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Health Implications of the Proposed Waelz Plant in Logansport, Indiana

Introduction

Waelz Sustainable Products (WSP) has proposed a new plant in Logansport, Indiana, that will process waste from steel mills to make zinc and iron products. The Waelz process, first invented in 1888, involves mixing electric arc furnace dust with a carbon source, like coal or petroleum coke, and heating it in kilns to between 1000° and 1500° Celsius. Zinc oxide is captured out of the fumes and referred to as Waelz zinc oxide or WZO. The residual solid material is high in iron and can be sold as Waelz iron product or WIP[1].

In Logansport, WSP is proposing to build a facility with two Waelz kilns on the property at 3440 W 300 S, Logansport, IN 46947[2].

Air pollution is released during the Waelz process. WSP filed an air permit application with the Indiana Department of Environmental Management or IDEM, on March 30, 2020[3]. The permit application includes WSP's estimates of what their air emissions would be if the facility were built. The air pollutants released from Waelz plants have impacts on human health. This paper describes the health impacts of some of the typical Waelz air pollutants.

Estimated Air Emissions

In the WSP air permit application, there are several estimates of what their air emissions would be if the proposed facility were built. Table 1 lists WSP's estimates from their permit application for the number

[1] Wikipedia (2019). *Waelz Process.* https://en.wikipedia.org/wiki/Waelz_process

[2] Ramboll (March 30, 2020). Waelz Sustainable Products, LLC - Logansport, Indiana, New Source Construction Permit Title V Application.

[3] IDEM Air Quality Permit Status Search. https://www.in.gov/apps/idem/caats/permitDetail.xhtml

of tons of each pollutant released in an entire year. The first column, “Estimated uncontrolled annual facility-wide”, lists WSP’s estimate of what the air emissions would be if there were no pollution controls in place. The middle column, “Estimated controlled including fugitives”, lists WSP’s estimate of what the emissions would be when the proposed pollution control devices were functioning and includes their estimate of fugitive emissions from roadways[4], but they do not include all of the potential sources of fugitive emissions. "Fugitive emissions" are pollutants released from emission source locations other than discreet point source vent stacks, and should include process and flue gases, material handling emissions that are released from process transfer points, flue duct breaches, leaks, building openings, conveyors, transfer points, and loading/unloading operations, as well as the fugitive emissions due to roadways. The right-hand column in Table 1 lists WSP’s estimate of controlled air emissions, but does not include fugitive emissions. The middle column has WSP’s nearest estimate of what the total air emissions would be at the proposed Logansport plant.

	Estimated uncontrolled annual facility-wide (pg 205, 216 & 217)	**Estimated controlled annual including fugitives (pg 204)**	**Estimated controlled annual excluding fugitive dust (pg 10 & 204 & 213)**
	in tons per year		
Carbon Monoxide (CO)	161.42	161.42	161.42
Nitrogen oxides (Nox)	124.27	124.27	124.27
Sulfur Dioxide (SO2)	17.15	17.15	17.15
Particulate Matter (PM)	11,589	178.75	171.13
Particulate matter 10 microns or less (PM10)	11,583	172.65	171.13
Particulate matter 2.5 microns or less (PM2.5)	11,582	171.5	171.13
Volatile Organic Compounds (VOC)	15.4	15.4	15.4
Mercury	0.11	0.11	0.11
Lead	29.44	0.38	0.38
Hexavalent Chromium	0.155		0.00151
Total Hazardous Air Pollutants (HAPs)	191.67	4.12	4.12
Dioxins/furans	no estimates provided		

Table 1. WSP’s estimate of air emissions in tons per year from the proposed Logansport Waelz plant.[5]

[4] Ramboll(March 30,2020). Waelz Sustainable Products, LLC - Logansport, Indiana, New Source Construction Permit Title V Application, pdf page 204.

[5] Ramboll(March 30,2020). Waelz Sustainable Products, LLC - Logansport, Indiana, New Source Construction Permit Title V Application

The term, 'hazardous air pollutants' or HAPs, was created in the Clean Air Act. It refers to a list of 180 chemicals that Congress wrote into the law. Table 1 lists a few of the HAPs that would be emitted if the Logansport Waelz plant were built.

Table 1 shows which air pollutants WSP estimates would be captured by the proposed air pollution devices and which would not. The first column has emissions without control devices and the middle column has the emissions with control devices. Since the numbers in the 2 columns are the same for carbon monoxide, nitrogen oxides, sulfur dioxide, volatile organic compounds, and mercury, the WSP permit application is saying that those pollutants would not be controlled by the pollution control devices that they have proposed. The number of tons is lower in the middle column compared to the left-hand column for particulate matter, lead, and chromium, so those pollutants would be controlled. "Control" in this circumstance means reduction of an air emission; it does not mean complete elimination of that emission.

Dioxins and furans are a family of related chemicals that arise as a byproduct of high temperature processes, like processes in steel mills and Waelz kilns. They are known to be released from Waelz plants[6], but they were not listed in the WSP air permit application.

The accuracy of WSP's air emission estimates for many of the pollutants is not known. The permit states that the estimates are based on stack tests from a similar facility, mass balance calculations, or laboratory analyses of the dust metal content[7] depending on the pollutant. There are stack test documents included in the permit application which show results on some of the pollutants: particulate matter, lead, nitrogen oxides, carbon monoxide, and sulfur dioxide. The documentation in the permit on mass balance is sparse, and the application does not specifically address air pollutants that would come from the coal or coke used in the kilns. Greenhouse gases and some hazardous air pollutants that would be expected from a Waelz facility are not listed in the permit application at all.

