1998, pp 1-3 thru 1-18.
[65] Asbestos Beach Survey Reports prepared for Illinois Department of Natural Resources by Carnow, Conibear & Associates, dated July 7, July 12, August 17, and September 16, 2004.

Table 2: Materials found at IBSP Beaches in Asbestos Surveys, Summer, 2004

Materials Type	# of Pieces	% of Total Materials Found	% Known or Presumed ACM	% Known Negative for Asbestos
Transite or transite-like materials[1] 131 small[2], 86 medium[3], 6 large[4] pieces	224	72.4 %	99.6 %	0.4 %
Transite or transite-like materials (curved), 4 medium, 2 large pieces	6	1.9 %	100 %	0 %
Flooring material (including tiles and mastic)	36	11.7 %	76 %	24 %
Paper-like materials (presumed insulation)	25	8.1 %	8.0 %	92.0 %
Roofing material and tar	5	1.6 %	0 %	100 %
Wallboard material	4	1.3 %	100 %	0 %
Miscellaneous	2	0.6 %	50.0 %	50.0 %
Unknown (undescribed)	6	1.9 %	50.0 %	50.0 %

[1] This grouping may include pieces of transite water or sewer pipe material because small pieces of large diameter pipe may appear to be flat. Six additional items were reported as curved.
[2] Palm size or smaller
[3] Hand size or smaller
[4] Larger than hand

Most of the pieces of ACM or apparent ACM found in 11 weeks in 2004 were described as small or medium in size. Assuming that the average size was 6 inches by 6 inches or smaller, the total area of the ACM that was found would be about 50 ft^2 (assuming an average thickness of about 3/4-inch, the materials would have a volume of about 3 ft^3 or 0.12 yd^3). Siding on a single small home or 12-inch diameter pipe that is 320 feet in length could produce 1000 ft^2 of material.

The high percentage of transite-like materials suggests that housing and construction materials were the source of most of the material found on the beaches in 2004. Information about findings in previous years indicates that both housing and non-housing items, including transite, siding, water and sewer pipe material, gaskets, and some brake pads, were found.[66]

The materials found contained asbestos bound in a matrix. Descriptions of materials found in and around the park indicated that some pieces were worn smooth from apparent wave action as well as normal deterioration from age and weather. 'Friable' (meaning that the material can be crumbled with hand pressure)[67] materials pose a higher likelihood of inhalation exposure from handling than materials with asbestos bound in a matrix. One piece of friable material was

[66] Comments by Steve Davis, Manager of Remediation Projects, IDNR, at a meeting hosted by the Illinois Attorney General's Office on July 11, 2003.
[67] OSHA Standard 29 CFR 1910.1001 App G, I. C.

reportedly found by IDNR before 2004[68] and three small pieces of friable material were found in July of 2004.[69]

As mentioned earlier, one of the goals of this report was to evaluate whether or not deterioration of ACM has resulted in higher concentrations of asbestos structures in IBSP sand and potential nourishment sand sources than that found in background areas. It is possible that ACM in and around the lakeshore environment deteriorates and generates fibers over time. The potential for inhalation exposure is greatly reduced if the deterioration occurs in water.

V. Potential Sources of Sand for Beach Nutrition

IBSP currently requires 80,000 - 100,000 cubic yards (yd^3) of sand per year for beach nourishment. IBSP undergoes continual erosion along most of the shoreline in the North Unit, and to a lesser extent, in the South Unit. The natural erosion trends near the north end of IBSP have been amplified because development along the shoreline north of the area has cut the supply of natural sand and man-made harbors intercept some of the supply that is available. In some areas, particularly south of the North Point Marina, the erosion rate can be on the order of 10 feet per year. Much of the erosion occurs during inclement weather and/or during winter months. The erosion is a natural phenomenon, and eroded materials ultimately move in a southward direction due to dominant wave forces.[70] Without human intervention, many of the unique features of the Park would undergo dramatic damage or would be washed away completely by erosion.

In previous years, IDNR has obtained nourishment sand from several sources. The most recent major source (2001-2002) was dredged sand from the Advanced Maintenance Area and Approach Channel for Waukegan Harbor. The dredged sand was placed about 400-800 feet off shore at IBSP through an arrangement between IDNR, IEPA, and the US Army Corp of Engineers Chicago District and pursuant to applicable permit requirements. This source provided 40,000 to 50,000 yd^3 per year for two years, representing about 50% of the annual sand 'budget' required to maintain a balanced sediment budget at IBSP. The dredged sand underwent a standard characterization before dredging. The sampling was performed under a standard protocol developed by the Corp for mechanical (vs. hydraulic) dredging. The sediments (lake-bottom sand) have been tested with bulk sampling methods for asbestos since 1997, and results obtained for 2002 indicated most samples were below the analytical limits of the method. There were traces of asbestos in one of nineteen lake-bottom sand sub-samples analyzed by PLM and one of four composite samples (from the nineteen sub-samples) analyzed by TEM.[71] No visible ACM has been reported in this dredged sand. In 2003, the dredged sand was placed in a designated open-water disposal area south of Waukegan Harbor instead of IBSP. The Approach

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[68] Personal communication with Steve Davis of IDNR on August 7, 2003.
[69] Asbestos Beach Survey Report prepared for Illinois Department of Natural Resources by Carnow, Conibear & Associates, dated August 17, 2004, Appendix B.
[70] Chrzastowski, Michael J., notes from a presentation for the Task Force on September 5, 2003, and Chrzastowski, M. J., Geology of the Zion Beach-Ridge Plain Field Trip Guidebook for the Great Lakes Section Annual Field Conference, September 14-16, 2001; printed by Illinois State Geological Survey.
[71] U. S. Army Corp of Engineers, Chicago District, Contaminant Determination for Waukegan Harbor Advanced Maintenance Area Dredging and Open Water Disposal, December, 2002, and Quality Assurance Project Plan/Field Sampling Plan for Advanced Maintenance Area and Approach Channel Sampling, Waukegan Harbor, September 16, 2002.

Channel was sampled for this study because it is the largest and most practical source of nourishment sand for IBSP.

Another nourishment sand source includes a large (no volume estimates available) stockpile of dredged sand from the cooling-water intake channel at the Midwest Generation (formerly Commonwealth Edison) power plant south of the Park. In September 2003, Midwest Generation representatives reported that the dredging sediment source for this stockpile was characterized for asbestos in the previous two years, and the results were below analytical limits of detection. This sand was dredged from an area that was near one of the seven pockets (Site 2) of ACM found outside the Johns-Manville property[72] and was relatively close to the 1959 Pan-Am Games shooting range berm location. This stockpile may contain ACM. This site was not sampled for this study, though a limited number of samples were previously collected at the sand pile for another study.[73] Consideration of this sand pile for usage as nourishment sand is pending resolution of asbestos and regulatory issues.

A third source of nourishment sand is the emergency stockpile that was created during the construction of the North Point Marina. This sand was characterized in 2000 for some parameters during a pilot study of sand screening. The purpose of the study was to determine the feasibility of mechanically screening the sand stockpile. The study indicated that screening was feasible and did not generate airborne asbestos levels greater than background levels at the site perimeter. Air sampling results near the process indicated that airborne asbestos concentrations were below occupational exposure limits. The maximum possible asbestos content of bulk materials in the sand before screening was estimated to be 0.0020%, assuming that all materials filtered by the screens were ACM, which is unlikely because of rocks and other debris in the sand. Twenty sand samples were analyzed after treatment; eighteen of these samples were analyzed with PLM and two were analyzed with TEM. No asbestos was detected in these samples.[74] However, the purpose of the pilot study of sand screening was to evaluate feasibility and not to characterize the contamination level of the screened sand. Consideration of this sand pile for usage as nourishment sand is pending resolution of asbestos and regulatory issues.

A smaller, but sustained source of sand is available from periodic dredging of the North Point Marina. This beach nourishment source was sampled for this study.

Other sources of nourishment sand have been considered and rejected by IDNR for various reasons in the past. One potential source was a McHenry County sand and gravel pit. Ten samples were collected in 1998 and analyzed by PLM. One sample had a trace amount of asbestos.[75] Another potential source was a sand stockpile at the Prairie Harbor Yacht Club, which was used in the past. Past visual examination at this site by IDNR indicated that materials with a transite-like appearance were present in the sand stockpile.[76]

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[72] First Amended Consent Decree entered in US and State of Illinois v. Johns Manville entered in federal district court on December 17, 2004, page 7 and Exhibit 4.

[73] Berman, et al, Waukegan Park District: An Evaluation of Offsite Asbestos and Air Pollutants and Their Potential Effect on Visitors to the Proposed Sports Complex in Waukegan, Illinois. p 5-6.

[74] Hanson Engineers, Inc., Report of Findings: Pilot Study for Sand Processing, February, 2000.

[75] Hanson Engineers, Inc., Asbestos Removal and Abatement Activities: Illinois Beach State Park, October 21, 1998, p 5-19.

[76] Chrzastowski, Michael J. presentation to the Task Force on September 5, 2003.

Previous Environmental Sampling

I. Air Sampling

Air sampling is generally the most useful measure of potential asbestos exposure. Several sets of air samples have been collected in and around IBSP for different evaluation purposes. A summary of previous findings is presented for informational purposes. The Occupational Safety and Health Administration Permissible Exposure Limit (8-hour Time Weighted Average) for asbestos is 0.1 fibers/cubic centimeter of air (f/cc) and the excursion limit for any 30 minute sampling period is 1.0 f/cc[77] (based on PCM analysis using the National Institute of Occupational Safety and Health (NIOSH) Method 7400 and counting fibers greater than 5 µm in length with an aspect ratio greater than 3:1).[78] Excursion samples are useful for assessing short-term activities that may result in increased exposure.

There is no current threshold for non-occupational airborne exposure to asbestos. Occupational exposure limits are presented for comparison purposes only and should not be considered to be an acceptable threshold for non-occupational exposures. At this time, risk assessments based on air sampling results are usually performed to estimate acceptable non-occupational exposure levels.

The useful information provided by a sample result is limited by the sampling method's detection limit and the sample analytical limits. The sample analytical limits are influenced by the method and the amount of sample collected. The analytical limits are the lowest concentration that can be determined to be statistically different from a blank (unexposed) sample. In the case of air sampling for asbestos, the analytical limit is influenced by the number of filter grids or fields examined, and the counting rules. The counting rules specify when the microscopist can stop examining new areas of the filter because additional information will not change the calculated count of the total filter.

The PCM Method 7400 estimated detection limit is expressed in the method description as 7 fibers/mm^2 of filter area. The actual limit of detection (LOD) must be calculated from the analytical limit and the sample volume.[79] In addition, the Evaluation of Method states that lower levels (fiber counts below 78.5 total in 100 counted fields) generally result in an overestimate of the fiber count when compared to results in the recommended analytical range.[80] For illustration, in the PCM results described below, the highest concentration reported was 0.06 f/cc (LOD = 0.036), calculated from a 30-minute excursion sample where a total of 10 fibers were counted in 100 counted fields.

The PCM samples presented below and listed in Appendix D were collected to evaluate OSHA compliance and appear to be appropriate for that purpose. However, the LODs were not

[77] Code of Federal Regulations, Title 29, Part 1910.1001, (c) General Industry Standards, Permissible Exposure Limits (PEL).
[78] Asbestos and Other Fibers by PCM, 7400, NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/15/94.
[79] Asbestos and Other Fibers by PCM, 7400, NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/15/94.
[80] Asbestos and Other Fibers by PCM, 7400, NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/15/94, Evaluation of Method section.

consistently reported. GLCEEH re-calculated the LODs according to the sampled volume information provided in the reports. The LODs were calculated using 2 decimal places (which was equal to or more than the significant digits in the sample volume calculations). The calculated concentrations are presented below and in Table D-1.

The LOD for TEM results is calculated by assuming one confirmed asbestos fiber above 95% of the expected mean blank value,[81] and factoring in the sample volume and number of grid openings analyzed. These results are presented in the text below and in Table D-2 as reported.

