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Ridgewood Public Schools
Office of the Superintendent

March 25, 2020

Daniel Fishbein, Ed.D., Superintendent of Schools
Ridgewood Public Schools
49 Cottage Place
Ridgewood, NJ 07450

Dear Dr. Fishbein:

The New Jersey Department of Health (NJDOH) prepared this Letter Health Consultation (LHC) at your request to address health concerns related to possible exposures from contaminated fill at the Orchard Elementary School. This LHC specifically addresses potential exposures at five areas around the school, including the use of the recreational field. This LHC was prepared under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). This evaluation is based on data collected as part of the March 2018 Limited Human Health Risk Assessment and Proposed Remedial Action Workplan prepared by your consultant, WSP USA.

Statement of Issues and Background

The Orchard Elementary School is located at 230 Demarest Street in Ridgewood, Bergen County. The school property is bounded to the north by municipal tennis courts and the Bellair Condominium Complex. Private residences are located east of the school, the Diamond Brook to the west, and wooded wetlands to the south. The school property contains the school building, a paved parking lot, two playgrounds, and a grass-covered recreation field.

The school property and surrounding area was historically used to dispose of municipal ash wastes from domestic boilers. These wastes contained arsenic, lead, and polycyclic aromatic hydrocarbons. The area is identified by the New Jersey Department of Environmental Protection (NJDEP) as the Ridgewood Ash Landfill. A portion of the landfill is on the existing school property. The ash landfill operations continued from the 1940's through the 1960's and included the use of historic fill to bring the site to its current grade when the Ridgewood Board of Education bought the property in 1964.

In 2007, a screening survey was conducted of non-ash fill soils at the school which covered the ash-fill at the site. This investigation found that this historic fill contained elevated levels of polycyclic aromatic hydrocarbons and lead above the NJDEP's residential direct contact standards.

Areas Sampled During March 2018 Limited Human Health Risk Assessment

Table 1 shows the areas that were sampled during the March 2018 risk assessment prepared by WSP USA. We used data from these areas to determine the likelihood for harmful health effects. The soil depths used in our evaluation were based on data collected at depths up to 10 inches below ground surface (bgs) which are considered the most accessible to children and staff at the school.

Table 1. Orchard Elementary School – Areas Sampled

Area and Description	Use/Ground Cover
1 – Recreational Field	Recreational field with predominantly thick grass/turf cover
2 – Northeast Area	Seldom used/patchy to healthy vegetative cover (grass, turf)
3 – Bellair Park Access Corridor	Used for ingress and egress with park benches/variable ground cover including sidewalks, grass, mulched landscaping
4 – Playground	Playground area with 12-24 inches of wood chip cover
5 – Front Access/Amphitheater	Used to access the school and the amphitheater which serves as an outdoor classroom/cover includes sidewalks, brick pavers, landscaped shrub areas, patchy to healthy vegetative cover (grass/turf)

Contaminants of Concern:

The first step in assessing the potential for health implications from environmental exposures is to compare the contaminant level with health-based screening values, in this case the NJDEP's residential direct contact soil cleanup criteria (RDCSCC). These screening values are the regulatory standard dictating clean up criteria; however, exceedances do not indicate that adverse health effects are likely to occur. Screening values are designed to be protective and are set well below the level where health effects have actually been noted.

For Orchard Elementary School, polycyclic aromatic hydrocarbons and lead were found in surface soil above the NJDEP's RDCSCC. These contaminants are associated with historic fill materials that were used to cover the coal-ash waste landfill.

Polycyclic Aromatic Hydrocarbons (PAHs) PAHs are a class of chemicals that occur naturally in coal, crude oil, and gasoline. They are also formed as a result of incomplete combustion of coal, oil, wood and other organic materials. In the environment, PAHs are found as complex mixtures of compounds, and many have similar toxicological effects and environmental fate.

Several of the PAHs and some specific mixtures of PAHs are considered to be cancer-causing chemicals. Other health effects (besides cancer) from ingestion exposure to PAHs have been found in animal studies but have not been observed in humans.

The following PAHs were determined to be contaminants of concern in soil at the school:

- *Benzo(a)anthracene*

- *Benzo(a)pyrene*
- *Benzo(b)fluoranthene*
- *Dibenz(a,h)anthracene*

Lead Lead can cause a variety of harmful health effects including damage to the nervous system, kidneys and the red blood cells. Children are the most sensitive to the harmful effects of lead since they absorb more lead into their bodies than adults and are more susceptible to its effects on brain development. Although lead can affect almost every organ and system in the body, the main target for lead toxicity is the nervous system. In general, the level of lead in a person's blood gives a good indication of recent exposure to lead and also correlates well with adverse health effects[1].