Health Implications

This paper lists some of the pollutants that would be released to the air if the Logansport WSP Waelz plant were built along with the ways those pollutants can impact human health. The degree to which the WSP emissions would increase health risks (i.e. a full risk assessment) is beyond the scope of this paper. As of the date of this writing, WSP has not provided an environmental health risk assessment, air quality predictive modeling, or an air quality impact review to help document the impact of its air emissions.

[6] Hung, P.C. et al (2012) Characteristics of dioxin emissions from a Waelz plant with acid and basic kiln mode. *J Hazard Mater,* 201, 229-235. https://www.ncbi.nlm.nih.gov/pubmed/22178278

[7] Ramboll(March 30,2020). Waelz Sustainable Products, LLC - Logansport, Indiana, New Source Construction Permit Title V Application, pdf page 8.

Table 2 gives a summary of potential health impacts from some of the pollutants WSP proposes to release into the air. These are not the health effects that occur with acute, high dose exposures to these pollutants. The table lists effects that have been documented when there is human exposure to low doses over months to years. In some cases, the best evidence of likely effects comes from toxicological studies on animals. While the table gives an overview, additional details on each pollutant are provided in the pages that follow.

	Health risks from chronic exposure[8]
Carbon Monoxide (CO)	fatigue; headache; dizziness; exacerbation of respiratory and cardiovascular diseases; reduced exercise endurance
Nitrogen oxides (Nox)	decreased lung function; increased risk of lung infection; eye, nose, and throat irritation
Sulfur Dioxide (SO2)	lung impairment; respiratory symptoms
Particulate Matter (PM)	respiratory symptoms; a decline in lung function; exacerbation of respiratory and cardiovascular disease; mortality
Volatile Organic Compounds (VOC)	depends on specific compounds but can include cancer; lung irritation; nausea
Mercury	Children: decreased memory, attention, and language skills Adults: decreased coordination, decreased visual sensitivity
Lead	Children: lower IQ, behavior and mental health problems, immune system changes, anemia Adults: high blood pressure, reduced male fertility, anemia
Hexavalent Chromium	Inhalation: nasal mucosa ulceration; perforation of the nasal septum; respiratory irritation; lung cancer Ingestion: gastritis; stomach ulcer; lower sperm count
Dioxins/furans	cancer; interfere with reproduction; weaken the immune system

Table 2. Potential health impacts known to be associated with chronic exposure to air pollutants.

It is worth noting here, that in general, children and unborn children are at higher risk from environmental exposures. This is because their bodies are still growing and developing, and the carefully orchestrated process of development can be disrupted by exposures to chemicals, including air pollutants. It is also because children breath more air, eat more food, and drink more water per pound of body weight than adults, so they take in more of whatever pollutants are present relative to their size. Finally, children are more likely than adults to accidentally ingest dust and soil, so they take in more pollutants that occur in dust and soil. Exposures to pollutants in air, water, food, dust, or soil can lead to health effects during childhood as well as lasting or even life-long effects[9].

[8]Adapted from Environmental Health from Global to Local, 3rd edition (2016) edited by H. Frumkin. John Wiley & Sons, Inc. pg 462 and from Toxicological Profiles by the US Agency for Toxic Substance and Disease Registry.

[9] Etzel, RA, and PJ Landrigan (2014). Chapter 2, Children's Exquisite Vulnerability to Environmental Exposures. In Textbook of Children's Environmental Health , edited by Landrigan and Etzel. Oxford University Press.

Carbon Monoxide

WSP estimates total facility-wide carbon monoxide emissions of 161.42 tons per year. To give perspective, that quantity can be compared to the amount released from vehicles. In 2017, which is the most recent year with data available, there were 272,480,899 highway vehicles in the US[10] and they released a total of 19,513,000 tons of carbon monoxide[11]. This means that highway vehicles in the US emitted an average of 0.0716 tons each over the course of the year. WSP's estimate of 161.42 tons of carbon monoxide in one year is the equivalent of a year's worth of driving for 2,254 vehicles.

The carbon monoxide levels people are exposed to in Logansport would likely be increased by the proposed Waelz plant, though quantifying the increase would require modeling that is beyond the scope of this report. Measured carbon monoxide levels are known to be increased near sources, like the Waelz plant, particularly during periods when the wind is still. The average carbon monoxide level for North America is 0.12 parts per million by volume or ppmv. Areas with dense traffic or industrial sources can reach 5 ppmv of carbon monoxide[12].

The current carbon monoxide levels in Logansport and Cass County are not measured and are therefore unknown. The state's closest carbon monoxide monitor is in Indianapolis[13]. The amount released from WSP would add to carbon monoxide from the traffic and industries that are already present.

Carbon monoxide acts on the body by blocking oxygen transport in the blood. High doses are fatal. At levels of just 0.5 to 10 ppmv in the air, it exacerbates respiratory and cardiovascular diseases, and in healthy people, it decreases exercise endurance. People with asthma or chronic bronchitis could experience more difficulty breathing. Carbon monoxide increases the risk of arrhythmias in people with cardiac disease[14].

