Sites of Concern: Public Space Soil Testing in North Brooklyn

NORTH BROOKLYN NEIGHBORS

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Introduction:

The prevalence of lead in urban soils has been well documented, with contamination in North Brooklyn coming from a variety of sources, including industry, paint, and leaded gasoline. Yet when a 2019 report by WNYC found that out of three city parks, the highest levels of lead were found in McCarren Park, community members were appropriately alarmed. While North Brooklyn Neighbors (NBN) had done quite a bit of work on lead in soils, with a particular focus on safety in urban gardening, we next undertook a comprehensive analysis of public space in Brooklyn's Community District 1.

With the onset of COVID-19, the importance of public outdoor spaces as a necessity for community safety, health and well-being, became increasingly apparent. Seniors, adults, children, and pets all use these spaces and in the process, breathe in the dust and play in the soil of parks and other public spaces.

Through a grant from the New York State Department of Environmental Conservation, NBN set out to sample as many publicly accessible open spaces within Brooklyn Community District 1 as possible. We tested not only for levels of lead in the soil, but a variety of other substances as well, including other heavy metals. The results confirmed that in many public spaces, soil is contaminated with a variety of heavy metals, the most concerning being the ubiquitous levels of lead and arsenic. Contamination is found throughout the Community District, though some spaces have higher levels of pollutants and are thus more problematic than others. McCarren Park, in particular, has some of the highest levels of arsenic and lead found anywhere in the district.

Methodology:

We identified 96 open spaces to sample. Over the course of approximately 12 months, our investigator visited each site to assess and sample.

Patchy grass at Cooper Park allowed for soil sampling with minimal vegetation disturbance.

Some spaces, such as community gardens, were behind locked fences. These sites, which are not easily accessible except between certain specific hours and times of the year (many of which were closed due to COVID-19) were excluded from our study. Community gardens are often well-managed and actively cared for, with soil inputs such as compost which can serve to reduce the harm of soil toxicants. Size of an open space did not necessarily correlate with the number of samples taken. Many spaces had paving or concrete. Similarly, portions of spaces with dense vegetation, such as grass, covering the ground were not sampled. In these cases, not only would it have been difficult to sample without disturbing the vegetation, these types of plants greatly reduce risk of exposure by acting as a cover. However, the vast majority of spaces with vegetation had patchy ground cover and we were able to sample patches with low or no vegetation. Tree beds, landscaped sections, and areas behind low fences were also sampled.

Sampling was done using a hand trowel. Immediately before sampling, a new, clean wipe was used to remove any visible dirt

on the trowel. Ground surface debris (such as rocks or scattered wood chips) was swept aside and the top two inches of soil was collected. Samples were labeled and placed in a clear, plastic bag. Before sending to the lab, bags were opened and aired out for weeks at a time, to reduce the moisture content of the soils. Soil drying was done both at the investigator's residence and at the NBN office.

In total, we were able to take 155 samples from 69 different public spaces located within North Brooklyn Community District 1.

Lab Analysis:

The samples were analyzed via mass spectrometry at the laboratory of Dr. Lucia Freire-Rodriguez at the New Jersey Institute of Technology Laboratory of Applied Biogeochemistry for Environmental Sustainability[1]. All samples were tested for 21 elements: magnesium (Mg), aluminum (Al), vanadium (V), total chromium (Cr(III) and Cr(VI)), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), selenium (Se), yttrium (Y), molybdenum (Mo), palladium (Pd), silver (Ag), cadmium (Cd), lanthanum (La), cerium (Ce), gold (Au), and lead (Pb). Some samples were analyzed for levels of beryllium (Be), calcium (Ca), strontium (Sr), and tin (Sn).

Soil Standards:

A full list of results is available in the appendix. The findings are compared against the soil cleanup objectives recommended by New York State Department of Environmental Conservation (NYSDEC). These standards determine the levels of contaminants allowable when remediating a site according to the planned land use for that site and are listed in parts per million (ppm).

Below is a table which lists standards for some contaminants examined in this report according to category. All soil cleanup objective standards are in parts per million (ppm).

Contaminant	Unrestricted (Protection of Ecological Resources)	Residential	Restricted Residential
Lead	63 (63)	400	400
Arsenic	13 (13)	16	16
Chromium (VI)	1 (1)	22	110
Chromium (III)	30 (41)	36	180
Copper	50 (50)	270	270
Nickel	30 (30)	140	310
Selenium	3.9 (3.9)	36	180
Silver	2 (2)	36	180
Zinc	109 (109)	2200	10,000

The most protective standard is termed "unrestricted use," meaning that any type of activity could occur on a parcel of land meeting these standards. The state also has guidelines for the levels which are

protective of “ecological resources.” Generally for the elements we tested, the unrestricted standard and standards for the protection of ecological resources are the same (with some exceptions, such as chromium III).

The other category is “restricted use”, meaning only certain activities can take place on the parcel in order to protect public health. The two categories that we will examine here are “residential” and “restricted residential.” “Residential” is the more protective of the two and is the level to which cleanup is recommended for soils at single family homes. The soil contamination at this level is meant to be protective enough that people can safely have vegetable gardens. Less protective is “restricted residential” and this is the standard to which NYSDEC would require remediation for a park. It includes, “active recreational uses, which are public uses with a reasonable potential for soil contact.”

