Radionuclide Contamination from the 1940s in a New York City Park – 14518

Carl Young, Cabrera Services Inc.

ABSTRACT

A large urban park in New York City is contaminated with radionuclides likely associated with the site's use as a municipal landfill in the 1940s. The site is Great Kills Park, which is part of the Staten Island unit of Gateway National Recreation Area, and is now a property of the National Park Service. Up to the 1930s, the area of the park was a wetland and barrier island. Beginning in 1933 a 'marine park' project was begun to develop Great Kills Harbor by the New York City Department of Parks. Under the direction of the urban planner Robert Moses, the park was operated as a municipal landfill from November 1944 until July 1948 to raise its elevation. Approximately 15 million cubic yards of municipal solid waste was disposed and partially covered with clay and sludge that was reclaimed from city sewage plants. Great Kills Park received roughly 35% of the city's municipal solid waste during its operation. As part of a Time Critical Removal Action, gamma walk-over and drive-over surveys are being completed and have to date identified over 100 spots.

INTRODUCTION

A 194 hectare (480 acre) urban park in New York City is contaminated with radionuclides likely dating from the 1940s, when the site was landfilled with municipal solid waste. The site is Great Kills Park, which is part of the Staten Island unit of Gateway National Recreation Area, and is now a property of the National Park Service. The park is located on the south shore of Staten Island on Lower New York Bay (Figure 1).

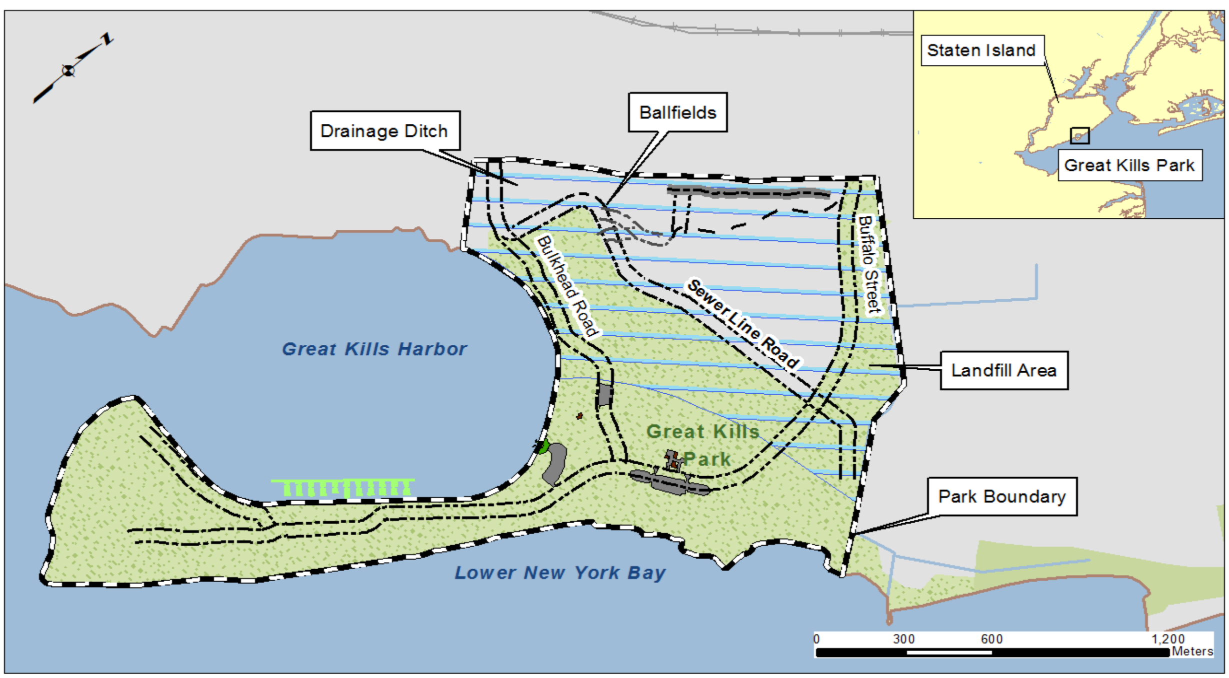

Figure 1 Great Kills Park, Staten Island, New York

The National Park Service was made aware of potential radiological contamination in the park in 2005, when the New York Police Department conducted a wide-area aerial radiological survey of the city. The National Park Service conducted a preliminary investigation to verify that radiological contamination was present. The National Park Service is now working with the US Army Corps of Engineers to conduct a Time Critical Removal Actions.