Particulate Matter

WSP estimates total facility-wide emissions of 178.75 tons of particulate matter, 172.65 tons of particulate matter up to 10 microns in size (PM 10), and 171.5 tons of particulate matter up to 2.5 microns in size (PM 2.5) per year. Though they are listed separately with different amounts, there is a footnote to the emissions table on pdf page 10 of the permit application indicating that 171.13 tons per

[10] US Department of Transportation, Bureau of Transportation Statistics. https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances

[11] US Environmental Protection Agency, Air Emissions Inventories. https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data

[12] Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological profile for Carbon Monoxide. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

[13] Indiana Department of Environmental Management. Carbon Monoxide Data Map. https://www.in.gov/idem/airquality/pages/monitoring_data/co.html

[14] Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological profile for Carbon Monoxide. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Chapter 2

year represents "total PM emissions", so the amounts of the different types of particulate matter may not be additive.

To put the amount in perspective, the WSP estimated emissions of 171.5 tons of fine particulate matter (PM 2.5) exceeds the reported PM 2.5 emissions from Essroc Cement Corp in Cass County, which were 137 tons in 2017[15]. Releasing 171 tons per year of PM 2.5 from WSP will add to the emissions that are already present and raise PM 2.5 levels in Cass County.

Particulate matter air pollution affects the lungs in both adults and children. In children, higher levels of particulate matter exacerbate asthma and increase the risk of bronchitis[16, 17]. They also affect the development of children's lungs. Children living in areas with lower levels of particulate air pollution have better lung growth and improved lung function as they grow up compared to children exposed to higher levels[18]. Particulate matter exacerbates asthma, and there is evidence that it can contribute to people developing asthma and other allergic disorders[19].

Fine particulate matter, 2.5 microns or less in size (PM 2.5), is linked to cardiovascular disease and mortality. A study of people in Indianapolis who suffered cardiac arrest, found that there was an increased risk for cardiac arrest when PM 2.5 air levels were higher[20]. After examining data from many such studies covering tens of thousands of patients, the American Heart Association concluded that higher exposure to PM 2.5 over hours to days increases the risk of both fatal and nonfatal cardiovascular events, like heart attacks[21]. Long-term exposure to higher PM 2.5 levels reduces life expectancy in the exposed population. Areas that have reduced their PM 2.5 levels have seen reductions in cardiovascular deaths[22, 23].

Fine particulate matter (PM 2.5) is also associated with detrimental effects during pregnancy. These particles are small enough to be inhaled into the small air sacks in the lungs (alveoli) and from there they get absorbed into the blood stream. This is how they can affect parts of the body other than the lungs

[15] US Environmental Protection Agency. Air Pollutant Report for Essroc Cement Corp https://echo.epa.gov/air-pollutant-report?fid=110000401459

[16] Schwartz, J. (2004). Air Pollution and Children's Health. *Pediatrics* 113:1037 - 1043.

[17] Berhane, K. et al. (2016). Association of changes in Air Quality with Bronchitic Symptoms in Children in California, 1993-2012. *J Amer Med Assoc* 315:1491-1501.

[18] Gauderman, WJ et al.(2015). Association of Improved Air Quality with Lung Development in Children. *New Eng J Med* 372:905-1013.

[19] Sompornrattanaphan, M. et al. (2020). The Contribution of Particulate Matter to Respiratory Allergy [Review]. *Asian Pacific J Allergy & Immunology* 38:19-28.

[20] Rosenthal, F, JP Carney, and ML Olinger (2008). Out-of-hospital Cardiac Arrest and Airborne Fine Particulate Matter: A case-crossover analysis of emergency medical services data in Indianapolis, IN. *Env Health Perspect* 116:631-636.

[21] Brook, RD, et al. (2010). Particulate Matter Air Pollution and Cardiovascular Disease: An update to the scientific statement from the American Heart Association. *Circulation* 121:2331-2378.

[22] Ibid.

[23] Combes, A. & G. Franchineau (2019). Fine Particle Environmental Pollution and Cardiovascular Diseases [Review]. *Metab: Clinical & Experimental* 100S:153944, 2019 11.

and potentially reach the unborn child. A study in Ohio found that higher PM 2.5 exposure for a pregnant woman increased the risk that her baby would be born prematurely[24].

Lead

Lead air emissions enter the body either through inhalation into the lungs or because the lead settles out of the air onto crops, soil, and other surfaces and is accidentally ingested. If lead settles on crops, people might eat it. If it settles on soil or surfaces, it becomes part of the dust which gets on people's hands or dishes where it can be consumed. The EPA estimates that adults accidentally eat 100 milligrams of dust every day and children accidentally eat 200 milligrams[25].

Children[26]	**Nervous system** Lower IQ Attention deficits Hyperactivity Poor impulse control Higher risk criminal behavior later in life Depression Anxiety Hearing damage Reduced coordination **Immune system** Possible increase in allergies Decreased resistance to infection **Hematologic** Anemia **Reproductive system** Delayed puberty
Adults	**Cardiovascular system** Hypertension Risk of heart attack **Reproductive system** Reduced male fertility **Hematologic** Anemia

Table 3. Health effects that are associated with lead. From the EPA's Integrated Science Assessment for Lead (2013).

Lead is toxic to the human body and its toxicity is well established. The first cases of lead poisoning due to lead paint were more than 100 years ago[27]. Its toxicity happens at the cellular level where it alters ion

[24] DeFranco, E. et al.(2016). Exposure to Airborne Particulate Matter During Pregnancy is Associated with preterm birth: A population-based cohort study. *Env Health* 15:6.
[25] US Environmental Protection Agency Standard Default Exposure Factors.
[26] Table of health effects was derived from EPA's Integrated Science Assessment for Lead
[27] Landrigan, P.J. and Etzel, R.A. (2014). Textbook of Children's Environmental Health. Oxford University Press

status and binds proteins which damages and sometimes kills the cell[28]. These cellular changes cause a number of health effects most of which cannot be reversed. At high levels, lead is lethal. At low levels, it has permanent effects, particularly for the unborn or young child, as listed in Table 3.