In some cases, the residential and restricted residential standards are the same, such as with lead and arsenic. For other contaminants, there is a different standard, such as trivalent and hexavalent chromium

Major Findings by Element:

Lead

2.6% of samples (4/155)

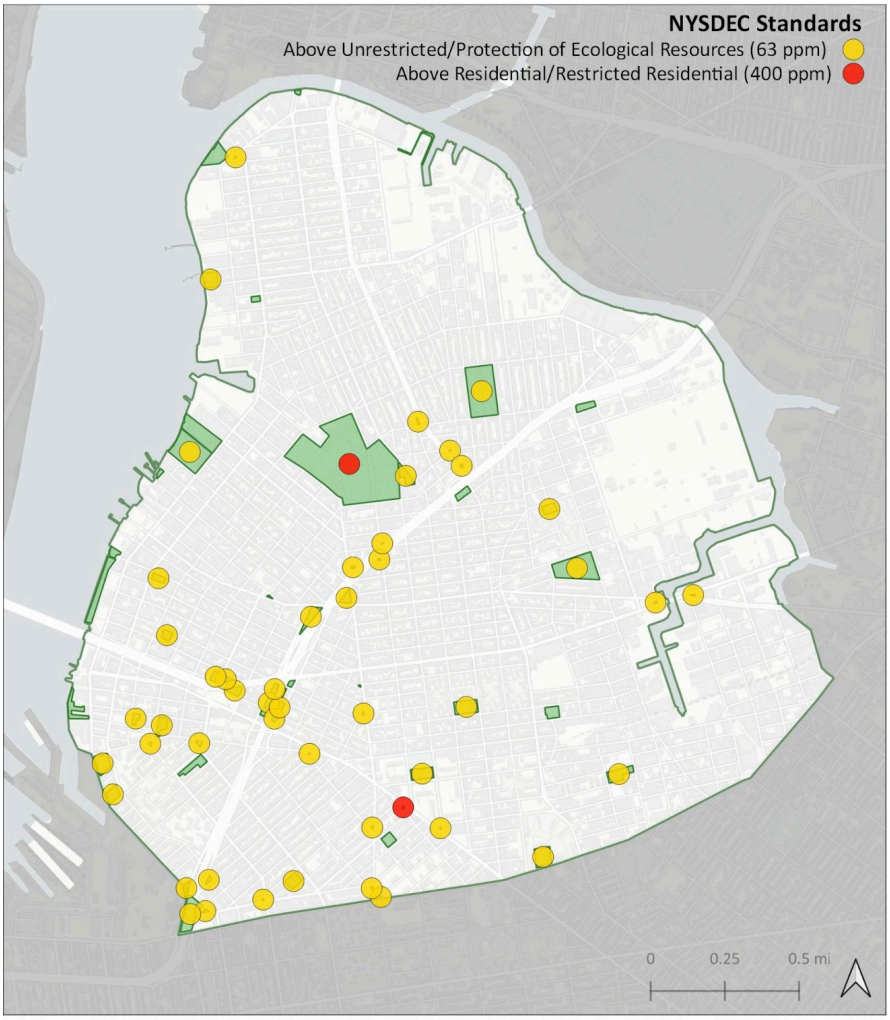
[2 of 69 public spaces] had lead levels higher than the NYSDEC standard for residential soils.

60.0% of samples (93/155)

