

Letter Health Consultation

CARNOTITE REDUCTION COMPANY SITE

CHICAGO, ILLINOIS

**Prepared by
Illinois Department of Public Health**

DECEMBER 4, 2013

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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Ms. Vernetta Simon
U.S. Environmental Protection Agency, Mail Code 5E-5J
77 W. Jackson Blvd.
Chicago, IL 60604-3507

Dear Ms. Simon:

On August 22, 2012, during a phone conversation with the Illinois Department of Public Health (IDPH), West Chicago Regional Office, you requested a letter health consultation on the Carnotite Reduction Company Site, Chicago, Illinois. Concerns included:

1. The presence of radioactive contamination in surface soil.
2. Possible radon infiltration into nearby buildings.
3. The possible presence of soil contamination at depths greater than 18 inches (the limit of detection from the surface with hand-held instruments).
4. The possibility that on-site construction could bring subsurface contamination to the surface, increasing human exposure.

Background and History

To evaluate the Carnotite Reduction Company (Carnotite Co) site, IDPH reviewed information and data supplied by the U.S. Environmental Protection Agency (USEPA, including gamma radiation survey results, radon monitoring results, maps, and soil sampling results), information on the USEPA Region 5 website (Action Memorandum and historical documents), and information found using a Google search for "Carnotite Reduction Company." U.S. demand for radium increased dramatically in 1913, when the U.S. government founded the National Radium Institute to research using radium for cancer treatment. From about 1915 to at least 1920, the Carnotite Co. ran a radium extraction facility near 26th Street, between Martin Luther King Drive and Ellis Avenue in Chicago. The historical address was 2600 S. Inglehart Court, but that street no longer exists. Historical maps show that Inglehart Court ran north-northwest to south-southeast across the site; however, USEPA has not found any detailed maps or photographs of the Carnotite Co. during its short period of operation. The Carnotite Co. site boundaries are uncertain, although an approximately 3 acre area with known surface and subsurface contamination has been identified along 26th Street and in parkland south of 26th Street. This 3

acre area resides within the northern part of the former Michael Reese Hospital and Medical Center (Michael Reese), which covered 37 acres.

Other industries that once operated on the northern part of the Michael Reese property included a large brewery and a paper company. The Conrad Seipp Brewery was on the northeastern part of the Michael Reese property and went out of business in 1933. The brewery was demolished in that year, and a hospital building was constructed. The paper company building eventually became the northernmost building on the Michael Reese property, Building 1. The years of its operation as a paper company are unknown. Building 1 was in an area potentially contaminated by the Carnotite Co. and was adjacent to the 3 acre area with known contamination. Several active railroad tracks are east of the site.

The Carnotite Co. owned and operated mines in Colorado and Utah. In 1919, it was one of four companies that mined 95% of the carnotite ore produced in Colorado. The U.S. dominated the world radium market until 1922, when Belgium began using pitchblende ore from the Belgian Congo. The pitchblende was 40 to 100 times more pure than carnotite, and by 1923, Belgian competition ended carnotite ore processing in the U.S.

The chemist, Dr. H.W. McCoy, was the president of the Carnotite Co., and he also was vice-president of the Lindsay Light Company, which processed monazite sands into thorium for gas light mantles at another location several miles to the north in Chicago. The Carnotite Co. mainly produced radium, along with some uranium and vanadium as byproducts. The Carnotite Co. used a method patented on January 21, 1919 by Dr. H. W. McCoy. The extraction process used a uranium ore, carnotite, which contains mainly (more than 99%) uranium-238, along with much smaller amounts of uranium-234 and uranium-235, as well as small amounts of radium, a radioactive decay product of uranium. The ore likely was delivered by rail. The carnotite ore used at the facility was sandstone, with carnotite in the cement that held the sand grains together. The extraction process used sulfuric acid to remove uranium and vanadium, with the radium remaining in the sand portion as insoluble radium sulfate. The process then used hydrofluoric acid to dissolve the sand, along with sulfuric acid to convert the radium to insoluble radium sulfate. The radium sulfate was left in the remaining residue. One ton of carnotite ore produced about 20 pounds of this residue, which was further processed to purify the radium. Radium was only a small component in the ore. During the 11-year period that the U.S. dominated the world radium market, all U.S. radium facilities combined produced only about 197 grams of radium. Because the extraction process used at the Carnotite Co. dissolved the sand, resulting in about 20 pounds of solid material from a ton of ore, most of the waste material would have been liquid, rather than solid. The US Environmental Protection Agency (USEPA) suspects that the Carnotite Co. may have sent this liquid waste into the sewer, floor drains, or reintroduced it into the process for further refining. Because streets in the area, including Inglehart Court, were abandoned during the redevelopment in the 1950s and 1960s, sewers running along those abandoned streets likely also were abandoned. Other options for liquid waste disposal commonly used at the time included streams or ditches (with Lake Michigan in the vicinity), waste ponds, dug wells, and dumping wastes on porous ground (such as the sand on-site).