The amount of lead required to affect a child is tiny. The US Centers for Disease Control recommends taking action if a child has 5 micrograms of lead or more per deciliter of blood. This is a very, very small amount of lead. It takes 28,350,000 micrograms to make just one ounce.

Children living in areas with lead contaminated soil have an increased risk of lead poisoning, and the higher the lead in the soil, the higher the risk[29, 30].

Waelz Sustainable Products requested a permit limit of 1,000 pounds of lead in their air emissions per year ("<0.5 tons"). Their air permit application states that the facility would have a potential to emit 760 pounds per year. In 2019, the lead emissions from the Waelz plant in Alabama were measured at 0.076 pounds of lead per hour[31]. If the emissions remained the same for a whole year, that would mean a total of 665.8 pounds per year or 0.33 tons per year, which is very similar to the Logansport WSP estimate.

Lead tends to settle out of the air in the first few miles[32, 33], and lead is a forever pollutant, meaning that doesn't break down over time. If 1000 pounds were emitted this year and again next year and the next, the lead would accumulate and the soil nearby would get increasingly contaminated. This accumulation effect has been documented many times in the soil near lead smelters[34].

Better control of lead emissions is possible. For comparison, the Exide lead smelter in Muncie used to have air emissions of up to 1700 pounds per year[35]. After a 2013 EPA enforcement action[36, 37], Exide brought additional pollution controls online and reduced their annual lead emissions to about 250 pounds per year. The Quemetco lead smelter in Indianapolis uses an additional pollution control device

[28] Klaassen, C.D.(2008). Toxicology: The Basic Science of Poisons

[29] Landrigan, P.J. and Etzel, R.A. (2014). Textbook of Children's Environmental Health, Oxford University Press. page 267 - 268

[30] Morrison, D, et al.(2012). Spatial relationships between lead sources and children's blood lead levels in the urban center of Indianapolis (USA). *Env Geochem Health,* DOI 10.1007/s10653-012-9474-y

[31] Steel Dust Recycling (April 22, 2019). Facility No.408-0010 Stack Compliance Test Results for -x002, x004, x006 Waelz Kiln with Baghouse.

[32] Sullivan, M. (2014). Tainted Earth: Smelters, Public Health, and the Environment. Rutgers University Press

[33] Ketterer, M.E. (2006). The ASARCO El Paso Smelter: A source of local contamination of soils in El Paso (Texas), Ciudad Juarez (Chihuahua, Mexico), and Anapra (New Mexico), Summary Report.

[34] Sullivan, M. (2014). Tainted Earth: Smelters, Public Health, and the Environment. Rutgers University Press.

[35] US Toxics Release Inventory

[36] United States of America and the State of Indiana v. Exide Technologies, Civil Action No. 15-cv-433, Complaint https://www.justice.gov/sites/default/files/enrd/legacy/2015/04/13/Exide_COMPLAINT.PDF

[37] United States and the State of Indiana v. Exide Technologies, Consent Decree, https://www.justice.gov/sites/default/files/enrd/legacy/2015/04/13/Exide_Consent_Decree.PDF

called a "wet electrostatic precipitator" or WESP[38], and their air emissions of lead for 2018 were just 11 pounds for the whole year[39].

The US EPA has regulated air emissions of lead under the Clean Air Act since the early 1970s. The Clean Air Act has significantly decreased lead in US air, but it has limits. For example, during settlement of the EPA enforcement action against the Exide secondary lead smelter in Muncie, IN, the Hoosier Environmental Council was part of a coalition that formally requested that Exide be required to install a wet electrostatic precipitator to get the tightest possible control of their lead emissions[40]. The request was denied because it went beyond what was required under the Clean Air Act[41].

As medical science has better defined lead's effects on the body, there has been a call from the public health community to strengthen the Clean Air Act when it comes to lead. In 2008 the EPA's Children's Health Protection Advisory Committee recommended lowering the National Ambient Air Quality Standard (NAAQS) for lead from 0.15 to 0.02 micrograms per cubic meter (ug/m^3), nearly a 10-fold reduction[42]. As of this writing, the EPA has not made that change.

There are some very good people working at the Indiana Department of Environmental Management (IDEM) who do all that they can to protect Indiana's environment. However, because of policies from the Indiana legislature[43] and the Governor's office, IDEM does what is required under the federal Clean Air Act, but no more. IDEM is unlikely to write an air permit for the Waelz plant in Logansport that goes beyond the Clean Air Act requirements.