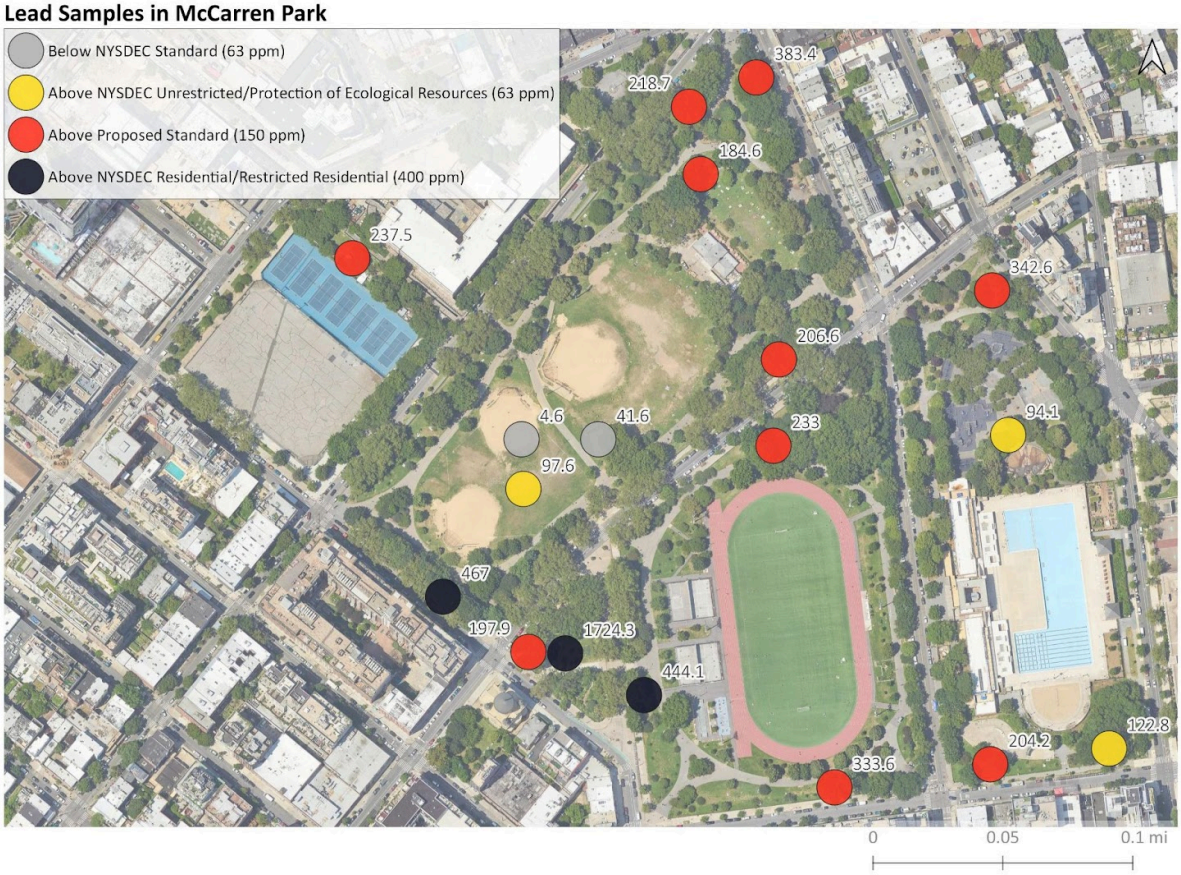
[50 of 69 public spaces] had lead levels higher than the NYSDEC standard for unrestricted use.

The results showed concerning levels of lead in many of the samples. The majority of samples had lead levels higher than those that the NYSDEC deems safe for unrestricted use. And four samples exceeded the residential/restricted residential standard of 400 ppm. Three of the four samples exceeding the standard were found at McCarren Park, and the other sample was taken from Lindsay Triangle.

Sites with Lead Levels above the NYSDEC Standards



Lead Samples in McCarren Park



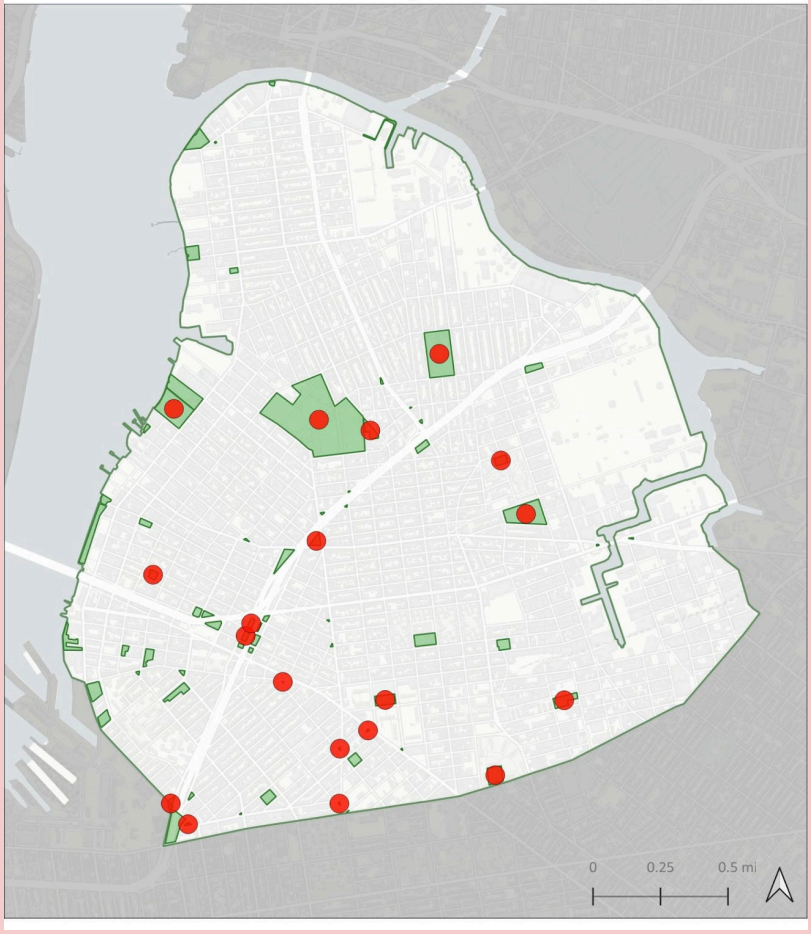
The literature shows that there is no safe level of lead exposure. Even the smallest amount of lead exposure can impact vulnerable populations. Children exposed to lead may experience inhibited growth, changes in brain development, and affected behavior. Thus it might be more instructive to look at the NYSDEC standards for unrestricted use. In this case, 50 of the 69 public spaces tested had at least one sample above the levels for unrestricted use.