The first set of air samples was collected to evaluate ACM discoveries in 1998. These were made to evaluate potential hazards to IBSP visitors. Twelve 4-hour area air samples were collected with aggressive agitation of sand and analyzed with TEM. No asbestos was found at the LOD of 0.005 structures/cubic centimeter of air (s/cc). In addition, twelve 30 to 225 minute personal PCM samples were collected on workers during pickup and removal of ACM. Eleven of the PCM results were less than the LOD, and the remaining sample result was 0.06 fibers/cc (f/cc).[82]

The second set of air samples was collected in August and September 1998. Four short-term (13-45 minute) area, one 30 minute personal, and one full-shift (8-hour) personal PCM air samples were collected during pickup and removal of large diameter ACM pipe. All results were less than the LOD.[83]

A third set of air samples was collected during the sand screening pilot study. The screening study involved digging ten different 10 cubic yard test pits (about 30,000 pounds each) from the emergency sand stockpile from the North Point Marina excavation. The sand was excavated by backhoe/front-end loader and transported to a vibratory screen unit that separated solids from sand at several screen sizes. Fifty-eight work area perimeter samples were collected over 4 to 8-hour periods over 3 days and analyzed by PCM, along with 20 background samples, 10 collected the day before and 10 collected the day after the pilot screening. All of the area samples were less than the LOD. Fifteen excursion (30 minute) samples and eighteen 8-hour personal PCM air samples were collected on the pilot study workers. All of the excursion (30-minute) samples were below the LOD. Thirteen of the eighteen 8-hour personal samples were below the LOD. Of the five remaining samples, three had concentrations of 0.01 f/cc and two had concentrations of 0.02 f/cc. Six 8-hour perimeter TEM air samples were also collected, with all results less than the limit of detection of 0.007 structures/cc.[84]

A fourth set of air samples was collected near the fishing pier located south of IBSP and Johns-Manville property. These samples were collected to evaluate the effectiveness of asbestos removal in the public fishing area located between the Johns-Manville site and the Midwest Generation plant. Thirty-eight samples were collected with a high volume pump (10 liters/minute) for approximately 5-8 hours (one was 30 hours) over the course of two days with aggressive sampling techniques and near fairly active human and vehicle movement. Thirty-six

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[81] Asbestos by TEM, 7402, NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/15/94.
[82] Hanson Engineers, Inc., Sampling for Asbestos Material, Oversight of Asbestos Removal Activities at Illinois Beach State Park, Volume I, May, 1998
[83] Hanson Engineers, Inc., Asbestos Removal and Abatement Activities at Illinois Beach State Park, October, 1998.
[84] Hanson Engineers, Inc., Report of Findings: Pilot Study for Sand Processing, February, 2000.

samples were below the limit of detection of 0.0016-0.0024 structures/cc with TEM analysis, and the other two had concentrations of 0.0017 and 0.0041 structures/cc respectively. A screening risk assessment was performed on the two positive samples, indicating risk levels well below U.S. EPA acceptable risk factors.[85]

A fifth group of air samples consisted of several sets of samples collected during beach sweeps in the summer of 2004. Personal samples were generally collected for compliance monitoring of personnel while performing surveys. Personal air samples for various working days of approximately 8 hours were collected and analyzed with PCM, and results were reported as 0.0019 - 0.0061 f/cc. The actual detection limits, quantifiable ranges and other sampling information were not included with the reports, but these samples appear to be below the limit of quantification. Five area air samples were collected on August 6, 2004 for approximately 7 hours and analyzed with TEM, and all were below the detection limit of 0.004 – 0.005 structures/cc. Two personal air samples were collected, one for 6 hours and one for 1 hour on the same employee while he apparently simulated typical beach activities such as building a sand castle, digging, walking, and laying in the sand. This worker did not handle ACM during this period.[86] The samples were analyzed with TEM, and results for the 6-hour sample were 0.005 structures/cc, reported as equivalent to the reported limit of detection (apparently, one fiber was detected). The 1-hour sample result was reported as below the LOD for that sample of 0.058 structures/cc.[87]

In summary 61 area and 2 personal air samples were collected at IBSP or near the Midwest Generation fishing pier by environmental contractors for IDNR or U.S.EPA and analyzed with TEM. The results indicate non-detectable concentrations on most (60 of 63) samples and concentrations (0.0017 to 0.005 s/cc, at or just above the LOD) on three samples analyzed by TEM. Personal monitoring of workers and analysis with PCM indicate asbestos concentrations (0.01 to 0.06 f/cc, above the LOD) on 6 of 123 samples collected. One of these six samples was collected on a worker during remediation of ACM and the other five were on workers close to the sand screening operation.

A complete listing of air sampling results collected at IBSP and near the Midwest Generation fishing pier is presented in Appendix D. The compilation of all air sample results indicates that no air samples (including full-shift samples, short term excursion samples, and intermediate length personal and area samples) exceeded the Occupational Safety and Health Administration Permissible Exposure Limit of 0.1 f/cc for an 8-hour Time Weighted Average or the Excursion Level (30-minute) of 1.0 f/cc using the PCM analytical method.[88] The air samples were collected under a variety of conditions and activities. Many of the air samples were collected while workers handled ACM during ACM pickup or abatement activities or while working close to sand screening operations that included agitation of large amounts of sand.

[85] Waukegan Asbestos Site, Waukegan, Illinois, Supplement to Response Engineering and Analytical Contract (REAC) Report Dated 29 July 2003.
[86] Personal communication, Carnow Conibear and Associates, Ltd, Field Supervisor, March 23, 2005.
[87] Asbestos Beach Survey Reports prepared for Illinois Department of Natural Resources by Carnow, Conibear & Associates, dated July 7, July 12, August 17, and September 16, 2004.
[88] Code of Federal Regulations, Title 29, Part 1910.1001, (c) General Industry Standards, Permissible Exposure Limits (PEL).

II. Sand Sampling

In early 1998, 173 sand samples were systematically collected at IBSP and analyzed by PLM methods for bulk samples. 165 of these samples were below the limit of detection for asbestos, and eight samples were less than 1% asbestos. Twenty-four sand samples were analyzed by TEM. Nine of these samples were below the limit of detection, thirteen of the samples were less than 1% asbestos, one had a trace amount of asbestos, and one was a core sample that identified ACM in a roadbed adjacent to Johns-Manville property.

Environmental Assessment of Asbestos in Sand

I. Rationale

One of the questions of interest regarding ACM contamination at IBSP was whether or not ACM was deteriorating from natural forces and contaminating beach sand with asbestos structures in areas where no ACM was visibly present. GLCEEH reviewed the analytical techniques and results of air sampling and other testing previously performed on beach sand and nourishment sand sources as referenced above. Although the bulk methods that were used are standard methods for characterizing ACM, the sample preparation and analytical techniques of these methods do not have sufficient analytical sensitivity for quantitative characterization of sand and soil. In order to perform the comparisons required to meet the goals of this study, it was necessary to define concentration distributions and to statistically compare potential beach nourishment sources with background levels and current levels of asbestos on the IBSP beaches.

II. Sampling Design

Sampling for asbestos structures was conducted in two lake-bottom sources of sand for beach nutrition, three comparison background locations, and the two IBSP (North and South) Units for a total of seven distinct areas. In order to perform a statistical comparison of potentially contaminated vs. non-contaminated sources, quantification of concentration and sufficient independent sample collection was needed to provide an assessment of variability of distribution. In order to obtain sufficient quantification of concentration, GLCEEH developed a study design that included collection of twelve independent samples in each of the seven areas.

Twelve samples were collected per area in order to provide relatively robust sampling for statistical comparison purposes. Power calculations suggest that 12 samples is a reasonable number to use to estimate the average concentration of asbestos at a defined location. GLCEEH estimated that 12 samples would be sufficient to define the mean concentration for each site with a 95% confidence and 30% maximum relative error and to provide a basis of comparison to potential sources of sand for beach nourishment.[89]

III. Analytical Methods

In order to allow comparison between areas and samples, a sensitive method was needed to detect low concentrations of asbestos. GLCEEH utilized the sampling numbers, protocols, and methods as described below. The method that was chosen differs from traditional methods for analyzing soil and sand, primarily because of the way the samples are prepared. The preparation

[89] Gilbert, Richard O., Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, NY, NY, 1987, p 33.

includes aggressive agitation of samples in a stream of air in a dust generator. The air stream then passes through a vertical elutriator that concentrates the asbestos by separating the respirable fraction (PM_{10}), defined as particulate matter that has an aerodynamic diameter of 10 μm or less, from the rest of the sample. The respirable fraction is captured on a filter, which is weighed and prepared for TEM analysis.

The advantage to this method is the use of a credible physical sample preparation method for releasing and quantifying releasable asbestos structures from sand. The results are reported in units of measurement (asbestos structures per gram of PM_{10}), which is relevant to the inhalation route of exposure. A variety of PM_{10} models are available that estimate emissions from certain activities or conditions.

The disadvantage of this method is that the reported concentrations of asbestos structures are a function of PM_{10} content of the sample instead of the total mass of the sample. Therefore, total PM_{10} content in the sample may be a consideration for interpretation of results, depending on the purpose of a given application.

Sample preparation and analysis was performed using the current iteration of the technique known as the Superfund Method for the Determination of Releasable Asbestos in Soils and Bulk Materials (US EPA 540-R-97-028, 1997) and modified in the Draft Modified Elutriator Method for the Determination of Asbestos in Soils and Bulk Material.[90] The method was further modified for this study because very low amounts of PM_{10} were present in the beach sand samples. In order to collect sufficient sample for appropriate analysis, the originators of the method modified it and tested the modification. In short, the elutriator main exit (ME) opening was utilized for sample collection instead of using the isokinetic sampling port. The method designers believed that a test for uniformity of distribution should be made to ensure that the airflow pattern at the ME opening would provide uniform distribution on sample collection filters. The test concluded that the sample deposit on the filters was adequately uniform for TEM analysis if the filters were rotated as in the test (See Aeolus, Inc. Final Report, Appendix C, pages 2-3 of 15). EMS Laboratories in Pasadena, CA, the primary analytical laboratory, reported that the filters underwent rotations of approximately ¼ turn each for a total of eight rotations during each elutriator run of approximately 15 minutes.

The original Superfund Method was developed under contract with U.S. EPA Region 9, although the method has not yet been officially peer reviewed or approved by U.S. EPA headquarters. The method was developed with the oversight of an expert panel, its performance has been documented in a peer-reviewed publication,[91] and over the history of its use, quality control data has been compiled.[92] It has been used to characterize potential environmental exposures at several Superfund sites, and has been used by U.S. EPA and state agencies in Oregon, Massachusetts, and New Jersey for this purpose. This method was also utilized in conjunction

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[90] Berman, D. Wayne, and Anthony Kolk, Draft Modified Elutriator Method for the Determination of Asbestos in Soils and Bulk Material, Aeolus, Inc. publication, May 23, 2000, p. 2-15.
[91] Berman, DW, "Asbestos Measurement in Soils and Bulk Materials: Sensitivity, Precision, and Interpretation-You Can Have It All", American Society for Testing and Materials, ASTM STP 1342, 2000.
[92] Personal communication with Dr. Wayne Berman, November 13, 2003.

with air pollution modeling and a risk assessment for the Waukegan Park District's proposed location of a recreation center on the previous Johns-Manville manufacturing site.[93]

For purposes of this report, the sample preparation and analytical method will be referred to as the Superfund/Elutriator Method.

In this study, approximately two kilograms of sand were collected per sub-sample, or 6-10 kilograms (13-22 pounds) per each of the 12 samples collected from each site. The sand was dried and the 3-5 sub-samples were homogenized into one sample. Some of the homogenized samples were split into duplicates for quality control purposes, labeled, and all samples transported to EMS Laboratories for Superfund/Elutriator analysis. For the analysis, approximately 70 grams were placed in the dust generator. The material underwent agitation in the dust generator, and an air stream carried it to the elutriator where the sample underwent particle size separation. The respirable fraction (PM_{10}) was collected on air filters. The method indicates that samples can be transferred from filters to grids by direct or indirect methods for analysis by TEM. The samples for this study were transferred by the direct transfer method. The results were reported as asbestos structures per gram of respirable dust (S/g PM_{10}).

For purposes of this discussion, MS/g PM_{10} means millions of structures per gram of PM_{10}. Asbestos structures are believed to have similar aerodynamic properties under some conditions as PM_{10}, even if they are longer than 10 μm. The normal target analytical sensitivity of the technique is 2 MS/g PM_{10} for the Superfund Method size range of structures to be counted. For this study, the sensitivity was increased (lowering the analytical limits) to approximately 1 MS/g PM_{10} by counting additional grids in the analytical stage to make the analyses more conservative. The lower analytical limits meant that the laboratory spent a greater amount of time on microscopy than normal for this method.