Evaluating the Possibility for Health Effects

The method for assessing whether a health hazard exists is to determine if:

- there is a completed exposure pathway from a contaminant source to a receptor population;
- exposures to contamination are high enough to be of health concern for cancer or other health effects (referred to below as "non-cancer health effects")

Site-specific exposure doses have been calculated and compared with health guideline comparison values (i.e. reference dose). If the calculated site-specific doses are below health guideline values, they are not expected to result in adverse health effects over a lifetime of exposure. Exposure doses were calculated using a "Public Health Assessment Site Tool" (PHAST) developed by the ATSDR.

Lead is evaluated using the US Environmental Protection Agency (EPA) Integrated Exposure Uptake Biokinetic (IEUBK)[2,3] model, as an exposure dose cannot be calculated.

Exposure Pathways

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;

[1] Agency for Toxic Substances and Disease Registry. 2019. Toxicological Profile for Lead. U.S. Department of Health and Human Services, Public Health Service. Atlanta, GA. May 2019. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp13.pdf

[2] [USEPA] United States Environmental Protection Agency 1994. Guidance Manual for the IEUBK Model for Lead in Children. Office of Solid Waste and Emergency Response. February 1994.

[3] [USEPA] United States Environmental Protection Agency. 2007. User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) Windows® Version – 32 Bit Version. Office of Solid Waste and Emergency Response. May 2007.

3. point of exposure;
4. route of exposure; and
5. receptor population.

Generally, the NJDOH considers three exposure pathway categories:

1) completed exposure pathways - all five elements of a pathway are present;
2) potential exposure pathways - one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and
3) eliminated exposure pathways - one or more of the elements is absent.

Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future. For Orchard Elementary school, the only possible completed pathway is the accidental ingestion of soil by children and staff at the school.

Evaluating PAHs and lead

The detailed approach to the evaluation of lead is in the section on page nine. Benzo[a]pyrene is by far the most extensively studied of the PAHs; therefore, the adverse effects of other less-studied PAHs can be inferred from the results obtained with benzo[a]pyrene[4].

The risk assessment model is used to determine the likelihood for health effects when the contaminant exceeds the health guideline comparison value. For Orchard Elementary School, the model accounts for exposures to children ages 5 through 11 (assuming 6 years of schooling from kindergarten to 5th grade) and school staff who are assumed to work at the school for 33 years[5]. Other model inputs come from the site-specific environmental data and parameter values (ex: for body weight and dermal absorption rates) published by the EPA and ATSDR[6]. For ingestion rates, we chose the more conservative approach and assumed an above average daily ingestion rate of 200 mg/day of the soil containing the contaminants of concern[7]. This ingestion rate was based on several studies of children's activity patterns and biokinetic modeling which found the average daily ingestion rate of 60 mg/day.

The exposure parameters used to calculate the exposure dose for benzo(a)pyrene are listed in Table 2.

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[4] Agency for Toxic Substances and Disease Registry. 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. U.S. Department of Health and Human Services, Public Health Service. Atlanta GA. August 1995. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp69.pdf
[5] Agency for Toxic Substances and Disease Registry. 2019. Public Health Assessment Site Tool (PHAST). Version 1.5.1.0. U.S. Department of Health and Human Services, Public Health Service. Atlanta, GA. December 2019.
[6] U.S. Environmental Protection Agency. 2011. Exposure Factors Handbook. Update for Chapter 5. Soil and Dust Ingestion. Updated September 2017. Available from: https://www.epa.gov/sites/production/files/2018-01/documents/efh-chapter05_2017.pdf
[7] Agency for Toxic Substances and Disease Registry. 2018. Exposure Dose Guidance for Soil and Sediment Ingestion. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. November 2018.

Table 2. Exposure Assumptions Used in Dose Calculations

Exposed Population	Ingestion Rate (mg/day) *	Body Weight (kg)	Exposure Frequency
Child ages 5 to < 6 years	200	19.7	180 days/year
Child ages 6 to < 11 years	200	31.8	
Adult ages ≥ 21 years	100	80	

*Represents above average ingestion rates (most conservative)

Non-Cancer Health Effects - Soil Ingestion and Dermal Contact

Exposures are based on accidental ingestion of contaminated surface soil for children and adults at the school. Non-cancer exposure doses for PAHs were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
IR = soil ingestion rate (mg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = Conversion Factor (10^{-6} kg/mg) and,
BW = body weight (kg).