Is the Standard Protective Enough?

The 400 ppm standard for lead in soil was set before 2012 when the government considered the level of concern for blood lead levels at 10 micrograms per deciliter (mcg/dL). The threshold of 150 ppm of lead in soil is based on research done by the Toxics Cleanup Program Policy and Technical Support Unit, 2010 in which it was found that a level of 150 ppm of lead in soil can lead to an approximate blood lead level of 5 mcg/dL[2].

However, the level for concern for blood lead levels has been continuously lowered over the past decades as additional research has come out making it clear that there is no safe level of lead in the human body. From 2012-2021, the level was set at 5 mcg/dL and in 2021, the blood lead reference level at which the Centers for Disease Control (CDC) would categorize a child as having higher blood lead levels (BLL) than most children is 3.5 mcg/dL.

Sites with Lead Levels above the Proposed Standard (150 ppm)



According to New York City's Environment and Health Data Portal, children in Greenpoint have by far the highest rate of elevated blood lead levels of any neighborhood in New York City, with Williamsburg/Bushwick also being in the top five. In 2019, 28.1 out of 1000 children had BLL above 5 mcg/dL in Greenpoint (13.4 out of 1000 for Williamsburg/Bushwick), which as outlined above, is an outdated standard. The rate of children with BLL above 3.5 mcg/dL in both neighborhoods is likely higher.

Many experts believe that 400 ppm as the standard for lead in soil is much too high. Some suggest 150 ppm as the level which is more safe for children. In our samples, if the standard is lowered from 400 to 150 ppm, that makes 36 samples exceed the limit, or just over a quarter of the samples (23.2% of samples [36/155]).

This is in line with previous studies that found that around 26% of samplines found within parks were below 150 ppm (Li et al. 2010).

In January of 2024, the Environmental Protection Agency (EPA) updated its guidelines to 200 ppm for lead in residential soils when cleaning up toxic sites. The EPA further states that a guideline of 100 ppm should be used where other lead exposures exist.

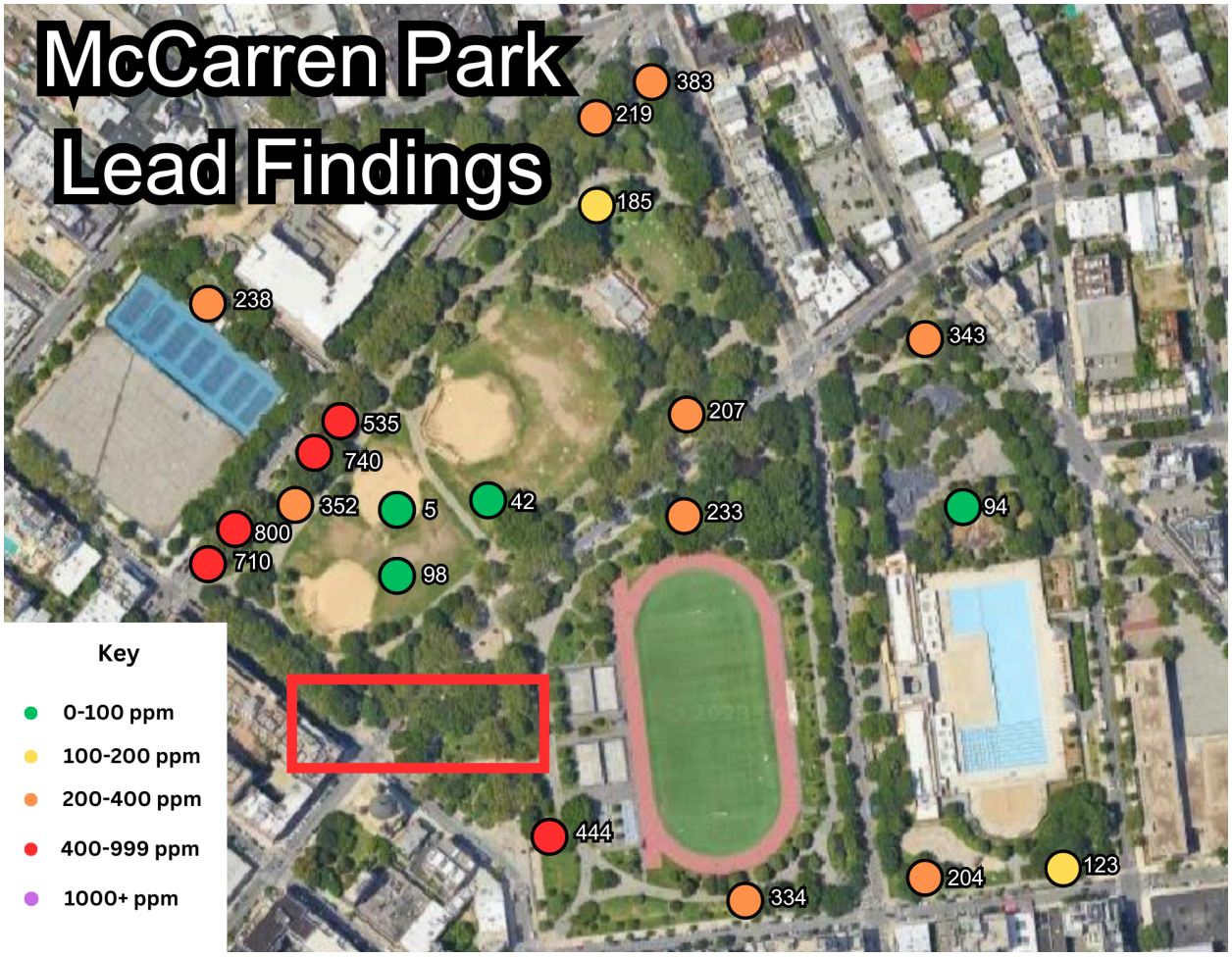
While lead can occur naturally in soils as a result of geographic processes, tests from the EPA showed geogenic lead levels in 83 soil samples to have a mean value of 13.2 ppm in New York State. Urban soils are likely to have higher concentrations of lead due to past industrial activities. In North Brooklyn, lead smelters and incinerators released large quantities of lead into the surrounding environment, and lead was used as an additive in commonly used substances such as paint and gasoline. While lead was largely phased out of many US products in the late 20th century, lead persists in the soil of many urban areas. Vehicle exhaust, industrial smoke, and construction dust settled onto nearby soils.