In order to maximize the ability to differentiate between physical characteristics of the structures by location, structures were counted using NIOSH Method 7402 counting rules and the Protocol Structure (defined in the Superfund Method) counting rules. Therefore this study was able to categorize structures into groupings consisting of asbestos mineral types, structures with lengths ranging from 5-10 μm in length, structures greater than 10 μm in length, and structures <0.25 μm, between 0.25-0.5 μm, and >0.5 μm in diameter. Because of the analytical limits and conversion factors used for calculation of concentration, for this study each structure counted by microscopy on a sample represents approximately 1 MS per gram of PM_{10}.

From a gravimetric perspective, a concentration of 1 MS/gram of PM_{10} in beach sand with a silt content of 0.3% is roughly equivalent to a mass to mass (weight of asbestos to weight of sand) ratio of 0.00000012% (assuming average PM_{10} fraction of the silt as 35%, sand density of 1.6 g/cm^3, average asbestos density of 0.6 g/cm^3 and average structure length of 10 μm and diameter of 0.5 μm). It should be noted that this estimate does not fully account for fibers less than 5 μm in length. This estimate is different than the ratio (percentage) expressed by the standard bulk

[93] Berman, et al, Waukegan Park District: An Evaluation of Offsite Asbestos and Air Pollutants and Their Potential Effect on Visitors to the Proposed Sports Complex in Waukegan, Illinois.

sampling method for asbestos, which is a visual assessment of the amount of asbestos relative to the amount of other materials as evaluated with microscopy.[94]

The total amount of PM_{10} was not measured directly for this study. However, PM_{10} content is related to and likely to be much less than the silt content of the sample. The silt concentrations for the samples were analyzed for the fraction of material that passed a No. 200 sieve by dry sieving, using ASTM Method C136-04. The silt fraction included particles less than approximately 70-75 μm in size. It should be noted that the relationship between asbestos structures and PM_{10} is linked to the fact that results (concentrations) are expressed as the number of asbestos structures per mass of PM_{10}. The relationship of asbestos concentration in sand is a function of the structures of asbestos/gram of PM_{10} as reported in this study, and the fraction of PM_{10} in the sand, which can be estimated as an undetermined fraction of the silt content of the sand. The silt content of the sand sampled for this study ranged from 0.1-1.0% for beach sand, and 8.3-9.2% for lake bottom sand.

IV. Field Methods

A systematic sampling plan was used to determine sample locations within each of the seven sites that were sampled. Locations were specified on a grid that provided for approximate equal spacing between samples and sub-samples in each location. The sub-samples were collected linearly within the allotted area of the grid,[95] which was defined to run from the water line to the high water mark. Samples were collected over the whole of each site characterized to be as representative as possible. The samples were collected during a period of low lake water levels, with levels in the summer of 2004 at about 176.3 meters vs. long-term average summer lake water levels of about 176.6 meters.[96]

Samples on beaches were collected at depths of six inches to represent potential exposure to beach visitors. Lake-bottom samples were collected at greater depths, on the order of 4 – 6 feet or more to represent the full depth of dredged sand. Each location had different area lengths and widths, so sample and sub-sample spacing varied by location, and in the case of lake-bottom sand, varied somewhat by depth.

Five sub-samples were collected for subsequent homogenization into each sample, except in the IBSP North Unit location. At IBSP North Unit, three sub-samples were collected for each sample. After the sampling team had finished collecting samples in IBSP South Unit, GLCEEH made a field decision to collect some IBSP North Unit samples on the same day. At the site (located between Kellogg Creek south to 21st St), the sampling team noted that the distance between the water line and the high water mark was narrow relative to other locations sampled, apparently because of beach erosion. The number of sub-samples was reduced to three because

[94] U.S. EPA Method for Determination of Asbestos in Bulk Building Materials, U.S. EPA/600/R-93-116 (7/93 Edition).

[95] Gilbert, Richard O., Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, NY, NY, 1987, p 21.

[96] Great Lakes Water Levels for Lake Michigan/Huron Graphed for Consecutive Years, U.S. Army Corp of Engineers; http://www.lre.usace.army.mil/_plugins/Programs/HistoricGreatLakesLevels/pages.cfm?page=consecyears&LakeID=2&YearID=105,106&MonthID=1,2,3,4,5,6,7,8,9,10,11,12&Max=0&Min=0&Mean=0&CFID=4509705&CFTOKEN=51020667

the sub-sample locations were close together and five sub-samples would not be likely to provide more information. Four samples made up of three sub-samples each were collected in the area of Kellogg Creek south to 21st Street. Eight more samples were subsequently collected from the feeder beach southward to the Camp Logan headland, which also had some narrow beach areas. GLCEEH made the decision to remain consistent for all samples collected in the North Unit. This may have affected the results somewhat relative to other areas, but GLCEEH felt it was an appropriate modification under the circumstances. It was difficult to sample the IBSP North Unit as systematically as other sites because the beaches were narrow, steep, gravelly, and discontinuous.

Lake-bottom sand coring attempted to reach the full depth that would be dredged, but this was not always possible. In some samples, the coring device was blocked or became stuck while coring. Actual coring sample depths in the lake bottom sand were approximately 4 - 6 feet at North Point Marina and 4 – 6.5 feet at the Approach Channel to Waukegan Harbor.

Beach sand samples were collected with a hand-held bucket auger. The Illinois State Water Survey collected samples of lake-bottom sand using the vibracore sampling method. A description of the method is contained in Appendix C, UAS, Inc. pages 26-33.

The Draft Modified Elutriator Method for the Determination of Asbestos in Soils and Bulk Material describes a field technique for homogenizing the sample from sub-samples into single samples. For this study, United Analytical Services, Inc. (UAS) performed the homogenization of sub-samples to samples in an enclosed area in the laboratory. For beach sand, samples were placed in marked zip-lock bags and transported to the UAS laboratory. Samples were weighed, dried, and weighed again to obtain moisture content. The samples were then homogenized using a riffle splitter per the method description. Several replicate portions of sand were pulled from each sample, with some being reserved for other purposes, such as silt content determination, QA/QC, and storage of archived samples.

Lake-bottom sand core samples were transported to the coring crew's base in Champaign, Illinois, where each core was subsequently cut into five equal lengths under UAS supervision. The sand was removed from each section and placed in zip-lock bags for transport to the UAS laboratory. The lake-bottom sand samples were prepared as described above. The remainders of the core samples are archived at ISGS and the remainders of the beach sand samples are archived at UAS, Inc.

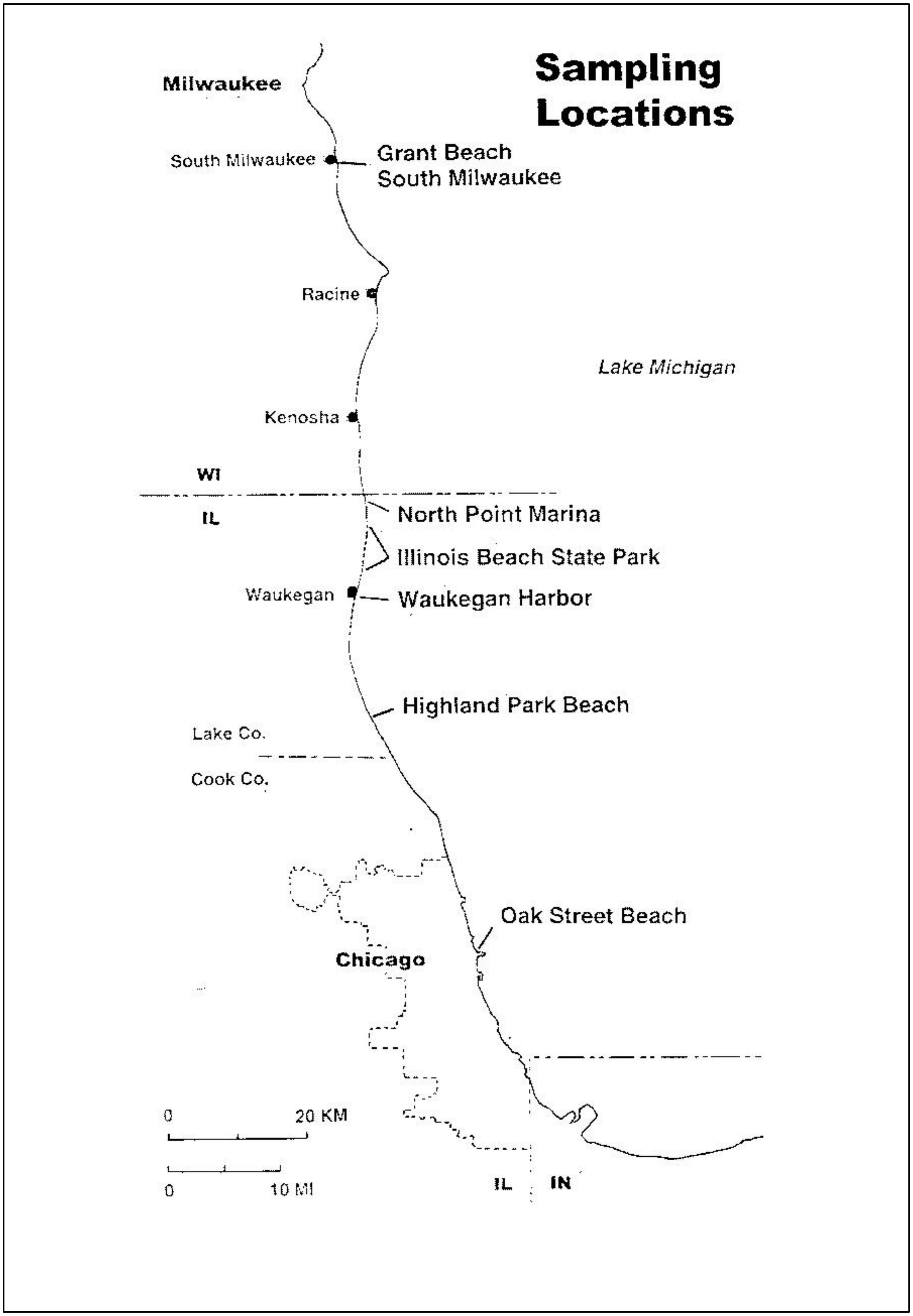
Prepared sand samples were then sent to EMS Laboratories in Pasadena, CA. More details about sample handling are provided in Appendix C, UAS, Inc. pages 1-3.

V. Descriptions of Sampled Areas: Beaches

The target areas for this study were the two lake-bottom sand areas and the beaches in the North and South Units at IBSP. The study was designed to try to control for influences from background asbestos structures and asbestos in water from other areas. Due to the prevailing north to south wave forces in the area studied, the study design included one background area north of IBSP and two south of IBSP. The areas chosen were modified from those originally proposed after consideration about reasonable expectations for access and appropriate beach history. There are few beach areas along the western shoreline of Lake Michigan that are not near industrialized or developed areas. The background areas were specified because they could be influenced by human activity, did not have apparent ACM in the sand, were subject to similar littoral drift, and had not been replenished with nourishment sand in the recent past.

Figure 2 illustrates the relative locations of the sampled sites, and the sites are described in the text that follows.

Figure 2: Overview of Sampled Sites



Grant Park Beach, South Milwaukee, Wisconsin: Grant Park Beach is located along a bluff coast within the Milwaukee County Park System. It is a natural area located within the Milwaukee-Racine urban/suburban corridor, which includes industrial facilities. The beach area may be buffered from nearby airborne sources of asbestos by the size and foliage of the park. The park lakeshore borders actively eroding bluffs consisting of glacial sediments. The beach sediments consist of a mixture of sand and gravelly sand. The shore along the northern part of the park beach is free of shore protection or other coastal engineering. This beach was chosen as a northern (updrift) background sampling site because of the natural shoreline and the location north of Kenosha, Wisconsin, where ACM was previously found along some beach locations. The 12 samples were collected over an area (length of shoreline times distance from water line to high water mark) of 4.8 acres.

Illinois Beach State Park – North Unit (Feeder Beach to Camp Logan): Beach sampling in the northern part of the state park's North Unit extended from the North Unit feeder beach southward to the beach built against the steel sheetpile and riprap armor on the north side of the Camp Logan headland. This sampled segment of shoreline has the highest rates of shoreline recession in the state park as well as along the entire Illinois coast. Long-term average annual recession rates are 10 feet per year.[97] The beach sediments consist of sand and gravelly sand as well as a variety of building debris from residential housing (bricks, cement, concrete, clay tile, ceramic tile, pipe from water and sewer connections, steel pipes, etc.). This debris is derived from the material disbursed from the feeder beach as well as from lake-bottom and shore erosion. Single-family detached housing was present along this beach segment prior to the mid-1970s land acquisition and land clearing by the State of Illinois. The sub-grade infrastructure of former housing is still present in the area. Eight of 12 samples collected in the North Unit were from this area. The 8 samples were collected over an area (length of shoreline times distance from water line to high water mark) of 2.0 acres.