Mercury

The estimate of mercury emissions in WSP's 2019 air permit application for Logansport is questionable. The application lists an estimated 0.11 tons per year of mercury emissions (220 lbs), but their application for Muncie stated a potential to emit of 1,540 pounds of mercury per year[44], 700% more, even though the Muncie and Logansport facilities would have been close to the same size. In Muncie WSP proposed processing 360,000 tons of EAF dust per year, and in Logansport they proposed processing 319,110 tons. Similarly, Waelz's sister facility, Steel Dust Recycling in Alabama, reported

[38] http://quemetco.com/wesp/
[39] US Toxics Release Inventory
[40] (April 20, 2015) Letter to Assistant Attorney General, Environment and Natural Resources Division, US Department of Justice concerning United States and the State of Indiana v. Exide Technologies, D.J. Ref. No. 90-5-2-1-11003.
[41] (Sept 24, 2015) United States' Brief in Support of Motion to Enter Consent Decree in the case of US and State of Indiana v. Exide Technologies, Civil Action No. 1:15-cv-00433-TWP-TAB
[42] Children's Health Protection Advisory Committee (June 16, 2008). Letter to EPA Administrator Stephen L. Johnson. https://www.epa.gov/sites/production/files/2014-05/documents/61608.pdf
[43] https://www.indianahouserepublicans.com/news/press-releases/wolkins-no-more-stringent-than-bill-will-be-law-after-veto-override/
[44] Ramboll (April 10, 2019). Waelz Sustainable Products, LLC - Muncie, Indiana, New Source Construction Permit Title V Application.

mercury emissions for 2018 of 1,328 pounds[45] while processing 350,000 tons of EAF dust. These data suggest that the WSP would have more than 220 pounds of mercury emissions per year, if it is built.

WSP is not proposing any pollution controls in Logansport that are designed to control mercury emissions. In fact, the air permit application lists mercury emissions as 0.11 tons per year without controls (page 205) and 0.11 tons per year with controls (page 204), so WSP admits that their pollution controls will not reduce mercury emissions. Yet, the Logansport application claims it will emit only 14% as much mercury as it would have in Muncie, even though the Logansport proposal would process nearly as much material (88.6% as much EAF dust as the Muncie proposal)[46].

There have been extensive studies of where mercury lands after it is released into the air[47, 48, 49]. The studies show that a significant portion of it lands near where it was released. Exactly how much depends on a number of factors like what form the mercury is in when it is released, how tall the smoke stack is, and the local weather. It is safe to say that the mercury from the Waelz plant proposed for Logansport would contribute to increased mercury in soil and water in Cass County and more widely in Indiana and the Northeastern United States.

After mercury lands on soil or water, microbes convert it to an organic form called methylmercury. Methylmercury accumulates up the food chain as larger organisms eat the bacteria and then even larger organisms eat them[50]. People are most often exposed to mercury by eating fish, especially fish that are the top predators in their food chain. That is true of both fish caught in streams and lakes and fish caught in the ocean.

Indiana has Fish Consumption Advisories that let anglers know how much fish is safe to eat based on how much mercury or PCBs are found in particular species of fish[51].

Studies have shown that local pollution sources affect local fish. For example, in Florida over ten years as local mercury emissions were reduced by over 90%, the mercury in local fish declined 60% [52]. This local effect means some of the mercury from the Waelz plant would wind up in Indiana fish, including fish in the Eel and Wabash Rivers.

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[45] US Environmental Protection Agency, Toxics Release Inventory. Data downloaded April 5, 2020.
[46] Ramboll (April 10, 2019). Waelz Sustainable Products, LLC - Muncie, Indiana, New Source Construction Permit Title V Application.
[47] Vanarsdale, A. et al. (2005). Patterns of mercury deposition and concentration in Northeastern North America (1996-2002). *Ecotoxicology,* 14, 37-52.
[48] Great Lakes Commission (2007). Mercury Deposition Monitoring in the Great Lakes States: Current activities and future directions.
[49] Sullivan, T.M., et al. Brookhaven National Laboratory (2001). Assessing the mercury health risks associated with coal-fired power plants: Impacts of local depositions.
[50] Agency for Toxic Substance and Disease Registry. ToxFaqs for Mercury. https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=113&tid=24
[51] https://www.in.gov/isdh/23650.htm
[52] Florida Department of Environmental Protection (2002). Integrating atmospheric mercury deposition with aquatic cycling in South Florida.

Mercury in its elemental form is a health hazard when it is inhaled. It is uncertain how much of the Waelz mercury emissions would be in the elemental form. It is also uncertain how the Waelz emissions would disperse. Elemental mercury tends to stay in the air for months, so the wind can transport it far from where it was emitted, whereas the divalent and particle-bound forms settle to the ground much faster and therefore closer to the source that released them[53].

Where ever the Waelz mercury emissions settle, they will contribute to a toxic pollution problem. Mercury is toxic to the brain in very small amounts. The adult lethal dose of methylmercury is just one gram, and it takes 454 grams to make one pound. The amount of methylmercury that produces non-lethal effects in humans is measured in micrograms. It takes one million micrograms to make a gram.

Low doses of mercury cause the following[54]:

In adults:	decreased coordination, decreased visual sensitivity
In children:	decreased memory, attention, and language skills

A young child or unborn baby's developing brain is especially sensitive to mercury. There is no cure for mercury damage to the brain.

The National Academy of Sciences and the EPA carefully reviewed all of the health data on mercury and concluded that to protect her unborn children, a woman should have no more than 0.1 micrograms of methylmercury per kilogram of her body weight per day[55] during her reproductive years. For example, a woman who weighs 60 kilograms (132 pounds) should have no more than 6 micrograms of methylmercury per day. In 2005 the average mercury concentration in the bass tested by the state of Indiana was 276 micrograms of mercury for every kilogram of fish[56]. To stay within the safe level of mercury, a 60 kilogram woman should eat no more than three-quarters of an ounce of bass per day. If she eats bass once per week, then she could safely eat 5 ounces.

The US has been working hard since 1990 to reduce mercury emissions. In some locations where mercury sources were shut down or added pollution controls, mercury in the local fish has gone down. The proposed Waelz plant emissions would be a step backward.