It is important to note that levels can vary widely within a short distance. For example, 22 samples were taken within the confines of McCarren Park. The concentrations of lead levels varied, from a low of 4.6 ppm taken from the middle of a baseball field to a high of 1724.3 ppm taken from a patchy grassy area.

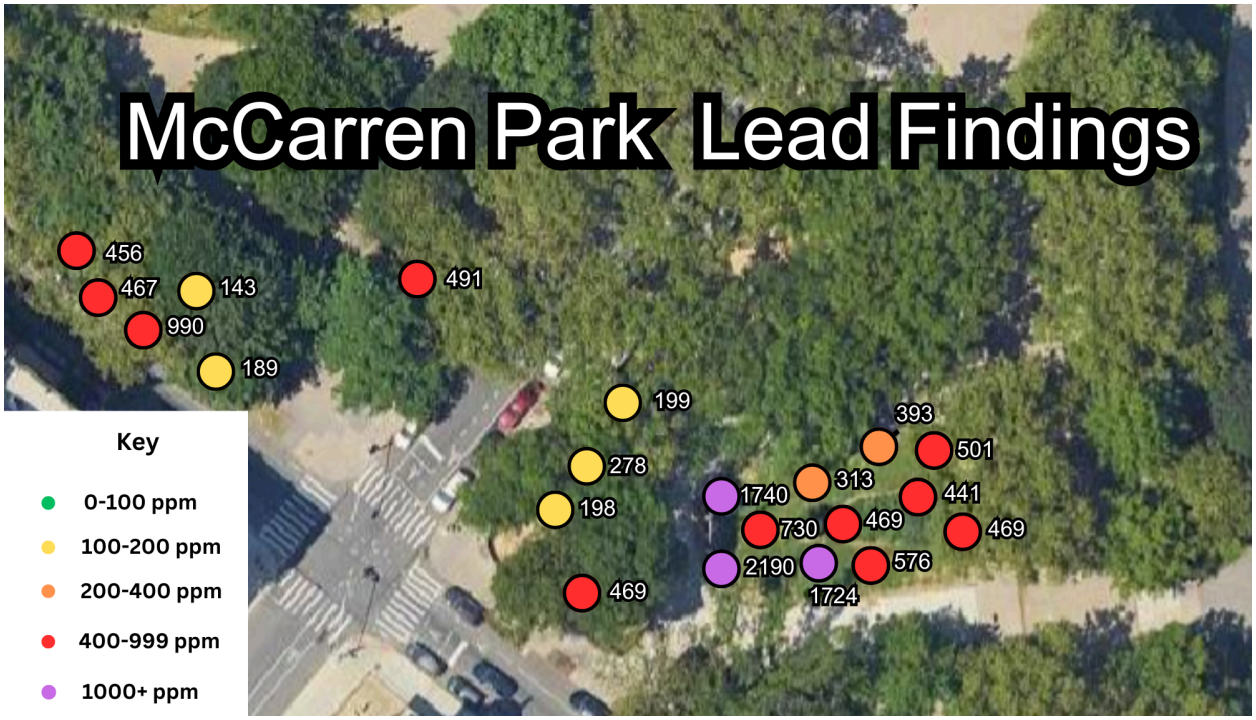
McCarren Park:

McCarren Park was the only public space of significant size where soil lead levels consistently tested above the NYSDEC standards for residential soils (400 ppm). Based on the initial findings, additional sampling of the park was done using a handheld X-Ray Fluorescence analyser on in-ground soil samples in 2023.

The two maps below display both sets of findings: the initial tests and follow up testing. Any marker that is red or purple is above the standards set by the NYSDEC.



Below is a map of the inset area:



As the maps illustrate, only specific areas of the park consistently test above safe standards for lead and thus spot-level interventions are likely to bring outsized safety benefits. Particular attention should be paid to the area found near the intersection of North 12th and Driggs and along the park's fenceline.