Illinois Beach State Park – North Unit (Kellogg Creek to 21st Street): Beach sampling in the southern part of the state park's North Unit extended from immediately south of the waterworks building near the mouth of Kellogg Creek to where 21st Street intercepts the beach. This is an actively eroding shoreline, but rates of shoreline recession are less than what occurs north of Camp Logan. The beach consists of sand and gravelly sand with some building debris. Single-family detached housing was present along this shore prior to the mid-1970s land acquisition and land clearing by the State of Illinois. The sub-grade infrastructure from this former housing is still present in the area. Four of the 12 samples collected in the North Unit were from this area. The sub-samples were located in closer proximity to each other for each sample than in most other areas because the distance from the water line to the high water mark was smaller. The 4 samples were collected over an area (length of shoreline times distance from water line to high water mark) of 1.6 acres.

Illinois Beach State Park – South Unit (Main Swimming Beach to Dead River): This segment of sampled beach includes the most heavily used beach areas in the state park, including the main

[97] Chrzastowski, M. J. and W. T. Frankie, 2000, Guide to the geology of Illinois Beach State Park and the Zion beach-ridge plain, Lake County, Illinois: Illinois State Geological Survey, Field Trip Guidebook 2000C, Champaign, 69 p. plus appendixes.

swimming beach, the beach near the park ranger office, and the beach near the state park resort. The sampling covered the beach area from the main swimming beach southward to the mouth of Dead River. The area south of Dead River is a designated nature preserve and has restricted public access. The reach of sampled beach is sand and gravelly sand. Rates of shoreline recession are less than in the North Unit, and the long-term erosion rates diminish to near zero with progression southward toward the mouth of the Dead River. The river mouth approximates a null zone along the state park shore with net erosion to the north and net accretion to the south.[98] The main swimming beach has received beach nourishment at various times to enhance beach recreation. The 12 samples were collected over an area (length of shoreline times distance from water line to high water mark) of 19.3 acres.

<u>Central Park Beach – City of Highland Park:</u> Central Park Beach is a municipal beach of the City of Highland Park and is managed by the city's park district. The beach is located at the lakeward end of Park Avenue and is north (updrift) of the City of Highland Park waterworks facility. This beach was chosen as a southern (downdrift) background site. It is centrally located along what is known as the "North Shore" which is primarily privately owned residential lakeshore extending along the string of lakeshore municipalities from the Village of Lake Bluff in the north to the City of Evanston in the south. Central Park Beach increases in width from north to south where it is built against the filled land of the Highland Park waterworks. The beach materials are dominated by sand and gravelly sand. This beach receives a natural supply of littoral sand from the north. Although net erosion has been common along the beaches and nearshore to the north of Highland Park,[99] the Central Park Beach is in a dynamic equilibrium (no net loss or gain). There is no known history of beach nourishment. The 12 samples were collected over an area (length of shoreline times distance from water line to high water mark) of 0.8 acres.

<u>Oak Street Beach – City of Chicago:</u> Oak Street Beach is part of the Chicago lakefront park system managed by the Chicago Park District. Oak Street Beach is located at the lakeward end of Oak Street and is bound on its west and south sides by Lake Shore Drive (US Hwy 41). The beach sand at Oak Street Beach is located within a few hundred feet of Lake Shore Drive. Oak Street Beach was chosen as an additional southern (downdrift) background site because of its central location along the Chicago lakeshore and because it appears to be subject to minimal erosion. Oak Street Beach has a long-term stability, and there is no known record that beach nourishment has been performed in the last 12 years or more. Most of the beaches along the Chicago lakefront are artificial beaches built since the late 1920s.[100] For example, neighboring North Avenue Beach was built during 1938-39.[101] Oak Street Beach has been in existence since at least 1926. The fine to medium sand at Oak Street Beach is apparently a combination of

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[98] Chrzastowski, M. J. and W. T. Frankie, 2000, Guide to the geology of Illinois Beach State Park and the Zion beach-ridge plain, Lake County, Illinois: Illinois State Geological Survey, Field Trip Guidebook 2000C, Champaign, 69 p. plus appendixes.

[99] Chrzastowski, M. J. and C. B. Trask, 1995, Nearshore geology and geologic processes along the Illinois shore of Lake Michigan from Waukegan Harbor to Wilmette Harbor: Illinois State Geological Survey, Open File Series 1995-10, Champaign, 93 p.

[100] Chrzastowski, M. J., 1991, Building, deterioration and proposed rebuilding of the Chicago lakefront: Shore and Beach, v. 59, no. 2, pp. 2-10.

[101] Chrzastowski, M. J., 2004, History of the uniquely designed groins along the Chicago lakeshore: Journal of Coastal Research, Special Issue No. 33, Functioning and Design of Coastal Groins: The Interaction of Groins and the Beach – Process and Planning (N.C. Kraus and K. L. Rankin, eds.), pp. 19-38.

naturally occurring littoral sediment that began to accumulate after the bulkhead that forms the southern limit of the beach was built, and sand imported in the early 1900s to expand the beach area. Most sand used in building Chicago beaches was derived from dredging the lake bottom off the Indiana coast at Indiana Shoals or by mining sand from dunes along the Indiana shore. The 12 samples were collected over an area (length of shoreline times distance from water line to high water mark) of 4.1 acres.

VI. Descriptions of Sampled Areas: Lake-Bottom Areas

North Point Marina Entrance Area: North Point Marina is a state-owned facility managed by the Illinois Department of Natural Resources (IDNR) and adjoins the North Unit of Illinois Beach State Park. The entrance area to North Point Marina receives an input of littoral sand from the north and acts as a localized sediment trap. Maintenance dredging is necessary to maintain a maximum design depth of minus 12 feet low water datum (LWD); LWD is a reference to the average of record low water levels. This dredging is done by the IDNR using a state-owned dredge. The dredged sediment is transported by slurry pipe to near the south end of the south outer breakwater where the sediment is discharged into shallow water. This provides a means to bypass the sand past the marina complex and allow littoral transport to move the sand along the state park shore.

Waukegan Harbor Approach Channel and Advanced Maintenance Area: Waukegan Harbor is a federal harbor maintained by the U.S. Army Corps of Engineers Chicago District. The approach channel refers to the area lakeward of the harbor entrance jetties. The Approach Channel and Advanced Maintenance Area should not be confused with the Waukegan Inner Harbor, which is a U.S. EPA designated Area of Concern (AOC). The Approach Channel and Advanced Maintenance Area receives an input of littoral sand from the north and requires periodic dredging to maintain a depth of minus 22 feet LWD leading to and from the jetty-defended entrance channel. The advanced maintenance area refers to an adjoining area to the north that is also dredged to minus 22 feet LWD in order to remove lake-bottom sand that would otherwise be transported into the approach channel. Over the past two decades, dredged sand from the approach channel and the advanced maintenance area has been taken by barge to two different disposal locations. One location is a designated offshore disposal area about three-quarter miles south of Waukegan Harbor. The other site is offshore of the feeder beach in the North Unit of Illinois Beach State Park as discussed earlier in this report.

VII. Potential Study Outcomes

The Illinois Attorney General's Asbestos Task Force agreed that the basic study design was worthwhile and should be undertaken in an attempt to resolve the ongoing issues at IBSP. The possible outcomes include a determination that:

- Potential nourishment sand sources have an asbestos structure concentration that is lower or not significantly different than background levels. This outcome would allow the use of the sand for nourishment purposes.
- Potential nourishment sand sources have an asbestos concentration that is higher than background levels. This outcome would be followed by a risk assessment that evaluates the use of the sand for nourishment purposes based on an acceptable level of risk.

Sampling Results and Discussion

The summary of results for all locations is presented in Table 3. Structures were counted using two different size ranges, one as defined by NIOSH Method 7402 and one defined as Protocol structures. Note that there is overlap between structures counted in these two size ranges when structure diameter is between 0.25 and 0.5 μm and diameter. Adjustments are made in the rest of this report to account for the overlap so that individual structures are not counted twice.

For the locations tested, the chrysotile structures are generally longer and thinner than the amphibole structures. There was generally good correlation between the two counting methods, presented graphically in Figure 3.

Table 3: Summary of Results from All Locations Sampled

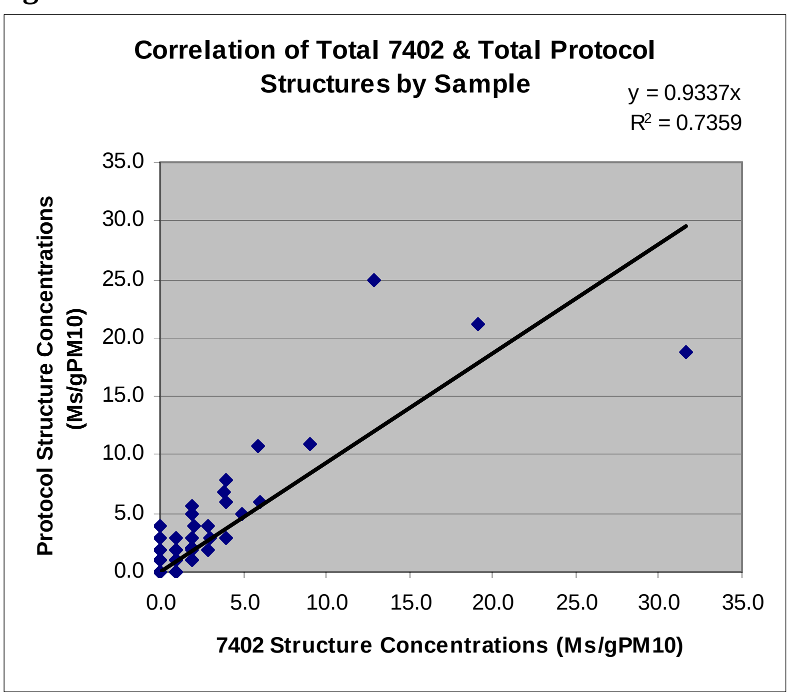
	NIOSH 7402[a] (PCME) Structures	**Protocol[b] Structures**	**Total # of individual structures counted**
Chrysotile Structures	39	79 (77% >10 μm long)	
Amphibole Structures	108	106 (40% >10 μm long)	
Column Total	147 (63% of total)*	185 (79% of total)*	234

* Note: The total percentage for both counting methods is more than 100% because the structures were counted by both methods overlap when structure diameter was between 0.25 and 0.5 μm.

[a] (7402 (PCME) Method: Fiber length > 5 μm, diameter >0.25 μm

[b] Protocol Structures: Fiber length > 5 μm and > 10 μm, diameter < 0.5 μm)

Figure 3:



The sampling results are summarized by location in Table 4. The counts presented are for the total number of unique structures, without overlap from the two counting methods. The results are presented graphically in Figures 4 and 5. The heights of the two figures are scaled equivalently to allow visual comparison of results. Oak Street Beach is excluded from Figures 4 and 5 for reasons explained below. A complete data set is presented in Appendix A.