Dermal exposure doses were also calculated and added to the ingestion doses to create a combined dose. The dermal dose was minimal compared to the ingestion exposure pathway. Dermal exposures doses were calculated using the following formula:

$$\textit{Dermal Exposure Dose (mg/kg/day)} = \frac{C \times AF \times EF \times CF \times ABS_d \times SA}{BW \times ABS_{GI}}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
AF = Adherence Factor to skin (mg/cm^2-event);
EF = Exposure Factor representing the site-specific exposure scenario (unitless);
CF = Conversion Factor (10^{-6} kg/mg)
ABS_d = Dermal Absorption Fraction to skin (unitless)
SA = Skin surface are available for contact (cm^2)
BW = Body Weight (kg).
ABS_{GI} = Gastrointestinal Absorption Factor (unitless)

The exposure point concentration (EPC), or the concentration term in the exposure equation, is derived to reflect a representative concentration at the exposure point or points over the exposure period[8]. Consistent with guidance from ATSDR, the 95% upper confidence limit (UCL) was used to estimate the EPC. Standard practice is to use the 95% UCL when there are eight or more samples (i.e. in Area 1 and Area 2). For remaining areas where there are fewer than eight samples, the maximum concentration is used.

Non-cancer health effects are assessed by comparing the calculated exposure dose to the reference dose via a ratio known as the "hazard quotient" or "HQ". The hazard quotient is defined as follows:

$$\textit{Hazard Quotient (HQ)} = \frac{\textit{Exposure Dose}}{\textit{Reference Dose}}$$

ATSDR has not derived oral health guideline values for PAHs because there are no adequate human or animal dose response data available that identify threshold levels for noncancer health effects. The animal data for ingestion of PAHs are limited because of conflicting results across studies, the use of inconsistent protocols (e.g., varying numbers of animals, administration of the test compound during different times of gestation), the use of only one dose, lack of study details, and most data are available only for benzo(a)pyrene.

Since benzo(a)pyrene is the only PAH with a health guideline value (i.e. a reference dose of 0.0003 mg/kg/day), exposure doses were calculated for this PAH. Following ATSDR guidance, this calculated exposure dose is representative of the other four PAHs without a health guideline value as benzo(a)pyrene has the lowest reference dose of other PAHs with available reference doses.

As the hazard quotient increases above 1, the potential for harmful effects increases. The calculated hazard quotients for all areas sampled were **below 1.0** for adults and children for benzo(a)pyrene. Therefore, non-cancer health effects are not likely from exposures to PAHs in surface soil at the school (See Table 3). The actual level at which health effects were observed in toxicological studies was at 0.092 mg/kg/day. The calculated dose for the Orchard Elementary school children using the highest benzo(a)pyrene concentration in Table 3 (Area 2) is 0.000025 mg/kg/day and is approximately 3,000 times lower than where health effects have been observed.

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[8] U.S. Environmental Protection Agency. 2015. Office of Research and Development. ProUCL Version 5.1.002 User Guide. Washington, DC. October 2015.

Table 3. Non-Cancer Health Effects –PAHs

Area	Number of Surface Soil Samples	Maximum or UCL Benzo(a)Pyrene Concentration (mg/kg) [a]	Maximum Child Hazard Quotient [b]	Maximum Adult Hazard Quotient [c]	Is there potential for Non-Cancer Health Effects?
1 – Recreational Field	16	3.51	0.078	0.011	No (HQ <1.0)
2 – Northeast Area	8	3.81	0.084	0.012	No (HQ <1.0)
3 – Bellair Park	4	2.88	0.060	0.009	No (HQ <1.0)
4 – Playground	2	2.42	0.050	0.008	No (HQ <1.0)
5 – Amphitheater	6	1.45	0.030	0.005	No (HQ <1.0)

[a] 95% UCL for Areas 1 and 2; maximum concentration for areas 3, 4 and 5; [b] Children ages 5 to < 6 years; [c] Adults ≥ 21 years; mg/kg = milligrams per kilogram

Cancer Health Effects Evaluation – Soil Ingestion and Dermal Contact

Theoretical increased numbers of cancers are calculated for cancer-causing contaminants using the site-specific exposure dose and cancer slope factor (CSF) provided in ATSDR health guideline documents. NJDOH evaluates the potential for cancer health effects by assessing the excess cancer risk relating to exposure over the background cancer risk.