SITE HISTORY

Historically, the area of the park was a barrier island with a wetland separating it from Staten Island. Beginning in 1933 a project was begun by the New York City Department of Parks to develop Great Kills Harbor into a 'marine park'. A steel bulkhead was installed around the harbor and 1.5 million cubic yards of sediment was dredged from the harbor and deposited in the wetlands and marsh behind a bulkhead. Under the direction of the urban planner Robert Moses, the park was landfilled with municipal solid waste to raise its elevation. Landfilling operations were conducted using barges and trucks from November 1944 until July 1948. Approximately 11 million cubic meters (15 million cubic yards) of municipal solid waste was disposed in the former wetlands area and reportedly covered with clay and sludge that had been reclaimed from city sewage treatment plants. The thickness of the fill layer ranges up to 4.5 meters (15 feet). [1] Great Kills Park received roughly 35% of the city's municipal solid waste during its operation. The Great Kills landfill was opened after barge-fill operations at Rikers Island were completed and was the immediate predecessor to the Fresh Kills Landfill, which was opened in 1947. [2] Great Kills was operated as a city park from 1949 until 1972, whereupon it became a part of the Gateway National Recreation Area (GATE). GATE is a 108 square kilometer (42 square mile) assemblage of units of the National Park Service, located across the coastlines New York City.

REMOVAL ACTIONS

An aerial background gamma radiation survey of New York City was conducted by the federal government at the request of the New York City Police Department Counterterrorism Unit in 2005 that identified five spots in the park. Further onsite investigations in 2005 measured the spots reading up to 12 microsieverts per hour (µSv/hr) (1.2 millirem per hour (1.2 mrem/hr)). The police department further determined that the source of the radiation was radium-226. The US Environmental Protection Agency (USEPA) conducted a Radiation Response Investigation and recovered several small pieces of radium-contaminated metal from the shallow subsurface. Upon the recommendations of the USEPA, the spots were fenced off from public access. The Agency for Toxic Substances and Disease Registry (ATSDR) performed a health consultation in 2007. [3] ADSDR recommended that a historical records search be undertaken to determine potential radiological and chemical contaminants, perform a complete characterization of the park, and perform complete radiological characterizations of the spots. A preliminary assessment was performed for the National Park Service in 2007 and concluded that the park was impacted by Naturally Occurring Radioactive Materials. [4]

An interim response action was conducted in 2010 to remediate five known locations. The locations were remediated, including a 370 megabecquerel (MBq) (10 millicurie (mCi)) radium medical source, but seven additional spots were also discovered. [5] One of the locations was an area of shallow contaminated soil approximately 10 meters across. A soil sample acquired from the edge of this area had elevated levels of uranium-238 at 5.62 becquerels/gram (Bq/g) (152 picocuries/gram (pCi/g)) and thorium-230 at 2.18 Bq/g (59 pCi/g) as well as other uranium decay progeny. The sample did not have the high concentrations that would be expected in ore, but the sample was intended as a confirmatory sample to mark the edge of the excavation, indicating that the waste that was excavated contained much higher uranium levels.

In 2013, a systematic gamma survey of the landfilled area commenced as part of a Time Critical Removal Action. The landfilled area is being cleared of most vegetation to allow for a combination of walk-over and drive-over surveys.

The major components of the drive-over system consist of an all-terrain vehicle equipped with a computer console, digital signal spectrometers, GPS units, and two four-liter sodium iodide gamma detectors encased in carbon fiber. The detectors are coupled to a photo multiplier tube system that produces analog signals for a digital spectrometer module, which produces a fully linearized 1024 channel spectrum for additional analysis using software. The spectrometer is able to achieve very clean linearized spectra, at high throughput data rates of approximately 10 counts per second data sampling. The drive-over system is also configured with global positioning system and gamma spectroscopy analysis.

The drive-over survey is designed to identify a 37 MBq (1 mCi) ^{226}Ra source buried up to 1 meter (3.3 feet) below ground surface under normal background conditions. The designed velocity of the drive-over survey system is one meter/second (m/s) based on the project design of 1 second residence time over an area 2 meters wide by 1 meter long giving a coverage of 2 meters square. Isotopic identification of radionuclides is available in real-time. The on-board computer is set to alarm when a count-rate corresponding to an exposure rate of 1 µSv/hr (0.1 mrem/hr) is detected, which amounts to roughly 10 times normal background reading. At these locations, the operator can park the detectors above the location for a period of several minutes to acquire the needed data to determine the depth of burial.