Table 4: Summary of Sampling Results by Location:
Total NIOSH Method 7402 Structures and Protocol Structures*

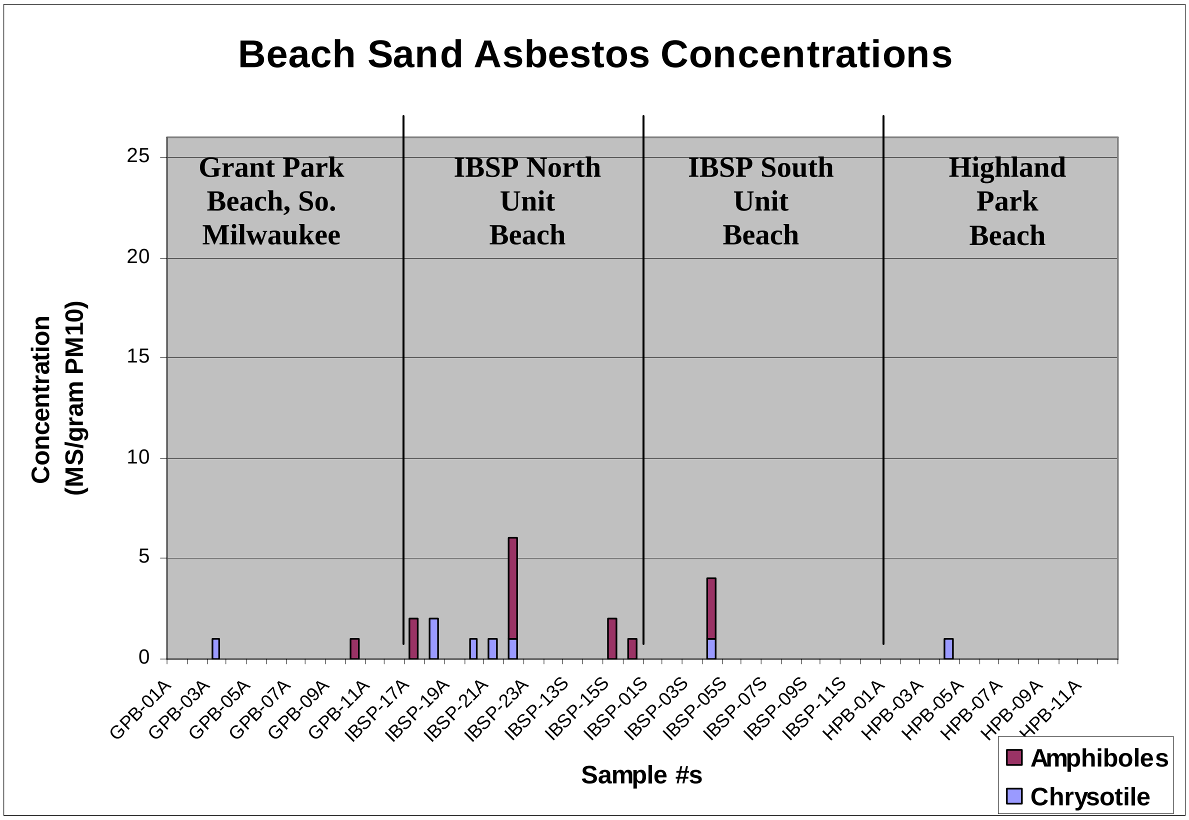
	Beaches Tested, North to South					Lake-bottom Sand Locations Tested	
	Grant Park, Milwaukee	IBSP North Unit	IBSP South Unit	Highland Park	Oak Street Beach	North Point Marina	Approach Channel Waukegan Harbor
# of samples collected	12	12	12	12	12	12	12
# Samples Positive for Asbestos	2	7	1	1	11	9	12
Minimum Concentration (MS/g PM_{10})[1]	0	0	0	0	0	0	1.0
Maximum Concentration (MS/g PM_{10})	0.97	5.9	4.0	0.97	42	6.0	25
Average (MS/g PM_{10})	0.16	1.22	0.32	0.08	9.25	1.97	6.23
95% UCL of Mean[2] (MS/g PM_{10})	0.64	3.34	1.74	0.43	24.74	2.97	10.14
Standard Deviation	0.38	1.68	1.12	0.28	12.31	1.94	6.42
Median (MS/g PM_{10})	0	0.98	0	0	4.40	1.47	3.97
% Protocol Structures >10 μm Length	100	61.5	0	0	28.2	60	84.5
% Amphibole Structures	50	67	75	0	87	58	29
Average Silt Content (%)	1.0	0.1	0.2	0.3	0.3	8.3	9.2
Average Moisture Content (%)	7.8	7.0	5.7	5.4	5.4	17.2	18.5

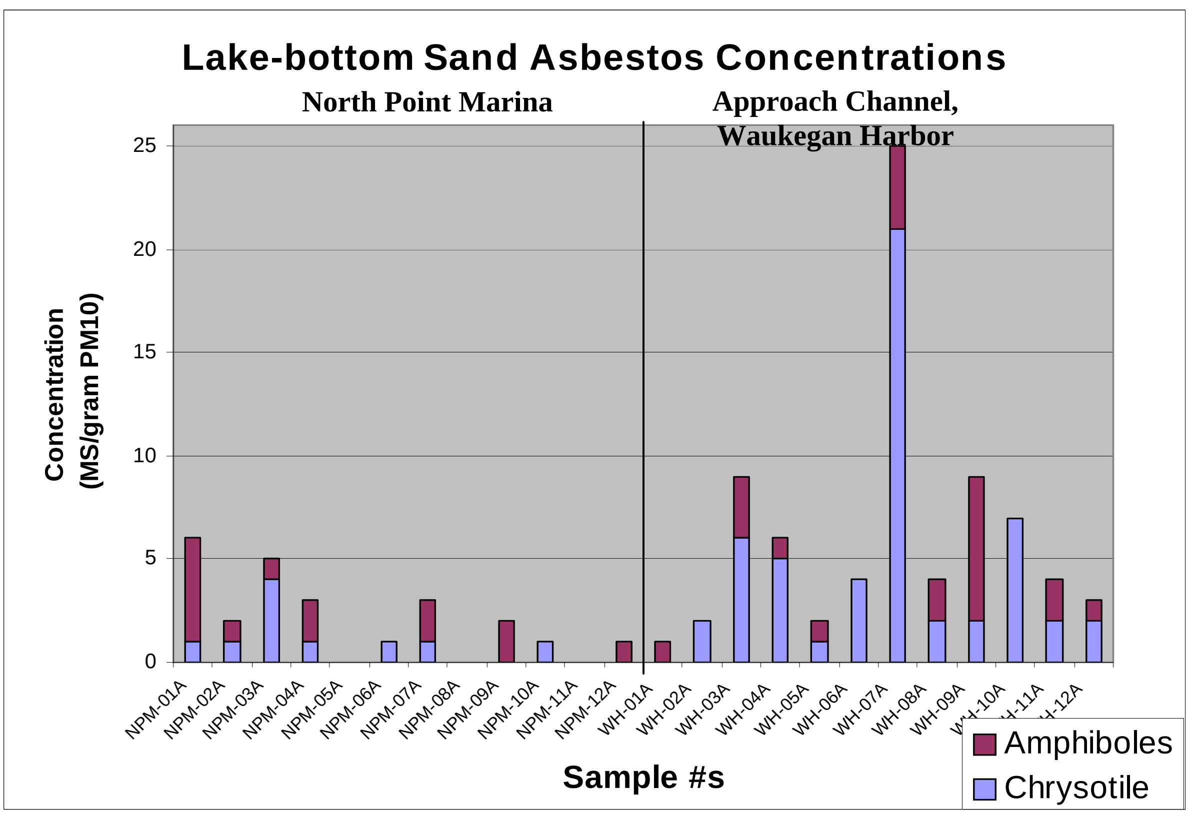
* 7402 (PCME) Method: Fiber length > 5 μm, diameter >0.25 μm
* Protocol Structures: Fiber length > 5 μm and > 10 μm, diameter < 0.5 μm
[1] Million structures > 5 μm in length/gram PM_{10}
[2] The 95% UCL (upper confidence limit) of the mean is the upper estimate of the mean that accounts for sampling uncertainty. The use of the 95% UCL helps to account for variation in data sets.[102]

[102] U.S. EPA ProUCL Version 3.0 User Guide April 2004, p viii

Figures 4 and 5: Beach Sand and Lake-Bottom Sand Concentrations

Note: Oak Street Beach results are included in Table 4 but excluded from these figures for reasons noted in the text below.





The results indicate that at least one sample was positive for some asbestos structures at every site tested. Amphibole structures were found at every site tested except Highland Park Beach. The silt content, which is relevant to the total amount of PM_{10} in the sand, was much lower (0.1 - 1.0%) at the beaches tested than in lake bottom sand (8.3 – 9.2%).

The Oak Street Beach site was selected as a background site for purposes of this study. However, sampling results indicated that the site had elevated asbestos structures per gram of PM_{10} compared to other beach sites. Due to the sensitivity of the sampling and analytical methods and in order to preserve a conservative approach, this site was subsequently excluded as a background site for purposes of this study because the results would have masked other study comparisons. It is uncertain if the results represent typical background conditions in the area or are influenced by unknown factors. No apparent ACM was seen at the Oak Street Beach site during sampling, nor has any been reported. In fact, the beach consisted of pure sand, free of rocks, gravel and debris. It is not known if the results were unusual for urban areas because GLCEEH was unable to locate sampling data collected with the Superfund/Elutriator method in urban background areas for comparison. One study of urban street dust and soil that used different sampling, preparation, and analytical procedures, is described briefly in Appendix E. [103]

The current study was undertaken to evaluate IBSP, and GLCEEH was authorized to perform the study as a public service to the Illinois Attorney General's Task Force. GLCEEH did not have a mandate to perform further inquiry at Oak Street Beach or any other background sites. GLCEEH provided a summary of the Oak Street Beach results to the Illinois AG's office to share with the appropriate authorities at the Chicago Park District and the City of Chicago.

Of the six remaining areas sampled, the two background sites (Grant Park Beach in South Milwaukee and Highland Park Beach) and the IBSP South Unit had low concentrations compared to the other areas sampled. North Point Marina lake-bottom sand results were similar to IBSP North Unit beach sand in total concentration, fiber size, and fiber type. The Approach Channel to Waukegan Harbor results appeared to be somewhat higher than other targeted sites, but may be within the natural variability of background lake-bottom sand, which is not known.

Several statistical analyses were performed to compare areas of interest by using the Mann Whitney Rank Test, which is a non-parametric (does not assume data distribution) 2-tailed test of the equality of 2 means. The test used the null hypothesis: There is no difference between areas tested. The results of these tests are presented in Table 5.

[103] Pitt, Robert. Asbestos as an urban area pollutant, Water Pollut. Control Fed., 60, 1988, pages 1993-2001.

Table 5: Tests of Sample Result Differences of Areas

Areas Compared	N_1[a]	N_2[b]	U[c]	p-value[d]	Result
Background Areas (Grant Park Beach and Highland Park Beach) vs.IBSP North Unit	24	12	216.0	0.0145	Difference is statistically significant ($p < 0.05$, 2-tail)
Background Areas (Grant Park Beach and Highland Park Beach) vs.IBSP South Unit	24	12	148.5	0.881	Difference is not statistically significant ($p \geq 0.05$, 2-tail)
Background Areas (Grant Park Beach and Highland Park Beach) vs. Approach Channel to Waukegan Harbor	24	12	286.5	<0.001	Difference is statistically significant ($p < 0.001$, 2-tail)
Background Areas (Grant Park Beach and Highland Park Beach) vs. North Point Marina	24	12	243	<0.001	Difference is statistically significant ($p < 0.001$, 2-tail)
IBSP North Unit vs. Approach Channel to Waukegan Harbor	12	12	129.0	<0.001	Difference is statistically significant ($p < 0.001$, 2-tail)
IBSP North Unit vs. North Point Marina	12	12	90.5	0.291	Difference is not statistically significant ($p \geq 0.05$, 2-tail)
North Point Marina vs. Approach Channel to Waukegan Harbor	12	12	117	0.008	Difference is statistically significant ($p < 0.01$, 2-tail)

[a] Number of samples results, group 1
[b] Number of samples results, group 2
[c] Mann-Whitney test statistic
[d] Probability of no significant difference

The sampling results indicated that IBSP North Unit results were significantly different (greater) than background areas and different (less) than the lake-bottom sand in the Approach Channel to Waukegan Harbor. The IBSP North Unit results were not significantly different than the lake-bottom sand in the North Point Marina.

GLCEEH is providing a screening level analysis of potential health effects for the target areas that include IBSP North Unit beach and two potential sand nourishment sources, North Point Marina and Approach Channel to Waukegan Harbor lake-bottom sand.

Screening Level Analysis of Potential Health Effects

I. Background and Scope

In order to interpret the results of asbestos concentrations in sand at Illinois Beach State Park (IBSP) and potential beach nourishment sources, a screening level analysis, and not a complete risk assessment, was undertaken. A quantitative risk assessment provides an estimate of the chance of a specific health effect occurring under specific exposure conditions. Asbestos risk assessment, in particular, involves evolving and complex groups of methods that are currently under debate as a result of recent findings at asbestos sites such as Libby, Montana.[104] This report recognizes the need to understand the results in a health context.

Risk estimates for asbestos are generally based on air sampling results, which are used in a risk assessment model to calculate risk. There are limitations inherent in predicting airborne asbestos concentrations from other media in general. In this case, an extremely sensitive sample preparation and analysis method is used to help predict asbestos emissions into air from sand. The sample preparation and analysis methodology is under review by the Science Advisory Board, but has not been approved by U.S. EPA.