It is important that these findings be immediately investigated and swift action taken. General recommendations for open space management North Brooklyn can be found near the end of this report. However, as the levels found in McCarren Park are particularly concerning, we have included specific recommendations for McCarren Park:

- A comprehensive assessment of lead levels in McCarren Park to identify hotspots.
- Immediately install a protective layer between exposed soil and human contact in the area near the intersection of North 12th and Driggs. The range of available options could include better lawn management with reseeding and watering to ensure lush grass cover; wood chipping; the addition of compost to soil; and/or a new layer of soil.
- Swift action to ensure the safety of the informal running path that skirts the perimeter of the park. Because this is a highly trafficked route, it is unlikely that the aforementioned interventions would remain in place for any appreciable length of time. Therefore, an alternative solution should be found, such as fencing off the path or spraying any dust with water while a long-term fix is discussed.
- Particular attention should be paid to the Green Dome community gardeners as the garden's proximity to a hotspot indicates that it may very well also have contaminated soils. Gardeners should be educated about safe gardening practices before discussing a longer term solution.
- Every effort should be made to inform the public of the risks without raising undue alarm. While it is urgent that the Parks Department take immediate steps, people can also take simple steps to limit their exposure, as explored at the end of this report.

Arsenic

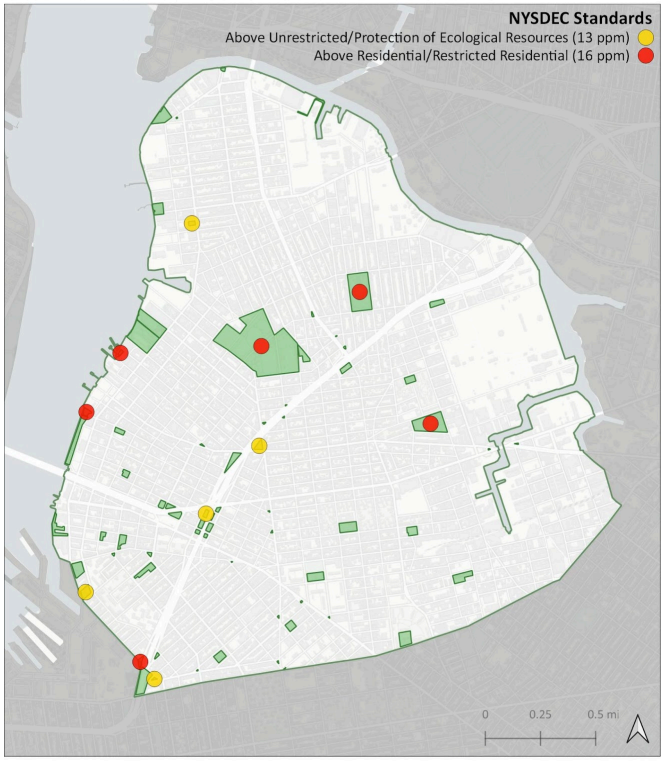
14.2% of samples (22/155) had arsenic levels higher than the NYSDEC standard for residential soils.

23.2% of samples (36/155) had arsenic levels higher than the NYSDEC standard for ecological health.

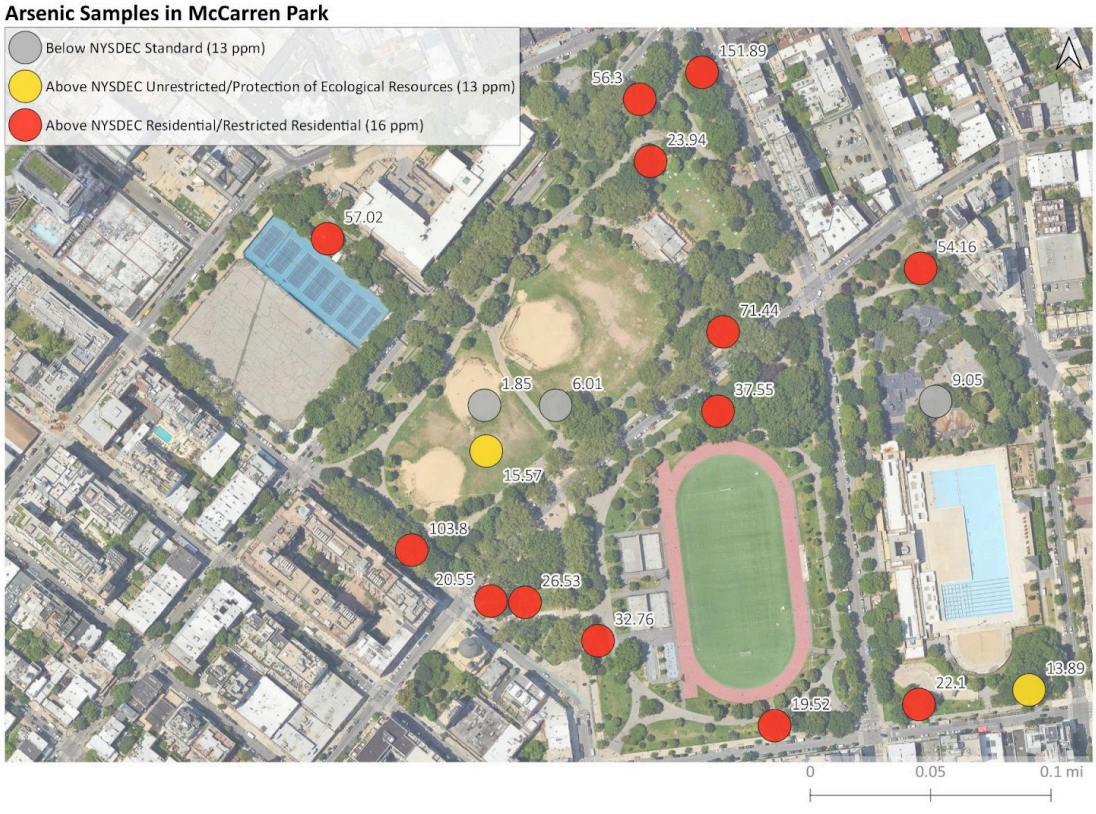
North 5th St. Pier, Cooper Park and McGolrick Park had samples with arsenic levels about the standards for residential soils. But most concerning were samples from Grand Ferry Park, Kent Ave and Hewes St and McCarren Park which contained samples seven to nine times the residential standards.