The original Michael Reese Hospital was built in 1880 at 29th Street and Grove Avenue, and this building was replaced by a larger hospital in 1907. In the 1950s and 1960s, Michael Reese

expanded and constructed many buildings. Construction and re-grading of the land during this development may have dispersed contamination from the Carnotite Co. site. The demolition of old buildings and the construction of the Prairie Shores apartments, five high-rise residential buildings south and southwest of the site, as well as tennis courts on the parkland south of 26th street, also may have dispersed radioactive contamination. The area was low-income before the Prairie Shores development, but the Prairie Shore apartments are mixed income, with rents from \$750 to \$2,000 per month.

In 1979, the Division of Radiological Health, IDPH, and USEPA conducted a radiological surface survey of the Michael Reese property and found several areas with radioactive contamination. The IDPH Division of Radiological Health concluded that the contamination did not pose an immediate health threat, but should be taken into account before any future construction. In 1979, IDPH did not notify USEPA about the contamination they found. The IDPH Division of Radiological Health subsequently became the Illinois Department of Nuclear Safety. After the September 11, 2001 terrorist attacks, the Illinois Department of Nuclear Safety became the Division of Nuclear Safety of the Illinois Emergency Management Agency (IEMA).

In September 2008, the owner of Michael Reese Hospital filed for bankruptcy. In June 2009, the City of Chicago (City) bought the former Michael Reese property. The City planned to use the property for the Olympic Village during the 2016 Olympics, but Chicago was not selected to host the 2016 Olympics. Before buying the property, the City conducted Phase I and Phase II environmental investigations, which did not survey for radiological contamination and also failed to mention the radioactive contamination found in 1979.

On August 12, 2009, IEMA confirmed the presence of radioactive contamination on the northern part of the former Michael Reese property, and they subsequently notified USEPA of the contamination. IEMA found total radium concentrations of 26 to 107 picoCuries per gram (pCi/g) and total uranium concentrations of 67 to 234 pCi/g. By October 5, 2009, the City began demolishing buildings on the former Michael Reese property. On October 5, 2009, USEPA met with the City Department of Environment to discuss remediation of the Carnotite Co. site.

From April 11 through May 4, 2011, under USEPA oversight, AECOM, an environmental consultant hired by the City, performed surface gamma radiation monitoring and made 215 subsurface borings at the Carnotite Co. site. AECOM found that fill, consisting of soil, gravel, concrete, bricks, and other building rubble overlaid the natural sand of the area. Over most of the property, the fill was 4 to 6 feet deep, but the fill was more than 12 feet deep under the tennis courts. AECOM also found many buried building foundations which were in the natural sand under the fill. Contamination was mostly in the top 4 feet of soil, and extended down to 12 feet only near 26th Street, on the northern part of the site. Under the tennis courts, contamination was within 4 to 5 feet of the surface. AECOM found total radium concentrations of 4.2 to 246 pCi/g in the top foot of soil, up to 530 pCi/g in the top 2 feet of soil, and the greatest concentration, 1,181 pCi/g, was at 5 feet of depth. AECOM also determined the isotopes of radium. Only 2 of 58 soil samples exceeded 5 pCi/g of radium-228, with the maximum concentration being 56 pCi/g at 5 feet of depth (same sample with 1,181 pCi/g total radium). By contrast, 26 of 58 soil samples exceeded 5 pCi/g of radium-226, with a maximum concentration of 1125 pCi/g. The greatest concentration of radium-226 in the top foot of soil was 240 pCi/g. Total uranium