A screening level analysis using conservative (protective) assumptions is appropriate to estimate the questions of concern for this study. A screening risk assessment provides an initial evaluation of a potential problem to determine whether further assessment and analysis is needed. The U.S. EPA has employed a screening approach in order to quickly analyze a large amount of data (e.g., the endocrine disruptor screening program[105]) or as a preliminary stage in the risk assessment process (e.g., soil screening levels[106]). By using very conservative (protective) assumptions, a screening risk assessment helps determine whether the potential for harm exists. If such potential is found, a more formal, precise assessment could be warranted.

The results of a screening assessment should *not* be viewed as an absolute quantitative estimate of risk, but as an indication of whether or not a situation should cause concern. For situations that warrant a screening approach, the general theme employed regarding estimating exposure and toxicity is to err on the side of being protective (in other words, overestimating risks) when faced with data gaps or other uncertainties in the estimates. In this way, decision-makers will be presented with a result that should represent a worst-case, and even unlikely high-end, scenario. In reality, the true exposures and risks are likely to be much less than what was estimated. There should therefore be an ample margin of safety as a result of these choices built into the screening assessment process so that the screening results can be followed up with one of two scenarios: 1) Proceed with further assessment, or; 2) The risk is so low that no further action is needed.

In the U.S. EPA Superfund program (as regulated under CERCLA and the National Contingency Plan), the acceptable cancer risk ranges from 1×10^{-4} to 1×10^{-6}, or 1 in 10,000 to 1 in 1,000,000. Estimated risk values within or exceeding this range may indicate that site management recommendations are needed, depending on site-specific characteristics and exposure scenarios as well as other factors.[107]

Under the Clean Air Act, asbestos is listed as a Hazardous Air Pollutant or HAP. The U.S. EPA is required to develop emission standards or NESHAPs (National Emission Standards for HAPs) for these compounds. The health considerations in setting a NESHAP requires the U.S. EPA to provide "…an ample margin of safety…". In addition, for known, probable, or possible human carcinogens (asbestos is a known human carcinogen recognized by the U.S. EPA, the National Toxicology Program, the National Institute for Occupational Safety and Health and the

[104] Region 8 Libby Asbestos http://www.epa.gov/region8/superfund/libby/ Accessed May, 2005
[105] Endocrine Disruptor Screening Program http://www.epa.gov/scipoly/oscpendo/ Accessed May, 2005
[106] Superfund Soil Screening Guidance http://www.epa.gov/superfund/resources/soil/ Accessed May, 2005
[107] 40 CFR Ch 1 (7-1-03 Edition) Subchapter J, Part 300.430

International Agency for Cancer Research (IARC), and others), the U.S. EPA must promulgate standards if existing standards result in lifetime excess cancer risks of greater than one in one million.[108]

This report focuses specifically on the contamination and possible health effects from asbestos in sand used for beach nourishment. This report does not attempt to estimate exposure from a person handling actual ACM because there are a large number of variables inherent in such an estimate, including meteorological conditions, material conditions, and type of handling. A basic protective recommendation for such materials is that exposures should be limited to the extent possible. This screening risk assessment focuses specifically on potential health outcomes from asbestos structure concentrations in sand at sampled sites.

The U.S. Environmental Protection Agency (U.S. EPA) has a great deal of guidance on risk assessment, including the Risk Assessment Guidance for Superfund that outlines the basic risk assessment process.[109] The U.S. EPA general approach to assessing risk can be summarized into four steps:

1. Hazard identification: What specific health endpoints can result from exposure to the compound? Endpoints or effects can include cancer.
2. Dose-response assessment: Data on epidemiologic and animal studies are collected to assess at what doses health effects were seen and can be predicted in order to quantify the dose-response relationship.
3. Exposure assessment: Exposure assessments identify the exposed population(s), and quantify the extent, magnitude, frequency, and duration of exposure that are relevant and appropriate for the site.
4. Risk characterization, in which the exposure and dose-response assessments are combined to produce a quantitative risk estimate and in which the strengths and weaknesses, major assumptions, judgments, and estimates of uncertainties are discussed.[110]

II. Screening Risk Assessment

Exposure Assessment

The exposed population was considered to be visitors to Illinois Beach State Park. As part of the screening assessment methodology, a susceptible population was selected for study: children playing on the beach and potentially inhaling asbestos. A child's lifetime risk is potentially higher due to the greater number of years of life after first exposure.

IDNR reports that IBSP had 1,400,000 visitors in calendar year 2003 and 1,262,396 visitors in calendar year 2004. The number of repeat visitors included in the visitor reports is not known. An unknown number of visitors are children. Based on observations on site visits, there are many more visitors to the IBSP South Unit beach than to the North Unit beach, which has more rocks and pebbles and is narrower from water line to high water mark. The IBSP South Unit beach

[108] Clean Air Act, Sec. 112. Hazardous Air Pollutants 1990 amendments http://www.epa.gov/oar/caa/caa112.txt accessed May, 2005.
[109] Risk Assessment Guidance for Superfund (RAGS) Part A http://www.epa.gov/oswer/riskassessment/ragsa/index.htm accessed May, 2005.
[110] EPA's Approach for Assessing the Risks Associated with Chronic Exposure to Carcinogens, www.epa.gov/iris/carcino.htm accessed 1/26/05.

results indicated that the beach was not significantly different from background beaches, so this screening risk assessment does not focus on IBSP South Unit. The IBSP North Unit sampling results indicated higher asbestos structure concentrations than background, so the IBSP North Unit beach results were used in the screening risk assessment.

Estimation of potential asbestos emissions into air from activities on the beach was done using data collected for this report and discussed in previous sections. To estimate risk, the exposure assessment data must be in terms of concentrations of asbestos fibers and/or structures in air. The sample collection, handling and analytical methods used for this study provide data that includes asbestos concentrations in terms of structures per gram of PM_{10} (the respirable dust fraction) in sand. Therefore, it is necessary to apply a model that accounts for the emissions of PM_{10} into air. There are a number of emissions models available for predicting PM_{10} emissions, and most of them were created to evaluate dust emissions from industrial machinery or activities. Several models were considered for this exposure assessment and rejected. Some of these, including emissions and dispersion models, require point source and receptor assumptions that GLCEEH does not believe are appropriate to the conditions at recreational beach locations. One run of a U.S. EPA dispersion program (Industrial Source Complex 3-Short Term or ISC3-ST) using one of the emission rates (0.00617 g PM_{10}/ hr) presented in the interim version of this report predicted PM_{10} emissions of 0.00069 mg/m^3. Another run of the ISC3-ST model with an emissions model from Cowherd predicted PM_{10} concentrations of 0.0026 mg/m^3. The concentrations predicted by these passive models fall within the range of 0.000086 – 0.00420 mg/m^3 predicted by a range of beach activities in the model presented below.

The model chosen for this analysis was developed from a U.S. EPA model for uncontrolled particulate (PM_{10}) emissions during sand and gravel processing.[111] This model was chosen because it is an activity-based model that is relevant to the current U.S. EPA and ATSDR approach of evaluating sites by using activity-based air sampling. This model also allows inputs for some of the variables that were measured, such as moisture content of the sand, and meteorological considerations, such as wind speed. There is no variable for silt content in the model, and because the silt content of the beach sand studied was very low, this model is likely to overestimate exposure for beach sand. The model may provide a more reasonable estimate for lake-bottom sand. The model allows the development of a relationship between a variety of dust-creating activities, such as someone running on the beach, playing in the sand, etc., by making assumptions about the amount of sand disturbed by these activities.

This model was modified to estimate asbestos emissions under the described scenarios:

1) Estimation of the emissions into a space that represents the play area or areas that a child or adult is in while the emissions are occurring. This is often called a box model. The box model converts the emissions factor into an estimated asbestos air concentration.
2) Application of a Time-Weighting Factor (TWF) to estimate the fraction of a lifetime during which the air exposure will occur. Because the slope factor (defined below) is based on an assumption of a lifetime of exposure, the TWF estimates a fraction of lifetime in the beach scenario.

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[111] U.S. EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24, December, 2002, App E, pp E-23 – E-24.

The first step in the calculation is to determine an average or typical emission of PM_{10} from the handling of sand on the beach. The emission factor used in the calculation is from the referenced U.S. EPA compilation of emission factors, Equation E-21, for the mass emitted from the dumping of excavated soils:

Equation 1:

$$M_{excav} = 0.35 \times 0.0016 \times \frac{\left(\frac{u_m}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \times \rho_{soil} \times A_{excav} \times d_{excav} \times N_A \times 10^3 \, g/kg$$

where: M_{excav} = mass emitted from excavation (g)

0.35 = PM_{10} particle size multiplier (g PM_{10} / g total mass)

0.0016 = emission factor (kg/Mg)**,** which incorporates a silt concentration for soil (silt concentration is relevant to the releasable fraction of PM_{10}; the measured silt content of the study beaches was 0.1 - 1.0 %, which is less than that of most soils; this risk estimate should be more protective).

U_m = mean wind speed (m/s) (EPA default = 4.69 m/s, ≈10 mph)

M = moisture content (%) (measured moisture content for samples averaged 6.2%)

ρ_{soil} = in situ density (Mg / m^3) (Millions of grams per cubic meter)

A_{excav} = areal extent of excavation (m^2)

d_{excav} = depth of excavation (m)

N_A = number of times material is dumped

Substituting the mass of material handled H_{soil} (Mg/hr) for $\rho_{soil} \cdot A_{excav} \cdot d_{excav}$ results in:

Equation 2:

$$M_{excav} = 0.35 \times 0.0016 \times \frac{\left(\frac{u_m}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \times H_{soil} \times N_A \times 10^3 \, g/kg$$

Substituting 5 m/s for the wind speed, 4% for the moisture content (the average measured moisture content of the study beaches, which were all sampled on summer days with no rain and included one sub-sample from the water line, was 6.2%, so this is a conservative estimate), 10 kg/hr (0.01 Mg/hr) for the mass of material handled (10 kilograms, or 22 pounds per hour), and 1 for N_A yields PM_{10} emissions of:

Equation 3:

$$0.00617 \; {}^{gPM_{10}}\!/_{hr} = 0.35 \times 0.0016 \times \frac{\left(\frac{5}{2.2}\right)^{1.3}}{\left(\frac{4}{2}\right)^{1.4}} \times 0.01 \; {}^{Mg}\!/_{hr} \times 1 \times 10^{3} \; {}^{g}\!/_{kg}$$

The second step in the calculation is to transform the emission rate (in mass per time) into an air concentration (in mass per volume air) for the exposure estimation. This is done with a box model to estimate concentration within the source and breathing zone. The box model has been applied to industrial and nonindustrial applications in indoor and outdoor environments. In indoor environments, the model is often modified with a mixing factor or multiplier to account for incomplete mixing of air in a particular location. For outdoor air models, the mixing factor is 1, meaning it is not a factor in the equation.[112]

The box model calculation is presented in Equation 4, where:

Equation 4:

$$C_{PM10} = \frac{M_{excav} \dfrac{1000 \, {}^{mg}\!/_{g}}{3600 \, {}^{\sec}\!/_{hr}}}{u_m \times width \times height}$$

where C_{PM10} = PM_{10} concentration (mg/m^3)
M_{excav} = mass emitted from excavation (g PM_{10} / hr)
U_m = mean wind speed (m/s)
width = estimated width of box(m)
height = estimated height of box (m)

Substituting M_{excav} and U_m from above, and assuming a very small (and conservative) box width (1 m) and box height (1 m) yields an estimated PM_{10} concentration (mg/m^3):

Equation 5:

$$0.000343 \, {}^{mg\,PM_{10}}\!/_{m^3} = \frac{0.00617 \, {}^{g\,PM_{10}}\!/_{hr} \dfrac{1000 \, {}^{mg}\!/_{g}}{3600 \, {}^{\sec}\!/_{hr}}}{5 \, {}^{m}\!/_{s} \times 1\,m \times 1\,m}$$

[112] Committee on Advances in Assessing Human Exposures to Airborne Pollutants, National Research Council, 1991, p 185, National Academies Press, www.nap.edu, accessed 3/27/06.

Multiplying the PM_{10} concentration by the asbestos content in the PM_{10} yields the asbestos concentration in structures per volume. For example, given an asbestos content of 1.0 MS/g PM_{10} yields:

Equation 6:

$$0.000343 \frac{mg\ PM_{10}}{m^3} \times 1.0 \frac{MS}{g\ PM_{10}} \times \frac{10^6\ S}{MS} \times \frac{g}{10^3\ mg} \times \frac{m^3}{10^6\ cm^3} = 0.00000034\ {}^{structures}\!/_{cm^3}$$

Equations 1 – 6 illustrate calculations that were used to estimate exposure. Two exposure scenarios (average or typical and reasonable maximum) were created for the screening estimate. These scenarios divide a person's life into three periods for exposure assessment, young child (0-2 years of age), child to young adult (3-16 years of age) and adult ($\geq$17 years of age). This allows for the appropriate adjustment of exposure parameters as a person matures. Table 6 summarizes the assumptions used for the exposure modeling calculations.