Notably, 13 of the 22 samples that had arsenic levels higher than the standards for residential soils were found in McCarren Park. And over 72% of the samples in McCarren Park tested above the standards for residential soils (13/18).

Sites with Arsenic Levels above the NYSDEC Standards



Arsenic Samples in McCarren Park



Arsenic has historically been used in some industrial processes, including those dealing with wood production, glass, and pharmaceuticals and have been used in herbicides and pesticides. Both long-term and acute exposure to arsenic can be consequential to human health. Long-term exposure has been associated with developmental issues, diabetes, issues with lung, heart, and bladder function, adverse pregnancy outcomes, and issues with cognitive function.

Total Chromium

There are two different types of chromium, trivalent and hexavalent chromium. Trivalent chromium is found in foods and is safe for human consumption. However, hexavalent chromium is a known toxicant that can cause health issues including skin disorders and lung cancer. As our testing did not differentiate between these two types of chromium, our results cannot be used to determine risk. However, as chromium can convert from trivalent to hexavalent chromium within the body, any finding of chromium should be treated with caution. We therefore recommend that further analysis of chromium in North Brooklyn be done to determine the particular chromium species and whether such levels are within the safety standards.

One sample, from McCarren Park, exceeded the NYSDEC restricted residential standards for either trivalent or hexavalent chromium. Further testing at this site is not necessary, it is evident that chromium exists there at unsafe levels.

Other Metals

In general, there are a number of other elements that were detected occasionally, but none reach a level of immediate concern.

Copper: Samples regularly tested above the NYSDEC standard for unrestricted use/protection of ecological resources at 50 ppm but did not approach the NYSDEC standard for residential/restricted residential[3].

Nickel: Multiple samples exceeded the standard for protection of ecological resources but none approached the unrestricted residential standards.

Selenium: One sample exceeded the standard set for the protection of ecological resources.

Silver: One sample exceeded the standard set for the protection of ecological resources.

Zinc: The majority of samples exceeded the standard for protection of ecological resources but none approached the unrestricted residential standards.

Soil Standards Discussion

While we compared our findings against the soil cleanup objectives of the NYSDEC, we are not convinced that in all cases these standards are as stringent as they should be.

Most glaringly, the standards listed as protective of human health for lead are too permissive. Both the residential and restricted residential standards for lead are set at 400 ppm. Yet the literature has shown repeatedly that there is no safe level of lead exposure; even the smallest amount of lead exposure can impact vulnerable populations. Children exposed to lead may experience inhibited growth, changes in brain development, and affected behavior.

In fact, the standards vary widely by organizing body. In some cases, the differences are because of differences in background levels. For example, soil in the Eastern United States naturally contains higher levels of arsenic than in other areas of the country. What this means is that the levels at which action (e.g., remediation) is recommended may be different, because background levels of arsenic are so high.

Yet science does not exist in a vacuum and in other cases differences in standards may be the result of a less precautionary approach, a lack of political willpower, or a worry that a change in levels may necessitate testing or remediation that would be very expensive.

It does not include pets, livestock, agricultural and horticultural crops. While true that we do not have cattle grazing in McGolrick Park nor do we grow tomatoes in Cooper Park, we do have pets and children that interact with the soil on a daily basis.

Recommendations:

In general, levels of lead and arsenic in the soils of open spaces in North Brooklyn are higher than desired for public safety. This random sampling has turned up numerous sites where levels exceed state recommendations. It also has uncovered specific areas of potential concern with other elements worth further study, particularly chromium.

It is our hope that this report will spur action in the following ways:

- The findings from this report should encourage city leaders to further investigate contamination in our public open spaces and to help prioritize the distribution of any park investments to those parks which have been shown to have the most contamination in combination with the highest usage for the most vulnerable populations. McCarren Park in particular is both a heavily used open space and the samples taken from the park were some of the most problematic and immediate action should be prioritized.