concentrations ranged from background (typically about 1 pCi/g) to 158 pCi/g in the top foot of soil, and from background up to 2,435 pCi/g in the top three feet of soil. The greatest total uranium concentration, 3,670 pCi/g, was at 7 feet of depth. The surface soil sample with the greatest concentration of uranium and radium also contained 75 pCi/g of thorium-234, 89 pCi/g of protactinium-234m, 257 pCi/g of lead-214, 233 pCi/g of bismuth-214, 3.53 pCi/g of actinium-228, 6.38 pCi/g of bismuth-212, and 2.91 pCi/g of thallium-208. Radium-226, thorium-234, protactinium-234m, lead-214, and bismuth-214 are radioactive decay products of uranium-238. AECOM also found that the concentrations of radium and uranium varied somewhat independently, although only two of 58 soil samples had uranium concentrations greater than 20 pCi/g, but radium concentrations less than 5 pCi/g. AECOM thought that the variations in radium and uranium concentrations were caused by differing amounts of contamination from the original ore (greater uranium concentrations) and the processed material (greater radium concentrations). The greatest radium and uranium concentrations were in the northwestern part of the site, along and under 26th Street. In this area, some of the greatest gamma spectroscopy readings were 12 feet deep in iron-stained sand, which may represent contaminated natural sand and not fill. This area near 26th Street had greater uranium concentrations and contamination at greater depths than the rest of the site. AECOM concluded that additional contamination was present north of the investigation area, under the Advocate parking lot.

During a December 7, 2011 meeting between the City and USEPA, the City said that it planned to demolish the last Michael Reese building, Building 1, and then secure the site. The only cleanup would be what was necessary for the demolition, and further cleanup would await redevelopment of the site. Several competing redevelopment plans had been proposed, due to the location near McCormick Place, available streets, and public transportation. On January 1, 2012, the City abolished the Chicago Department of Environment and reassigned its staff to several different departments. USEPA is concerned how this will affect future interactions between USEPA and the City, as well as any City oversight of radiation monitoring or cleanup activities at the Carnotite Co. site.

In 2012, USEPA performed radon monitoring in the basements of buildings near the site. Three-day and 90 day radon monitors in the Advocate building and three-day monitors in the Prairie Shores buildings found radon concentrations below the USEPA action level of 4 pCi/L, and most measurements were less than 1 pCi/L. Prairie Shores denied USEPA access to use 90 day radon monitors, but Prairie Shores hired a contractor to run 90 day monitors. The 90 day monitors also found concentrations less than 4 pCi/L; however, they violated the sampling protocol by having no control samples.

In June 2012 and on December 10, 2012, investigations by USEPA confirmed elevated gamma radiation in the area found by AECOM, as well as contamination in additional areas not surveyed by AECOM. The areas of contamination were discontinuous, which may have reflected the covering of buried contamination by more than 18 inches of clean material, discontinuous deposition of contamination by industrial or waste disposal practices at the Carnotite Co., or movement of contamination during past construction in the area. AECOM found no contamination in several borings south of the tennis courts, but USEPA found contamination in parkland further yet to the south, indicating that subsurface contamination is also discontinuous in that area. This area of contamination was east of the northernmost Prairie Shores parking lot.

USEPA found elevated gamma radiation readings along a sewer line at 30th Street and Cottage Grove, along the southwestern side of the Michael Reese property. USEPA is uncertain whether the apparent sewer line-related gamma radiation readings originated from the Carnotite Co., the possible past disposal of radionuclides in the sewer by Michael Reese in the era before governmental regulation of radionuclide disposal, or the use of construction or fill materials either of Carnotite Co. origin or other material with naturally occurring radioactive material (NORM) content. USEPA found some spots with slightly elevated gamma radiation levels scattered on the Michael Reese property. A parking lot of Prairie Shores north of 29th Street also had elevated levels of gamma radiation about 2 to 3 times greater than background. USEPA estimated that about 22,000 cubic yards of contaminated soil exist at the Carnotite Co. site, but this estimate may increase if further investigation finds additional contamination.

IDPH, USEPA, and Agency for Toxic Substances and Disease Registry (ATSDR) staff conducted a site visit on January 23, 2012. The area around the site included an Advocate medical center, residential high-rise buildings, parks, and tennis courts. A parking lot for the Advocate medical center was immediately north of an area with known contamination, and the parking lot likely covers contamination. The Advocate building is north and northeast of that parking lot. Twenty-sixth street curves southward east of Advocate and then curves eastward toward Ellis Avenue. The former Michael Reese Building 1 and its concrete parking lot were north of 26th Street and east of the most highly contaminated area along 26th Street. By January 23, 2013, Building 1 had been demolished. Prairie Shores, with five high-rise, mixed-income apartment buildings, was south and southwest of the site. The northern parking lot of Prairie Shores was immediately south of a contaminated area, and the parking lot may cover contaminated soil. The 27th Street Metra train station was east of the site and was used by about 100 people per day. There is no parking at the train station, which must be reached by walking from the west or the south. From the west, people walk along 26th street through the area of the site with the greatest contamination. From the south, people walk along Ellis Avenue. Parkland, with open areas and tennis courts, were south of 26th street and north and east of the northernmost parking lot of Prairie Shores. The areas with known contamination (including the parkland and tennis courts) were fenced to prohibit public access, but the fencing did not have barbed wire. The fencing excludes people from the most contaminated parkway (and sidewalks) along 26th Street and Ellis Avenue. Some unfenced parkway along 26th Street had gravel to reduce exposure to contaminated surface soil. A gate on Ellis Avenue near the Metra station permitted pedestrian traffic, but prevented vehicular traffic on 26th Street (now a dead end) from entering Ellis Avenue. Ellis Avenue was closed to vehicular traffic between 26th Street and 29th Street. The areas with known or suspected contamination were covered with grass, pavement, or gravel, and no bare soil was noted.