Hexavalent Chromium

WSP estimates emissions of only 0.0015 tons (3 pounds) of hexavalent chromium per year on page 213 of the air permit application, though there will be much more hexavalent chromium in its process. The

[53] Kim, MK and KD Zoh, (2012). Fate and transport of mercury in environmental media and human exposure. *J Prev Med Public Health,* 45:335-343.
[54] US Environmental Protection Agency (2011). Technical Support Document: National-scale mercury risk assessment supporting the appropriate and necessary finding for coal- and oil-fired electric generating units.
[55] Committee on the Toxicological Effects of Methylmercury, Board on Environmental Studies and Toxicology, National Research Council, National Academy of Sciences. (2000). Toxicological Effects of Methylmercury.
[56] Data aquired by the author from the Indiana Department of Environmental Management in December 2008.

permit application states that hexavalent chromium makes up 0.012% of EAF dust (page 211), which is the material entering the WSP plant. The plant will receive a total of 319,110 tons of EAF dust per year, and 0.012% of 319,110 tons is 38 tons of hexavalent chromium. The application states that the uncontrolled emissions would be 0.155 (page 216) and the controlled emissions would be 0.0015 tons per year (page 213), but does not explain what happens to the rest of the 38 tons that went into the plant. It could wind up in the products, Waelz zinc oxide and Waelz iron product, or it could be converted to another form of chromium. The application does not include that information. If it is converted to chromium III or chromium IV, those forms are essentially non-toxic.

While 3 pounds is a small quantity relative to the other pollutants, hexavalent chromium (or chromium VI) is included here because it is particularly toxic. Hexavalent chromium is a potent carcinogen, and inhalation can lead to lung cancer. It can also cause tissue damage where it comes in contact with the body. Chronic exposure to as little as 0.004 mg per cubic meter in the air causes ulceration of the nasal mucosa and perforation of the nasal septum. Workers exposed to more than 0.002 mg per cubic meter had decreased lung function during the work day and workers exposed to more than 0.01 mg per cubic meter had throat irritation and bronchitis. Ingestion of hexavalent chromium increases the risk of stomach cancer and causes irritation or ulceration of the lining of the stomach and intestines and lowers sperm counts[57].

In animal studies, female ingestion of hexavalent chromium decreased the number of viable pregnancies, increased the number of miscarriages, and led to birth defects in the offspring. The daily doses given to the animals in these studies ranged from 6 to 52 milligrams per kilogram of the animal's body weight[58], so they were given much more than people would be exposed to, except in the worst cases of drinking water contamination. Hexavalent chromium was the contaminant in drinking water that led to the famous lawsuit depicted in the movie *Erin Brockovich.*

Urban areas generally have 30 nanograms, which is the same as 0.00003 milligrams, per cubic meter of air or less. Chromium released to the air is estimated to stay in the air less than 10 days. It tends to settle out onto the ground. [59]

Workers at the proposed WSP plant in Logansport would have the greatest risk of exposure to the hexavalent chromium from the Waelz process, particularly workers exposed to the EAF dust. Risks to other workers would depend on where the hexavalent chromium winds up during the Waelz process.

[57] US Agency for Toxic Substances and Disease Registry (2012). Toxicological Profile for Chromium. https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=62&tid=17 chapters 2 & 3
[58] Ibid.
[59] US Agency for Toxic Substances and Disease Registry (2012). Toxicological Profile for Chromium. https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=62&tid=17 chapter 6

Dioxins/Furans

The Waelz process is known to release dioxins and furans to the air[60], though they were not included in WSP's air permit application. Dioxins and furans are a family of chemical byproducts formed in high temperature processes. Some dioxins are considered carcinogens. Animal studies suggest that low dose exposure can interfere with reproduction and weaken the immune system[61].

Where the dioxins and furans wound up after release from the proposed Logansport Waelz plant would depend on the height of the smoke stack and whether they were bound to particles. Studies of dioxin released from a Waelz plant in Taiwan, showed that people living closer to the plant had higher blood levels of dioxin[62].

There have been a number of publications over the last 20 years about methods for controlling dioxin and furan emissions from Waelz facilities:

> In 2000, a symposium on metal recycling included a report from Recytech in France on how a Waelz plant reduced dioxin emissions by 99%[63].
>
> In 2003, an article on reducing dioxin and furan emissions from Waelz facilities was published by a research team in Germany[64].
>
> In 2005, a Waelz facility used activated carbon injection to reduce the concentration of dioxin in its air emissions by more than 97%[65].

Despite the 20-year old literature on controlling dioxin emissions from Waelz plants, WSP has not proposed controls for dioxin in its air permit application for Logansport.

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[60] Hung, P.C. et al (2012) Characteristics of dioxin emissions from a Waelz plant with acid and basic kiln mode. *J Hazard Mater,* 201, 229-235. https://www.ncbi.nlm.nih.gov/pubmed/22178278

[61] Agency for Toxic Substance and Disease Registry. ToxFaqs for Chlorinated Dibenzo-p-dioxins. https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=363&tid=63

[62] Tsai, Y. et al. (2014). Health risk from exposure to PCDD/Fs from a Waelz plant in central Taiwan. *Aerosol and Air Quality Research,* 14:1310-1319.