In New Jersey, approximately 45% of women and 49% of men (about 47% overall), will be diagnosed with cancer in their lifetime. This is referred to as the "background cancer risk." The term "excess cancer risk" represents the risk on top of the background cancer risk and is referred to as the Lifetime Excess Cancer Risk, or LECR. An LECR of "one-in-a-million" (1/1,000,000 or 10-6 cancer risk) means that if 1,000,000 people are exposed to the cancer-causing substance at a certain level for a period of time, then one cancer above the background number of cancers may develop in those 1 million people over the course of their lifetime (considered 78 years).

To put the LECR of 10-6 in context of New Jersey's background cancer risk, the number of cancers expected in 1 million people over their lifetime is 470,000 (47%) in New Jersey. If these 1 million people are all exposed to the cancer-causing substance for a specific duration, then 470,001 people may develop cancer instead of the expected 470,000 over the course of their lifetime (78 years). This theoretical cancer risk estimate is not the actual number of cancer cases that will occur in an exposed community but estimates an excess theoretical cancer risk. This theoretical cancer risk is not a prediction that cancer will occur.

According to the United States Department of Health and Human Services (USDHHS), the cancer class of contaminants detected at a site is as follows:

1 = Known human carcinogen
2 = Reasonably anticipated to be a carcinogen
3 = Not classified

PAHs are considered "Reasonably anticipated to be a carcinogen."

Cancer exposure doses were calculated using the following formula:

$$\textit{Cancer Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW} \times \frac{ED}{AT}$$

where,

mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = exposure point concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (mg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg);
ED = exposure duration in years (varies with age and scenario);
AT = averaging time of 78 years; and
BW = body weight (kg).

The site-specific assumptions and exposure factors used to calculate the LECR are the same as those used to assess non-cancer health effects. The LECR was calculated by multiplying the cancer exposure dose by the EPA's cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$.

The LECR for PAHs was calculated using the following formula:

LECR = Cancer Exposure Dose x CSF

where,

CSF = Cancer Slope Factor $(mg/kg/day)^{-1}$

To evaluate potential cancer risk associated with exposure to PAHs, the concentrations of individual detected PAH compounds are converted to an equivalent benzo(a)pyrene concentration. Benzo(a)pyrene equivalent concentrations are calculated by multiplying the concentration of individual detected PAH compounds by their toxicity equivalency factor (TEF), a value that relates the relative toxicity of the individual PAH compounds to the toxicity of benzo(a)pyrene. The total benzo(a)pyrene equivalent concentration for all detected PAHs are obtained by summing each of the individual PAH compound's benzo(a)pyrene equivalent value. A benzo(a)pyrene equivalent concentration was not calculated for dibenz(a,h)anthracene since there is an available cancer slope factor specific to this PAH[9]. Therefore, dibenz(a,h)anthracene is evaluated separately from other PAHs (as shown in Table 5).

This total benzo(a)pyrene equivalent concentration was used to calculate the cancer risk for PAHs. Table 4 shows the calculation for Area 1 (Rec Field):

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[9] California Environmental Protection Agency. 2015. Office of Environmental Health Hazard Assessment. Air Toxics Hot Spots Program Guidance Manual. February 2015. Available from: https://oehha.ca.gov/media/downloads/crnr/2015gmappendicesgj.pdf

Table 4. Recreational Field – Benzo(a)pyrene Equivalent Derivation

Contaminant	95% UCL Concentration (mg/kg)	Toxicity Equivalency Factor	Benzo(a)pyrene equivalent (mg/kg)	Total Benzo(a)pyrene Equivalent
Benzo(a)anthracene	3.593	0.1	0.3593	4.18
Benzo(a)pyrene	3.505	1	3.505	
Benzo(b)fluoroanthene	3.114	0.1	0.3114	

As shown in Table 5, the LECRs for the benzo(a)pyrene equivalent and dibenz(a,h)anthracene were added together to get the total LECR for children and adults, assuming above average ingestion rates. LECRs for children ranged from approximately 4 to 7 in 1,000,000 individuals. The LECRs for adults ranged from approximately 1 to 3 in 1,000,000 individuals. Both LECRs represent a very low cancer risk.