On October 2, 2013, the City notified USEPA that they are in the process of submitting a license application to IEMA for a temporary storage facility to be used during the cleanup of the Carnotite Co. site. After removal and temporary storage, the radioactive materials will be shipped to a licensed off-site permanent disposal facility. The City needs to do further characterization of the site to determine the nature, extent, and total volume of contamination before they can complete their license application. They will use 5 pCi/g of total radium above background as the cleanup criterion (uranium mill tailings standard).

Exposures and Associated Health Risks

Everyone is exposed to background levels of alpha, beta, and gamma radiation from naturally occurring radionuclides in the environment. Exposure to alpha and most beta particles requires the radionuclide to be ingested or inhaled, although some have enough energy to penetrate the outer layer of skin and expose the skin underneath (dermis). People also are exposed to radiation through human-generated sources, mainly medical in nature. People who receive repeated x-rays or radiation therapy are exposed to more radiation than most people. Smokers expose their lungs to radiation levels up to 56 times background because tobacco plants accumulate naturally occurring polonium-210 from the soil, which is then present in the smoke.

Depending upon the absorbed radiation dose and exposure duration, ionizing radiation can cause cancer. Cancers caused by radiation cannot be distinguished from cancers that occur spontaneously or are derived from chemical exposures. Also, cancers caused by radiation usually occur 10 or more years after exposure. Although high doses of radiation can cause mutations and cancer in animals and humans, the effects of low doses are less certain. As for chemical carcinogens, some researchers believe that body repair mechanisms can handle low doses of radiation, and that higher doses are needed to cause cancer. To be protective, USEPA assumes that any increased exposure to radiation increases the cancer risk, and they have classified all radionuclides as known human carcinogens.

The Carnotite Co. processed uranium ore, which contains radium as a decay product. The vast majority (99%) of natural uranium is uranium-238, which has radium-226 as a decay product. Because grass, gravel, or pavement covers all the contaminated soil, ingestion of radionuclides from contaminated soil likely is minimal. Exposure to gamma radiation from the contamination is more likely. Gamma radiation can travel easily through the air, and a person walking over a source of gamma radiation may be exposed to increased amounts of gamma radiation. However, large buildings, concrete sidewalks, and asphalt pavement may attenuate gamma radiation, reducing exposure. Because people walking to the Metra station walk along the street, shielding from the asphalt may reduce gamma radiation exposure. IDPH calculated gamma dose exposure rates using the USEPA Federal Document 12 guideline and the radionuclide concentrations in the soil sample with the greatest surface concentrations of radium and uranium, using the dose coefficients for whole body exposure for contaminated soil of infinite depth. For uranium, the percentage of isotopes present in contamination at the Carnotite Co. site are unknown and may have been affected by processing at the Carnotite Co.. However, more than 99% of the uranium in carnotite ore is uranium-238, and the gamma radiation produced by uranium-234 and uranium-235 have less energy than the gamma radiation produced by uranium-238.

Consequently, for all dose calculations, IDPH used the dose coefficient for uranium-238. If a person walks through the contaminated area for 20 minutes each day to and from the train station, for 250 days per year, their dose would be 21.6 millirems per year (mrem/yr). IDPH considers this to be a maximum likely exposure situation under current conditions. Bismuth-214 and lead-214, two radioactive decay products of uranium-238, contribute about 98% of the dose, 21.1 mrem per year. A dose of 21.6 mrem/yr is considerably less than the 310 mrem/yr annual average total radiation dose from all natural sources. This is also less than the 100 mrem/yr of exposure greater than normal background permitted for the general public by USEPA and the