[63] Mager, K. And Meurer, U. (2000). Recovery of zinc oxide from secondary raw materials. Chapter in Fourth Internation Symposium on Recycling of Metals and Engineered Materials. https://books.google.com/books?hl=en&lr=&id=BbzVAAAAQBAJ&oi=fnd&pg=PA329&dq=secondary+zinc+production+techniques&ots=jrhJ0i13SB&sig=fISMLdQ-wOD47i4IS9wUZCKQIY0#v=onepage&q=secondary%20zinc%20production%20techniques&f=false

[64] Mager, K et al. (2003). Minimizing dioxin and furan emissions during zinc dust recycle by the Waelz process. *Journal of the Minerals, Metals, and Materials Society,* DOI: 10.1007/s11837-003-0099-6 https://www.researchgate.net/publication/228984038_Minimizing_Dioxin_and_Furan_Emissions_during_Zinc_Dust_Recycle_by_the_Waelz_Process

[65] Chi, K.H. et al (2007). PCDD/F emissions and distributions in Waelz plant and ambient air during different operating stages. *Environ Sci Technol,* 41(7), 2515-2522. https://www.ncbi.nlm.nih.gov/pubmed/17438809

Carcinogens

Generally speaking with carcinogens, the risk of cancer is higher at higher doses and decreases with lower doses, but the risk does not get to zero until the dose is zero. With environmental contaminants the "dose" is determined by the amount of the contaminant in the air, water, food or dust a person is exposed to. Adding hexavalent chromium and dioxin, which are both potent carcinogens, to the local environment, even in small amounts, increases the risk of cancer.

Greenhouse Gas Emissions

Waelz Sustainable Products' air permit application for Logansport does not have an estimate of greenhouse gas emissions, but the same company's application for Muncie did. It stated that the Muncie Waelz facility would have had the emissions of greenhouse gases listed in Table 4[66].

	tons per year, potential emissions	global warming potential	Total warming potential
carbon dioxide	417,932	1	417,932
methane	0.97	30	29.1
nitrous oxide	0.1	270	27
			417,988

Table 4. Estimated greenhouse gas emissions from the proposed Muncie Waelz plant, and their global warming potential relative to carbon dioxide[67].

According to the EPA, the typical passenger car emits 4.6 tons of carbon dioxide per year[68], so the Muncie Waelz facility would have been the equivalent of adding 90,867 cars to the road. WSP has proposed handling less electric arc furnace dust at the Logansport Waelz plant than it proposed for Muncie. It proposed 360,000 tons per year in Muncie, but just 319,110 in Logansport, which is 11.4% less. It can be concluded that the Logansport plant will have about 88.6% of the greenhouse gas emissions, or the equivalent of 80,508 more cars added to the roads.

Greenhouse gases contribute to climate change. Purdue University Climate Change Research Center has published a series of reports on how Indiana's climate is changing and what effects this is having[69]. Briefly, Indiana is seeing increasing numbers of days over 90 degrees and increasing precipitation in the

[66] Ramboll (April 10, 2019). Waelz Sustainable Products, LLC - Muncie, Indiana, New Source Construction Permit Title V Application. page 217.
[67] US Environmental Protection Agency (2017). Understanding Global Warming Potentials. https://www.ncbi.nlm.nih.gov/pubmed/17438809
[68] https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle
[69] Purdue University (2020). Indiana Climate Change Impacts Assessment. https://ag.purdue.edu/indianaclimate/

winter and spring. This is impacting hoosiers' health by increasing the risk of heat stroke, flooding, poor air quality, and certain 'tropical' diseases like West Nile and Zika[70].

Prevailing Winds

The center of the city of Logansport is approximately 3.5 miles downwind of the proposed WSP site. Many neighborhoods are closer. The proposed WSP site is southwest of the city (Figure 1) and the wind in Cass County is most often coming out of the southwest and blowing toward the north and east, so it will be blowing from the WSP site toward the city (Figure 2).