Table 6: Summary of Exposure Modeling Assumptions

	Age Range	Average or Typical Exposure	Reasonable Maximum Exposure	Comments
Asbestos, structures/gram PM_{10}		Mean of 12 samples (7402 Structures)	95% UCL of 12 samples (7402 Structures)	Based on sand samples
IBSPN	All	0.90	3.89	Average or typical estimate based on average concentration, reasonable maximum estimate based on 95% UCL[a]
Waukegan Harbor	All	2.96	12.58	
North Point Marina	All	1.23	2.01	
Physical variables				
Rate of handling, kg/hr	0 – 2	5	10	Rate of sand handling adjusted for age group.
	3 – 16	10	100	
	≥ 17	10	50	
Wind speed, m/sec	All	5	10	Daily average
Moisture (mass %)	All	4	4	Below observed mean
Width of box, m	0 – 2	1	0.5	Box width adjusted for age of person.
	3 – 16	2	1	
	≥ 17	2	1	
Height of box, m	0 – 2	1	0.5	Box height adjusted for age of person.
	3 – 16	2	1	
	≥ 17	2	1	
Exposure variables				
Hours/day exposed	All	2	4	Estimated time playing in sand
Days/Year exposed	All	25	50	Beach days per year
Number of Years	0 – 2	2	2	Years of exposure
	3 – 16	14	14	
	≥ 17	54	54	
Hours in Lifetime	All	613,200	613,200	Total hours in a 70 year life-span

[a] The average (mean) value is an unbiased estimate of the true value of a set of data. The 95% UCL (upper confidence limit) of the mean is the upper estimate of the mean that accounts for sampling uncertainty. The use of the 95% UCL helps to account for variation in data sets. However, the UCL can be erratic, inflated, or unstable in small data sets, especially with results below analytical limits or with outliers.[113] This can readily be seen by comparing the 95% UCL of this table with the 95% UCL of Table 4, which combined both 7402 and Protocol structure counts. In all 3 locations listed above, the mean was lower in Table 6 than in Table 4, while the 95% UCL was greater in two locations in Table 6.

Assumptions:

1. Asbestos structures in sand can be released when the sand is disturbed.
2. The emissions model assumes that a child ≤ 2 years of age would aggressively disturb 5 – 10 kilograms (11 - 22 pounds) of sand per hour, children 3-16 years of age would aggressively disturb 10 – 100 kilograms (22 - 220 pounds) of sand per hour, and adults ≥

[113] U.S. EPA ProUCL Version 3.0 User Guide April 2004, p viii-ix.

17 years of age would aggressively disturb 10 – 50 kilograms (22 - 110 pounds) of sand per hour.

3. The emissions model assumes silt content typical of soil which is likely to be significantly higher than beach sand and somewhat higher than lake-bottom sand. This would tend to overestimate the PM_{10} content and overestimate actual concentrations of PM_{10}. The actual silt content of soil used to develop this model has not been verified; however, another emissions model in the source document for the applied model indicates a default soil silt content of 18%.[114] Therefore, the emissions model may overestimate emissions from the sand sampled in this study.

4. The emissions model assumes average moisture content of 4% in the sand vs. 6.2%, which was the measured value from beach samples collected on dry summer days. The moisture content of sand near the water line, where children may be more likely to play, is higher. The moisture estimate is set low to overestimate risk. Asbestos structures can become airborne more easily when moisture content is low.

5. The emissions model assumes that the source and the child's (≤ 2 years of age) breathing zone are within a space of 0.5 to 1 meter (approximately 1.5 to 3 feet) in height and width. The space is adjusted to 1 – 2 meters (approximately 3 – 6 feet) for children ≥ 3 and adults.

6. The emissions model assumes that the exposed person is downwind of the source 100 % of the time. This is unlikely and indicates a protective estimate of exposure.

7. A Time-Weighting Factor (TWF) was also applied to account for a less than lifetime exposure for the time spent on the beach. A protective estimate of this activity was estimated to be two to four hours per day, 25 to 50 days per year, for 70 years of life.

<u>Toxicity Assessment</u>

A Unit Risk Factor or slope factor has been developed by the U.S. EPA from epidemiological studies to estimate lifetime excess cancer risks. A unit risk factor is a slope factor with some exposure assumptions included for estimating inhalation cancer risks specifically. In the case of asbestos, most of the available toxicity data are from high concentration exposures in industrial settings. Low dose extrapolation methods used to model dose-response relationships below existing data can be a source of uncertainty. Such methods apply a dose-response graph based on exposure versus disease, draw a straight line to apply to low-level exposures, and assume the same slope of the line would apply. These and other cancer risk estimation methods have recently been revised for carcinogens by the U.S. EPA in newly released Guidelines for Carcinogen Risk Assessment.[115] However, these guidelines do not appear to address asbestos because it is not believed to have a mutagenic (specific interaction with DNA) mode of action. It is the U.S. EPA's "long-standing policy position that use of the linear low-dose extrapolation approach provides adequate public health conservatism in the absence of chemical-specific data indicating differential early-life sensitivity or when the mode of action is not mutagenic."[116]

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[114] U.S. EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24, December, 2002, App E, pp E-25, Equation E-24.

[115] U.S. EPA Guidelines for Carcinogen Risk Assessment, EPA/630/P-03/001B, March 2005, http://yosemite.epa.gov/opa/admpress.nsf/0/33d8dfc4dfe30aa085256fd3005bdbeb?OpenDocument

[116] U.S. EPA Guidelines for Carcinogen Risk Assessment, EPA/630/P-03/001B, March 2005, and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F, pp 1-19 – 1-20. http://yosemite.epa.gov/opa/admpress.nsf/0/33d8dfc4dfe30aa085256fd3005bdbeb?OpenDocument, accessed April, 2005.

Carcinogens are generally considered to have no threshold, or no safe level of exposure, although the uncertainty surrounding the dose-response relationship increases at low exposure levels. Several sources, including the U.S. EPA, have developed unit risk factors for asbestos. For this screening risk assessment, the U.S. EPA IRIS Inhalation Unit Risk Factor of 0.23 per f/ml[117] was generally applied. This slope factor is based on the additive risk of lung cancer and mesothelioma, using a relative risk model for lung cancer and an absolute risk model for mesothelioma.

It should be noted that the IRIS file for asbestos states that: "…The unit risk is based on fiber counts made by phase contrast microscopy (PCM) and should not be applied directly to measurements made by other analytical techniques."

The data for this study was collected using TEM instead of PCM, which adds uncertainty to the risk estimate. However, the most accurate and sensitive method for measuring asbestos fiber content in air is transmission electron microscopy.[118]

In this study, the asbestos structures were counted two ways: With the 7402 (PCM Equivalent or PCME) size definitions and with the Protocol (Superfund Method) size definitions. The exposure modeling considered 7402 asbestos structures, as well as the sum of 7402 and Protocol asbestos structures while accounting for overlap between the two. A large number (258 - 312) of grid openings were counted on each filter, providing a greater level (as compared to typical air sample analysis) of precision to the TEM counting results.

Protocol structure counting effectively resulted in 55% more chrysotile structures counted and 26% more amphibole structures counted overall than would have been counted by 7402 counting rules alone. In general, PCM would not detect the non-7402 Protocol structures. The addition of Protocol and 7402 structures could overestimate potential risk.

One of the iterations of the risk characterization presented below includes an addition of the counts from the two counting methods. The upper confidence limit (UCL) calculations are more stable with the additional counts. Considering the correlation between Protocol and 7402 structure counts (Figure 3), GLCEEH believes that combining these structure counts is a conservative approach and is more protective of the exposed population than 7402 counts alone would be for this model.

Different slope/unit risk factors have been calculated by a variety of investigators and agencies.[119] U.S. EPA and a selected science advisory board have reviewed a risk assessment protocol of asbestos toxicity (dated 2003) authored by D. Wayne Berman (one of the developers

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[117] U.S. EPA IRIS, http://cfpub.epa.gov/iris/quickview.cfm?substance_nmbr=0371, accessed 3/17/05.
[118] ATSDR Toxicological Profile for Asbestos, www.atsdr.cdc.gov/asbestos p.157.
[119] Waukegan Asbestos Site, Waukegan, Illinois, Supplement to Response Engineering and Analytical Contract (REAC) Report Dated 29 July 2003, referencing Stayner LT, Smith R, Bailer J, Gilbert S, Steenland K, Dement J, Brown D and Lemen R.; and Exposure-Response Analysis of Respiratory Disease Risk Associated with Occupational Exposure to Chrysotile Asbestos. Occupational and Environmental Medicine, 1997; 54:646-652; and NRC. 1984. Asbestiform Fibers – Non-occupational Health Risks. National Research Council, Committee on Non-Occupational Health Risk.

of the Superfund/Elutriator sample preparation and analysis technique used for this study) and Kenny S. Crump.[120] The protocol under review appears to utilize a more complex application of several different slope factors based on fiber length and type, some of which are greater than and some less than the U.S. EPA slope factor. The protocol presumes that amphibole structures and structures >10 μm have greater potential toxicity.

The last available report of review of the protocol by the science advisory board suggested some differences of opinion on toxicity relative to fiber dimensions, and called for additional work on other issues.[121] The final draft of the protocol has been posted on an EPA web site, [122] but as of the date of this report, the proposed protocol is still undergoing revision and review by U.S. EPA. IRIS contains a note that states: "The carcinogen assessment summary for asbestos may change in the near future pending the outcome of a further review now being conducted by the CRAVE Work Group."[123]

It is not within the scope of this study to evaluate the proposed protocol. GLCEEH decided not to apply the protocol before it has been revised, reviewed, and incorporated into IRIS with detailed instructions for application. GLCEEH chose to use the current standard screening risk assessment approach, first using the current U.S. EPA IRIS Unit Risk Factor of 0.23 per f/ml, before considering a more complex model. This approach may be revised if and when U.S. EPA IRIS provides additional information and guidance in the future.

In summary, the screening risk assessment performed for this report includes several ways of estimating toxicity from the sampling data that was collected for this study:

1) Application of the U.S. EPA IRIS Unit Risk Factor of 0.23 per f/ml to predicted air concentrations of 7402 (PCME) structures.
2) Application of the U.S. EPA IRIS Unit Risk Factor of 0.23 per f/ml to predicted air concentrations of 7402 (PCME) and Protocol structures added together;
3) IRIS Risk Assessment Protocol with estimated 7402 (PCME) and Protocol structure counts and calculated URF of 0.345 per f/ml from a life table for early life (extended to age 16) exposure to asbestos,[124] which is the most conservative (protective) approach.

GLCEEH believes that these are appropriate approaches given the U.S. EPA's recent announcement of the Asbestos Project Plan and the emerging science about asbestos toxicity discussed above. These approaches are conservative (protective) in terms of overestimating potential risk, as are the carefully considered site management recommendations provided in the recommendations section of this report.

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[120]U.S. EPA October, 2003, Final Draft: Technical Support Document for a Protocol to Assess Asbestos-Related Risk. Available at http://www.epa.gov/oswer/riskassessment/asbestos/pdfs/asbestostech1-5.pdf, accessed 2/28/06.
[121] U.S. EPA May 30, 2003, Report on the Peer Consultation Workshop to Discuss a Proposed Protocol to Assess Asbestos-Related Risk. Available at http://www.epa.gov/oswer/riskassessment/asbestos/pdfs/asbestos_report.pdf accessed 2/28/06.
[122]U.S. EPA October, 2003, Final Draft: Technical Support Document for a Protocol to Assess Asbestos-Related Risk. Available at http://www.epa.gov/oswer/riskassessment/asbestos/pdfs/asbestostech1-5.pdf, accessed 2/28/06.
[123] U.S. EPA IRIS, http://cfpub.epa.gov/iris/quickview.cfm?substance_nmbr=0371, accessed 3/17/05.
[124] U.S.EPA, "Airborne Asbestos Health Assessment Update", EPA/600/8-84/00F, June, 1986, Table 6-3, p. 165.