Traditional walkover surveys are being conducted in areas that are not accessible to drive-over surveys. The typical walkover survey occurs along parallel transects across a defined area, with the transects being 1 m apart. Each transect contains data points that are 0.5 m apart set by the operators pace of 0.5 m/s. A GPS is coupled to a radiological meter and 7.6 x 7.6 cm (3 x 3 inch) sodium iodide detector to give coordinate-based positional data.

To date more than 100 spots with ground surface readings exceeding 1 µSv/hr (0.1 mrem/hr) have been identified. Several of the locations have to date been investigated and radium-contaminated debris has been found. One radioactive consumer item has also been recovered to date, which appears to be a radioluminescent post marker.

DISCUSSION

Radium needles and tubes were used for brachytherapy [internal radiotherapy] from approximately the 1920s to the 1950s, when they were replaced by reactor-produced radionuclides. Until the 1950s radium was the exclusive radionuclide used for brachytherapy. In the 1940s brachytherapy sources were comparatively expensive and recognized as hazardous and were not discarded. [6] Lost needles were actively searched for, including the use of private investigators, and publishing notices to the public in newspapers. [7]

A large hospital would have had a stock of up to 100 brachytherapy sources of various sizes. The most-common size was 370 MBq (10 mCi), ranging up to the 1.11 GBq (30 mCi) size. The largest American producer of brachytherapy sources was Radium Chemical Company (RCC) located in New York City. From 1939 to 1944 RCC occupied a building located at 235 E. 44th St. In 1944, RCC moved to 60-06 27th Avenue, Woodside, Queens. The 44th Street location was found to be contaminated with radium. [8] The 60-06 27th Avenue location was also highly contaminated with radium. [9] During the subsequent cleanup of its final location, USEPA removed 10,000 radium needles for disposal. The inventory was called 'the world's largest cache of radium'. [10]

The soil sample acquired in 2010 had several radionuclides from the U-238 decay chain, consistent with the presence of uranium ore. Large quantities of uranium ore were stored on Staten Island at the former Archer Daniels warehouse during the mid-1940s. The ore was owned by African Metals Corporation (a division of Union Minière du Haut Katanga). The uranium content of the ore was sold to the US Government for use in the Manhattan Project, while the balance of the mineral content remained the property of African Metals Corporation. The warehouse was located at the foot of the Bayonne Bridge at 2393 Richmond Terrace, Port Richmond, Staten Island, New York. The warehouse was apparently demolished sometime between 23 December 1943 and 16 June 1946. No records have been found that indicate the disposition of the debris from the warehouse demolition. The warehouse location is 10 kilometers (6 miles) from Great Kills Park. At the time of its use for uranium ore storage, the warehouse was owned by the Archer Daniels Midland Company. The warehouse property is contaminated with uranium ore. The former Archer Daniels Midland warehouse site is known as the 'Staten Island Warehouse' to the Department of Energy Office of Legacy Management, who have declared the site eligible for cleanup under the Formerly Utilized Sites Remedial Action Program (FUSRAP). [11]

CONCLUSIONS

To date more than 100 spots have been located in Great Kills Park that have ground-surface gamma readings exceeding 1 µSv/hr (0.1 mrem/hr). The occurrence of a large amount of radioactive debris and sources in the landfill layer suggests that a decontamination effort was conducted in the 1944-1948 timeframe and that some or all of the contamination resulted from disposal of these wastes. The sources may have been lodged in contaminated equipment and inadvertently disposed. Examples of this equipment include laboratory benches or cabinets. The responsible party may have had a large inventory and poor quality control practices. The data suggest that the former Radium Chemical Company is a potentially responsible party, especially because of the timing of their relocation to the company's ultimate office location. The disposal of the radioactive waste may have resulted from discarding or decontamination of unwanted equipment during the move.

Uranium ore may also be present in the former landfill area and it may have come from the former Archer Daniels Midland warehouse, which was located not far away from Great Kills Park. Records indicate that the warehouse was demolished during the time of use of the park site as a municipal landfill, and the landfill would be the most likely destination for the building debris. Finally, there is evidence of the disposal of commercial products that are radioactive, such as the post marker that was recovered.

Use of municipal solid waste to fill wetlands and low-lying areas has been an important waste-management option for New York City for more than 100 years. A recent study found that over 185 square kilometers of coastline has been landfilled in the five boroughs of New York City. [12] Historic landfills would have accepted industrial wastes as well as municipal solid wastes. Eleven radionuclides from the uranium-238 decay chain rank in the upper half of the list of 275 substances in the US Environmental Protection Agency's Priority List of Hazardous Substances. [13] Therefore radionuclides should be suspected in many historic landfills.

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