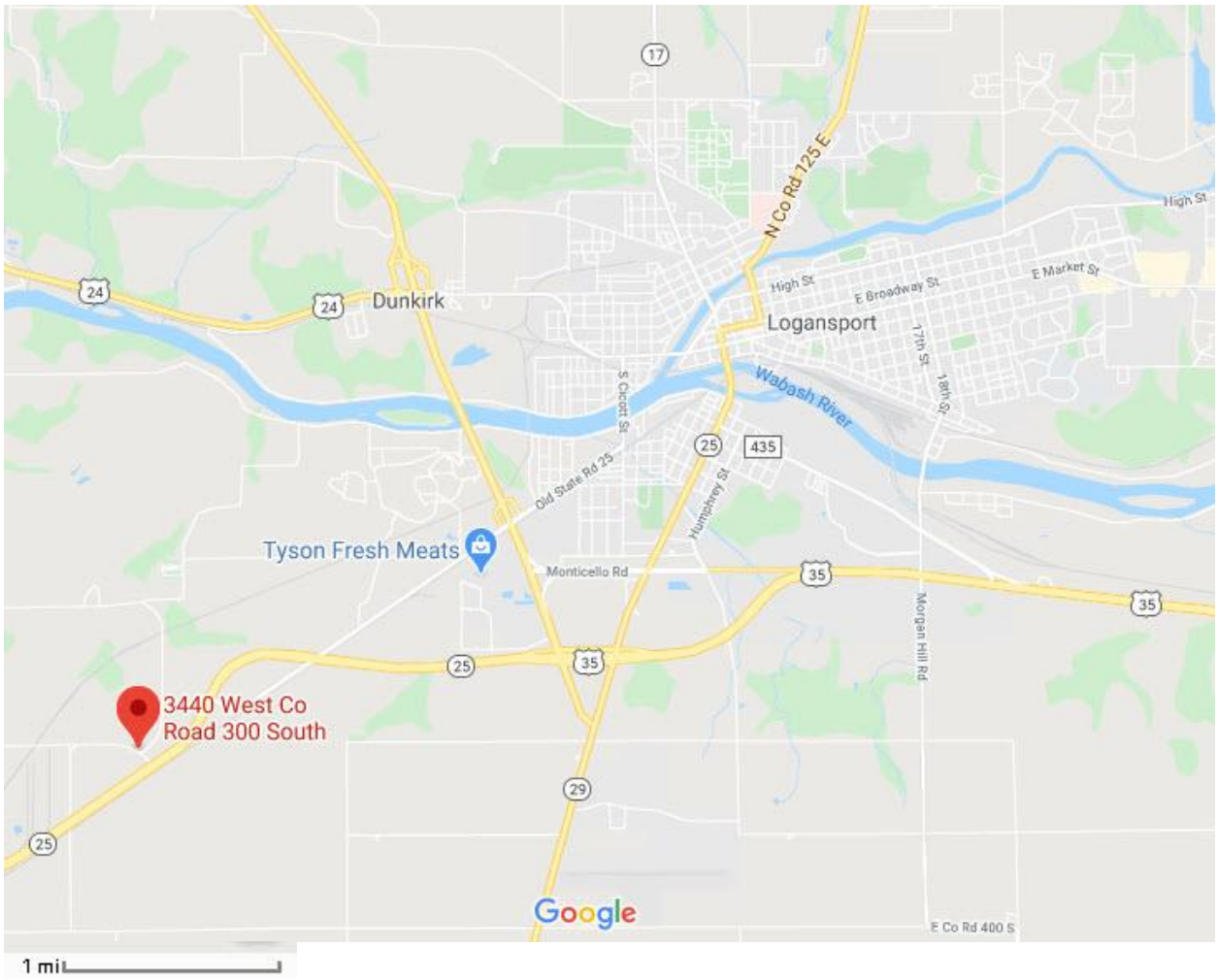

Figure 1. Proposed WSP site at 3440 West Co Road 300 South and the city of Logansport. From Google Maps.

[70] Filippelli, GM, et al.(2018). Hoosiers' Health in a Changing Climate: A report from the Indiana Climate Change Impacts Assessment. Purdue Climate Change Research Center, Purdue University, West Lafayette, Indiana. https://ag.purdue.edu/indianaclimate/hoosier-health-report

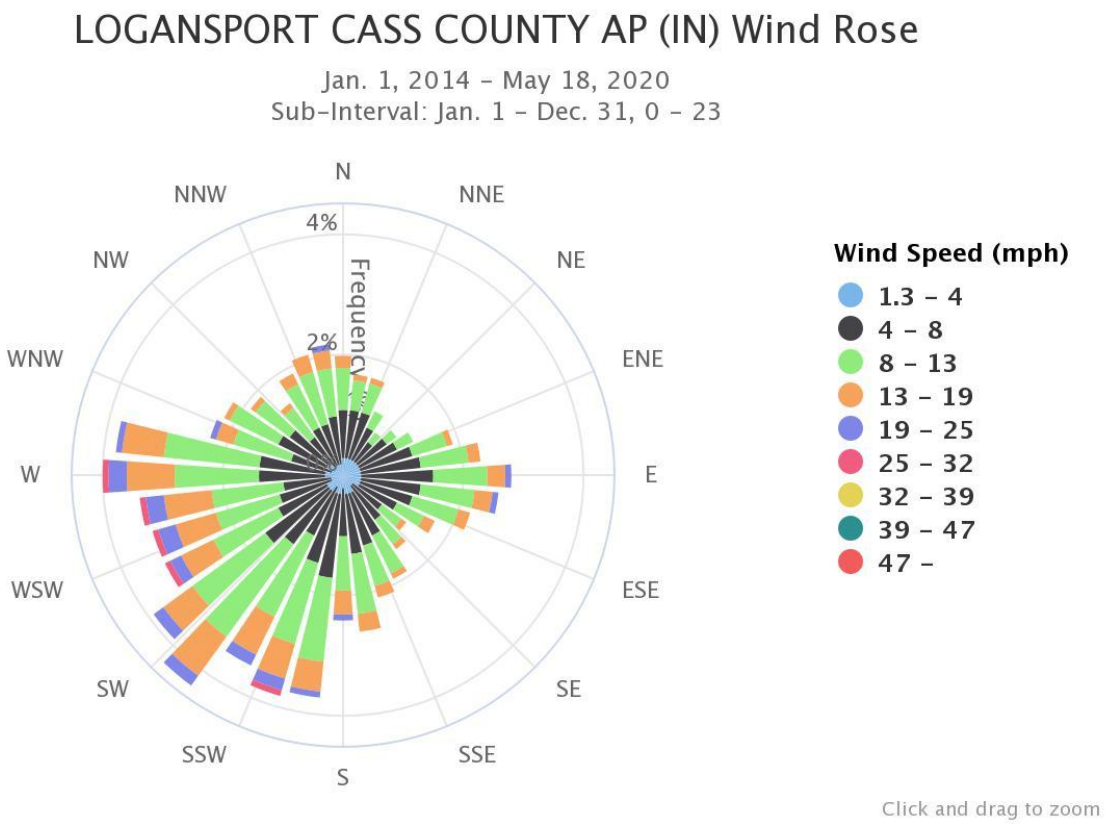

Figure 2. Wind rose for Cass County, Indiana, from the Midwestern Regional Climate Center

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