Table 5. Lifetime Excess Cancer Risk (LECR) - PAHs

Area	Benzo(a)pyrene Equivalent Concentration (mg/kg) [a]	Dibenz(a,h) anthracene Concentration (mg/kg) [b]	Total Child LECR [c]	Total Adult LECR [d]
1 – Recreational Field	4.18	0.63	7 in 1,000,000	3 in 1,000,000
2 – Northeast Area	4.57	0.299	6 in 1,000,000	2 in 1,000,000
3 – Bellair Park	3.41	0.81	7 in 1,000,000	3 in 1,000,000
4 – Playground	2.95	0.37	5 in 1,000,000	2 in 1,000,000
5 – Amphitheater	1.74	0.404	4 in 1,000,000	1 in 1,000,000

[a] PAH concentration in surface soil relative to benzo(a)pyrene. 95%UCL was used to calculate the benzo(a)pyrene concentration for Areas 1 and 2; maximum concentration used for Areas 3, 4, and 5; [b] 95% UCL was used for Areas 1 and 2; maximum concentration used for areas 3,4 and 5; [c] Children ages 5 to < 11 years; [c] Adults ≥ 21 years; mg/kg = milligrams per kilogram

Evaluating Lead

ATSDR has not developed a health guideline comparison value for lead, because a safe blood lead level in children has not been determined. Instead, exposure to lead is evaluated by using the Integrated Exposure Uptake Biokinetic IEUBK model that predicts blood-lead concentrations that would result from exposure to lead levels found in the environment. For Orchard Elementary School, the concentrations of lead in soil were incorporated into this model to predict blood lead levels for children.

The correlation between lead-contaminated soil and blood lead levels is influenced by many factors, including access to soil, presence of ground cover, levels of lead in soil, lead bioavailability, the size and composition of the lead particles, behavior patterns (especially of children), seasonal variation of exposure conditions, and the route of exposure[10]. Blood lead levels are indicators of exposure and are the most widely used index of internal lead body

[10] U.S. Environmental Protection Agency. 2003. Assessing Intermittent or Variable Exposures at Lead Sites. Office of Solid Waste and Emergency Response. Washington, D.C. November 2003.

burdens. Until recently, children were identified as having a blood lead level of concern (i.e., an elevated blood lead level) if the blood lead level was 10 µg/dL or greater. CDC recently began using a reference value of 5 µg/dL, which is currently the 97.5th percentile of blood lead in a representative sample of children in the U.S. 1-5 years of age[11,12].

Children are more sensitive to the health effects of lead exposures and the primary route of exposure for ingestion of lead is via hand to mouth activity. Given the lack of a potential exposure pathway for adults, only children were included in this evaluation of lead exposures and possible health effects.

As shown in Table 6, all predicted blood lead levels in each area sampled were below the CDC target level of 5 µg/dL. Therefore, adverse health effects from lead exposures in soil at the school would not be expected.

Table 6. Blood Lead Results from the EPA IUEBK model

Area	Average Lead Concentration (mg/kg) *	Maximum IEUBK Predicted blood lead level (µg/dL) **
Area 1 – Recreational Field	159	1.9
Area 2 – Northeast Area	153	1.8
Area 3 - Bellair Park Access Area	194	2.1
Area 4 - Playground	86	1.3
Area 5 – Front Access/Amphitheater	76	1.3

*represents surface soil; **This age group represents 5-year-old children; ug/dL = micrograms of lead per deciliter of blood; mg/kg = milligrams per kilogram

Conclusion

The NJDOH concludes that exposures to PAHs and lead in surface soil at the Orchard Elementary School are not likely to harm people's health. Based on our risk assessment using site specific scenarios and above average ingestion rates, the NJDOH concludes that harmful health effects are not expected from the potential exposure pathway to soil contaminants. It should be noted this evaluation assumes the areas are not covered with grass and mulch, i.e. that direct contact with soil is occurring. Therefore, it can be assumed that the exposures or the actual risk would be lower as these areas are predominantly covered. The outside areas of the school, including the recreational field, can continue to be used without posing a health risk to children until soil remediation is completed to bring levels below the NJDEP RSCSCC. Although based on our evaluation harmful health effects are not expected to occur with continued use of the recreational field, NJDOH supports the actions being planned as prudent measures to protect public health.

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[11] Agency for Toxic Substances and Disease Registry. 2019. Toxicological Profile for Lead. U.S. Department of Health and Human Services, Public Health Service. Atlanta, GA. May 2019. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp13.pdf

[12] Centers for Disease Control and Prevention. 2012. Blood Lead Levels in Children. January 2012. Available from: https://www.cdc.gov/nceh/lead/prevention/blood-lead-levels.htm

Please feel free to contact me at 609-826-4984 or by email at Christa.Fontecchio@doh.nj.gov if you have any questions.

Sincerely,

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