Risk Characterization

The estimates from the exposure and emissions modeling (Equations 1- 6) performed above are multiplied by the time weighting factor and the Unit Risk Factor to generate two sets of risk estimates for each of the three target sites with asbestos concentrations greater than background. These two estimates are considered to be for an "average or typical exposure" and a "reasonable maximum exposure." U.S. EPA guidelines state "While it is an appropriate aim to assure protection of health and the environment in the face of scientific uncertainty, common sense, reasonable applications of assumptions and policy, and transparency are essential to avoid unrealistically high estimates (of risk)."[125] The risk characterizations presented in Table 7 are justified in this report in the Toxicity Assessment and Risk Characterization sections.

For example, using the reasonable maximum estimate of exposure at IBSP North Unit beach, the IRIS Unit Risk Factor of 0.23, and the measured concentration of 7402 asbestos structures in sand, the emissions model predicted that a child ≤ 2 years of age that handled about 10 kilograms (22 pounds) of sand with 4% moisture content per hour in a space that was 1/2 meter across by 1/2 meter tall, in a 10 meter per second (20 mile per hour) wind, could be exposed to about 0.0000066 (6.6×10^{-6}) asbestos structures per milliliter of air. If the child did this for 4 hours per day, 50 times per year for 2 years, the calculation of risk is as follows:

a) Risk for age 0 – 2 years: (5.6×10^{-6} s/ml) x (4 hours x 50 days x 2 years)/(613,200 hours in a 70-year lifetime) x 0.23 (Unit Risk Factor) x 10 (ADAF) = **9.9×10^{-10}**

b) Risk for age 3 – 16 years: The amount of sand handled per hour is greater (100 kilograms or 220 pounds) but the space the child is in is larger as well. The calculation of risk is as follows: (1.4×10^{-5} s/ml) x (4 hours x 50 days x 14 years)/(613,200 hours in a 70-year lifetime) x 0.23 (Unit Risk Factor) x 3 (ADAF) = **1.7×10^{-8}**

c) Risk for age 17 – 70 years: The amount of sand handled per hour is less (50 kilograms or 110 pounds) but the space the adult is in stays about the same. The calculation of risk is as follows: (7.0×10^{-6} s/ml) x (4 hours x 50 days x 34 years)/(613,200 hours in a 70-year lifetime) x 0.23 (Unit Risk Factor) = **3.3×10^{-8}**

The cumulative risk of these three exposure risks over a lifetime is 5.1×10^{-8} or **0.051×10^{-6}** using the reasonable maximum exposure estimate. The average or typical exposure is estimated to be 1.0×10^{-10} or 0.0001×10^{-6}. This is about $1/500^{th}$ of the reasonable maximum exposure.

The results for realistic and upper estimates of risk are calculated in this manner, with several iterations for comparison. The predicted exposures are for the following locations: IBSP North Unit; a beach nourished with lake-bottom sand from North Point Marina; and a beach nourished with lake-bottom sand from the Approach Channel to Waukegan Harbor. The calculations are made in the manner described above with adjustments as described in the notes to Table 7. These results can be compared to the U.S. EPA acceptable risk level of 1.0×10^{-6} (or 1.0E-6).

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[125] U.S. EPA Guidelines for Carcinogen Risk Assessment, EPA/630/P-03/001B, March 2005, and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F, p 5-3. http://yosemite.epa.gov/opa/admpress.nsf/0/33d8dfc4dfe30aa085256fd3005bdbeb?OpenDocument, accessed April, 2005.

Table 7: Risk Characterization

		North Point Marina	IBSP North Unit Beach	Approach Channel to Waukegan Harbor
Risk level	Summary of risk for all age ranges combined for lifetime risk			
Average or Typical Exposure	URF 0.23 per f/ml lifetime, 7402 Structures[a]	0.00014×10^{-6}	0.0001×10^{-6}	0.00034×10^{-6}
	URF 0.23 per f/ml lifetime, 7402 & Protocol Structures[b]	0.00023×10^{-6}	0.00014×10^{-6}	0.00072×10^{-6}
	URF 0.345 per f/ml lifetime thru age 16, 7402 & Protocol Structures[c]	0.00026×10^{-6}	0.00016×10^{-6}	0.00081×10^{-6}
Reasonable Maximum	URF 0.23 per f/ml lifetime, 7402 Structures	0.027×10^{-6}	0.051×10^{-6}	0.17×10^{-6}
	URF 0.23 per f/ml lifetime, 7402 & Protocol Structures	0.039×10^{-6}	0.04×10^{-6}	0.13×10^{-6}
	URF 0.345 per f/ml lifetime thru age 16, 7402 & Protocol Structures	0.046×10^{-6}	0.052×10^{-6}	0.17×10^{-6}

[a] IRIS Risk Assessment Protocol with estimated 7402 (PCME) structure counts only.
[b] IRIS Risk Assessment Protocol with estimated 7402 (PCME) and Protocol structure counts.
[c] IRIS Risk Assessment Protocol with estimated 7402 (PCME) and Protocol structure counts and calculated URF from life table for early life (0.345 per f/ml, extended to age 16) exposure to asbestos.[126]

This screening risk estimate, using conservative (protective) worst-case assumptions, indicates risk levels that are less than the U.S. EPA level of one in one million excess cancer risk (by factors ranging from >1000 for average or typical exposures to 6-40 for reasonable maximum estimates). This indicates that the true cancer risks to beach users at IBSP are less than the standard range of acceptable risk. It also indicates that nourishment sand from the North Point Marina and the Approach Channel to Waukegan Harbor, if applied to the beach, would not raise the risk above the U.S. EPA level of one in one million excess cancer risk.

Important sources of uncertainty in this analysis includes:

1. The predictive certainty of the emissions model for PM_{10} releases and the applicability of PM_{10} releases to accurately represent asbestos emissions;

2. The sample preparation (Superfund/Elutriator) method's ability to appropriately represent the ratio of asbestos structures to PM_{10} in the natural sand environment;

3. The comparability of microscopy performed by the 7402 and Protocol methods to the microscopy (PCM) used to develop the U.S. EPA slope factor;

[126] U.S.EPA, "Airborne Asbestos Health Assessment Update", EPA/600/8-84/00F, June, 1986, Table 6-3, p. 165.

4. The appropriateness of the U.S. EPA Unit Risk Factor and its inherent assumption of a linear and no-threshold exposure-response relationship.

Discussion and Conclusions

The screening risk assessment indicates the asbestos structures in the sand pose minimal health risks to beach visitors performing normal beach activities at the IBSP North Unit or beaches nourished with lake-bottom sand from the North Point Marina or the Approach Channel to Waukegan Harbor, as addressed in Table 7, based on the sample results and the emissions model utilized. The screening risk assessment estimates do not address the potential risk from handling ACM. The condition, friability, and handling circumstances for any particular piece of ACM are not predictable. GLCEEH believes that the greatest potential risk to beach users in the targeted areas is the potential handling of ACM.

The historical review of IBSP indicates that ACM washing onto the beach is still a concern. It appears that most of the ACM is housing or construction related. Approximately 74% of the materials found by environmental contractors who performed beach surveys during eleven weeks in 2004 were transite or transite-like materials. In the past, such materials were typically used for siding or water/sewer pipe. A great deal of mixing of sand and potential sources of ACM has occurred due to the natural forces of the lake and the transport of sand for beach nourishment purposes. There are several possible sources of ACM in the general area.

Some ACM may still be present in the remainders of the feeder beach. The estimate of the volume of sand on the feeder beach indicates that it has been depleted to about 1% of original volume from 1989 to 2004. There also may be some available store of ACM buried shallowly in the beach sand or buried or exposed in shallow water in the area. ACM may also still be present in the remainders of housing infrastructure located near Kellogg Creek and 21st Street.

The strongest lake forces that may affect ACM present on the lake bottom in the nearshore zone are wave action, littoral drift, and ice scouring. These forces generally act parallel to the shore or towards the shore.[127]

Natural lake forces may explain why ACM and other materials tend to wash up on the beaches. The tendency of smaller particles, including asbestos structures, to progress toward the deeper lake bottom might account for the much lower silt content of beach sand versus lake bottom sand at the North Point Marina and the Approach Channel to Waukegan Harbor. The silt content and its asbestos component are reduced when sand from these sources is deposited offshore, as is the most recent practice for beach nourishment from these sources. This is supported by the differences in measured silt content of beach sand (0.1 – 1.0% silt) versus lake-bottom sand (8.3 – 9.2%).

ACM has been found on beaches in both IBSP North Unit and IBSP South Unit. However, the sampling results indicate that the concentration of asbestos structures per gram PM_{10} in sand at

[127] Personal communication with Coastal Geologist Michael Chrzastowski on March 17, 2005.

the IBSP North Unit beaches are significantly greater than at the IBSP South Unit. The sampled areas of IBSP South Unit do not have levels of asbestos structures that are statistically significantly different than levels found at background areas, although the ACM findings appear to be comparable on both beaches. Therefore, the ACM findings alone do not account for higher levels of asbestos structures at the IBSP North Unit beach. The source of the higher levels is not apparent from the available information. Levels at IBSP North Unit may be due to past practices of transporting nourishment sand from other areas directly to the Feeder Beach, although there is insufficient information to verify this possibility. IBSP South Unit beaches are much more popular among users than IBSP North Unit beaches.

Historical information was also reviewed for this report. Air sampling results from 61 area and two personal air samples analyzed by TEM and collected in or near IBSP by environmental contractors for previous IBSP reports indicate non-detectable concentrations on most (60 of 63) samples and minimal concentrations (just above the LOD) on three samples. Personal monitoring of workers and analysis with PCM indicate asbestos concentrations above the LOD on 6 of 123 samples collected. The one of six samples with elevated levels was collected on a worker during remediation of ACM and the other five were collected on workers close to the sand screening operation. All air sample concentrations for workers were below the OSHA Permissible Exposure Limit. These samples were collected under a variety of conditions and activities.

Recommendations

As detailed above, the asbestos structure concentrations in sand in the target areas at IBSP North Unit and IBSP South Unit beaches and lake-bottom beach nourishment sources at North Point Marina and the Approach Channel to Waukegan Harbor predict risk levels less than the U.S. EPA benchmark risk level of one in one million. At this time, the results of this study indicate that there is no reason to exclude the use of these lake-bottom sand sources for beach nourishment. For an extra measure of safety, lake-bottom sand should continue to be deposited off shore, as is the current practice, rather than directly to onshore areas of the beaches. Although this suggestion may inhibit erosion control options in the future, it is the most prudent approach unless or until more information is known about asbestos concentrations in lake-bottom sand.

The management of IBSP must minimize potential for human exposure to ACM whenever possible. ACM is still present in the general area. Therefore, four recommendations are presented:

1) Beach surveillance and pickup of ACM appears to be the only currently available means to remove ACM from the ecosystem. In 2004, the surveys documented ACM findings so that the numbers, volume, locations and types of ACM at IBSP could be evaluated. This is useful information. Therefore, GLCEEH recommends that beach surveillance for ACM should be continued and expanded. Surveys may be difficult and even dangerous during periods when the nearshore is frozen, so the schedule should not include those time periods. A reasonable schedule would be 2 surveys per week during the months of March to May and September through November. Additional surveys (3 times per week) should be performed during the summer periods of high beach activity. This schedule could include targeted surveillance after inclement high wind and wave events. These surveys should include detailed record

keeping of ACM findings, including date, location, size, and description of materials. Only a small percentage of suspect materials need to be tested for asbestos content if similar materials have been found and tested before, although new types of materials should continue to be tested. Air sampling of personnel performing such surveys should continue in accordance with applicable OSHA and/or Illinois Department of Labor rules and regulations. The results of air sampling and the effectiveness of beach surveillance should be reviewed annually to monitor possible changes in the level and dynamics of ACM findings and the need for increased or decreased surveillance. Surveillance should be a high priority and should not be allowed to fall off due to funding reductions or other reasons unless or until it is determined that ACM findings are declining.

2) Current IBSP visitor education about ACM should be reviewed to determine whether visitors understand the issues and can recognize common ACM types found at IBSP. Visitor education should be a high priority and should not be allowed to fall off due to funding reductions or other reasons unless or until it is determined that ACM findings are declining.
3) Areas that are impacted by erosion, that had housing communities present in the past, and that may still have housing infrastructure in place should be surveyed for ACM. The area from Kellogg Creek to 21st Street in the IBSP North Unit may be one such area. If infrastructure that includes ACM is present, it should be remediated by using techniques in accordance with applicable Illinois Department of Public Health, OSHA, and/or Illinois Department of Labor rules and regulations for asbestos abatement.
4) Alternative options for long-term beach nourishment and erosion management should be explored in full in order to reduce the expense and potential environmental and ecological impacts involved in obtaining sand for beach nourishment.