U.S. Nuclear Regulatory Commission. However, any change in land use could increase exposures, particularly if the duration of exposure is increased. Although unlikely, continuous 24 hour exposure to the area of the site with the greatest surface soil concentration would result in a dose of 2,261 mrem/yr, which would greatly exceed the regulatory limit for the general public. Although greater radioactive contamination occurs with depth, exposure to this contamination is not presently occurring because of shielding by overlying soil. Any construction activities could bring subsurface contamination to the surface, increasing exposure. Construction workers also could be exposed to subsurface contamination. IDPH recommends that USEPA will require radiation monitoring during any construction in the areas known or potentially contaminated by the Carnotite Co. site, and if radiation is found, USEPA will require a site safety plan and the proper disposal of contaminated soil. IDPH also recommends that USEPA will decide whether they or they and the City will provide oversight of any excavation or construction in areas potentially contaminated by the Carnotite Co. site. The removal of contaminated soil will prevent future exposure to site contaminants and associated exposure to increased levels of gamma radiation.

High dose exposure to gamma radiation can cause leukemia and non-Hodgkin's lymphoma, as well as cancers of the brain and central nervous system, bladder, bone, breast, colon, esophagus, kidney, lung, parathyroid, rectum, salivary glands, skin, stomach, and thyroid. However, the health effects of low levels of radiation, such as occurring at the Carnotite Co. site, are less certain. Some areas of the world have natural radiation levels about two to six times greater than average background levels. Health studies of people in those areas have not observed increased cancer rates; however, according to the National Academy of Sciences publications, Biological Effects of Ionizing Radiation (BEIR), 1990 and 1996, limitations of those studies reduce their sensitivity for detecting increased cancer rates. To be protective, USEPA assumes that any increased exposure to radiation increases the cancer risk, and they have classified all radionuclides as known human carcinogens.

Radium decays to produce radon, which may migrate several feet through soil into nearby buildings. Although radon monitoring did not find elevated radon concentrations in Advocate or Prairie Shores, those buildings may not have been constructed on contaminated soil. Construction of a building on radium-contaminated soil without an adequate cleanup may result in elevated indoor radon levels. Inhalation of elevated levels of radon may increase the risk of lung cancer.

Conclusions and Recommendations

The Illinois Department of Public Health concludes that exposure at the Carnotite Co. site to the area with the greatest surface radium and uranium concentration for 20 minutes per day, five days per week, 250 days per week, for 50 years is not expected to harm people's health. IDPH considers this to be a maximum likely exposure scenario, given current conditions at the site. Actual exposures may be less frequent and may be negligible. However, any change in land use could increase exposure duration, increasing cancer risks. With increased exposure duration, exposure may exceed the regulatory limit for the general public. Any excavation without adequate monitoring may bring subsurface contamination to the surface, increasing exposure. Construction of buildings in contaminated areas without removal of contamination near

foundations may cause increased indoor radon concentrations and building occupants could also be exposed to increased levels of gamma radiation, and for longer periods of exposure. Increased exposure may increase the risk of cancer. Cancers that may be increased by radiation exposure include leukemia and non-Hodgkin's lymphoma, as well as cancers of the brain and central nervous system, bladder, bone, breast, colon, esophagus, kidney, lung, parathyroid, rectum, salivary glands, skin, stomach, and thyroid.

The Illinois Department of Public Health recommends:

1. Prior to any excavation or redevelopment and under USEPA oversight, the City should establish institutional controls to require radiation monitoring during any excavations or redevelopment of areas possibly contaminated by the Carnotite Co. site. If elevated radiation levels are found, a site safety plan should be developed, and proper disposal of any excavated contamination should be required. IDPH also recommends that USEPA determine if they or they and the City will provide oversight of any construction or excavation activities in areas possibly contaminated by the Carnotite Co. site.
2. Under USEPA oversight, to prevent possible radon infiltration and possible exposure to elevated levels of gamma radiation, any radioactively contaminated material near a proposed building foundation should be removed and sent for proper disposal.
3. Under USEPA oversight, the City should continue maintaining fencing of the contaminated areas to minimize gamma radiation exposure of people walking through the Carnotite Co. site. Barbed wire may be installed to further inhibit trespassing in the closed areas of the site.
4. USEPA should continue to provide oversight for monitoring and cleanup activities in the areas with known or suspected contamination from the site.

If you have any questions about this document, please contact me at our West Chicago Regional Office, 630-293-6800 or tom.baughman@illinois.gov.

Sincerely,

Tom Baughman, PhD
Environmental Toxicologist

cc: West Chicago Regional Office
Environmental Toxicology, Springfield
ATSDR