Grass at the Marsha P. Johnson State Park appears denser than the ground cover at the other major parks in North Brooklyn.

- Increase budget for open space care and management. Soil that is under heavy wood chips, regularly has compost added, or is under some other sort of ground cover such as grass, protects (to some degree) humans and animals alike from exposure. For example, while testing at Marsha P. Johnson was not as extensive as planned[4], the park is well-cared for in comparison to the local open spaces nearby. For the most part, grass is much more lush and less patchy compared to elsewhere in the neighborhood, providing better protection from open soil exposure.

- Better design of open spaces with planning as to which areas should be accessed by children and which should be off-limits to protect and grow vegetation. During the investigator's visits to many playgrounds, areas that were "fenced off" for vegetation were behind inadequate fencing.

These fences were either so low that toddlers would simply step over them and access the bare dirt behind the fence, or many had gates that were open. While the idea of inaccessible spots in open spaces may be controversial, currently the fenced off areas are both inadequate to keep children and pets out and also did not protect vegetation well enough to keep soil covered. These spaces should either be accessible to the public and maintained safely, or should be devoted to vegetation and permeable surfaces.

- When undergoing capital investments, redesign and invest in parks to both provide a full range of ecosystem services and to ensure that contaminated soil is properly cared for and covered. This report is NOT a recommendation to simply cover (i.e.,brick or concrete) over all exposed soil in the neighborhood. Instead, thoughtful planning about how open spaces can serve the community in terms of extreme weather events, such as precipitation and heat need to be balanced with ensuring children in particular are protected from contaminated soils.

Impermeable surfaces make up a large portion of Sternberg Park

    - Permeable surfaces in open spaces need to be increased and serve as places to help manage flooding in our neighborhood. This will allow water to reach the water table instead of diverting runoff to storm drains and contributing to sewer overflow into our waterways. Yet it is necessary to consider the type of cover for these permeable surfaces, as well as access during the design phase keeping in mind the levels of soil contamination.
    - As extreme heat events are predicted to continue and increase in the coming years, one method of combating the urban heat island effect is to replace concrete with vegetation. Yet patchy grass or plantings with bare soil could increase exposure to soil contaminants. As NYC invests in open spaces, it is important to consider how to increase vegetation and greening initiatives, while also ensuring soil remains covered.

- Parents and caregivers should be aware of not only which open spaces are contaminated with toxic metals, but also to seek out locations for play with covered soils. Spreading a blanket on the ground when near exposed soil for a picnic, wiping down hands after playing and before eating, and keeping children away from exposed soil generally are all good practices for reducing chances of contamination.

- Dog owners should take heed as pets track soil from open spaces into the home environment. Wiping a dog's paws will reduce contaminants in the house, which is especially important when the household contains young children. Dog owners also need to take responsibility for ensuring dogs are kept on leashes at all times where regulations require. Heavy dog traffic, including pet waste, has a deleterious effect on vegetation and can lead to exposing soil which had previously

been protected by grass. Dogs may also dig through wood chips or other cover, leaving bare soil exposed. For the protection of both the dogs themselves and the community, pet owners should be encouraged to be part of the solution.

Conclusion

Our findings indicate that the alarm bells raised by previous studies cannot continue to be ignored, nor can they be dismissed as anecdotal evidence. By methodically sampling throughout the entirety of the public spaces found in Brooklyn Community District 1, we have shown that the extensive contamination found throughout the neighborhood warrants action, indeed it is necessary to keep the Brooklyn area residents safe. The Parks Department and New York City government must fund comprehensive fixes to our open spaces to ensure that all those who enjoy our public open spaces can do so with confidence in their safety and that of their children. Fixes can be as easy as increased wood chips, but our report also invites a broader reflection on the safety and future function desired from our neighborhood's open spaces.

Endnotes:

[1] "Soil samples were homogenized with a pestle and mortar and air dried to remove water content. Approximately 1 g of soil samples were digested by adding 1 mL nitric acid and 3 mL hydrochloric acid. The digestion was performed for 60 min at 65 oC and then for an additional 60 min at 80 oC using a DigiPrep System. After digestion, DI water was added to the samples to 10 mL. All digested samples were filtered through 0.45 um filters, and diluted 10x or 100x with DI water for analysis using an Agilent ICP-MS 7900."

[2] Li et al. 2010. "Lead in New York City Soils." in Megacities 2050: Environmental Consequences of Urbanization Proceedings of the VI International Conference on Landscape Architecture
to Support City Sustainable Development.

[3] One further note: One set of copper results came back alarmingly high at levels that regularly exceeded those for residential and restricted residential levels (270 ppm). The tests were then performed again and results were more in line with the rest of the results in the neighborhood. Both sets of results are included in the dataset.

[4] Due to lab error, only one sample was tested from Marsha P. Johnson State Park, despite numerous submitted samples. Thus the testing of this park is less comprehensive than others in the study and should be viewed as more preliminary than others.

Appendix 1

Overview of Sample Site Locations in Brooklyn Community District 1