Trinity Consultants

MEMORANDUM

To: Jason Feldman, Green Era Partners & Rick Vamos, DAI Environmental

cc: Chloe Reece, Trinity Consultants

From: John Ke and Annie Casburn, Trinity Consultants

Date: February 7, 2024

RE: Green Era Chicago, IL Facility Modeling

Green Era is a non-profit organization that owns and operates a facility located at 650 W 83rd Street, Chicago, Illinois 60620 (Chicago facility). The Chicago facility consists of a renewable energy facility and hub for urban agriculture and green jobs. At the north side of the facility there is a digester tank and an equalization tank. Green Era plans to add a retention pond (basin) and roadway around the retention pond.

Executive Summary

The Chicago Department of Public Health (CDPH) has requested that Green Era complete an air quality impact assessment for emissions associated with their proposed project to add a semi vegetated basin to the north side of their facility. As part of the permitting process for this new basin, Green Era has provided CDPH with a site map detailing the location of the new basin. Trinity utilized this information to create a base model for the analysis. This air quality impact assessment has been conducted following CDPH air modeling guidance and models the impacts of $PM_{2.5}$, PM_{10}, and NO_2. Trinity was able to demonstrate that the proposed project does not cause a National Ambient Air Quality Standard (NAAQS) exceedance for any of these listed pollutants and their corresponding averaging periods.

Model Setup

Modeled Sources

For the sake of this analysis, emissions were only modeled from sources associated with the north side of the facility, where the proposed basin will be. Activities that will take place in this area of the facility that potentially contribute to the air quality impact assessment include lawncare, the driving of a maintenance truck across an access drive, and wind erosion[1]. An emission factor for the lawncare activities was estimated based on the CDPH MOVES Non-Road Lookup Table. The emission factor used in the models was then calculated based on estimated lawncare frequency. The emission factor for emissions associated with the access driveway was estimated using AP 42 Section 13.2.2 Unpaved Roads equation 1a. A complete list of modeled sources is included in Appendix B and detailed emission calculations are included in Appendix C.

Modeled Receptors

In the air dispersion modeling analysis, ground-level concentrations were calculated within five Cartesian receptor grids. The grids are defined as follows:

[1] AP-42 Section 13.2.5.3 equations 2 and 3 were used to estimate emissions due to wind erosion. Based on maximum daily wind speed data from the National Climatic Data Center for each day from 2018-2023, a maximum friction velocity was calculated per AP-42 Section 13.2.5.3 equation 3. This calculated maximum friction velocity was less than the threshold friction velocity, so the erosion potential is 0.

- Fence Line Receptors: A line consisting of evenly spaced receptors 50-meters apart placed along the facility fenceline
- 50-meter Cartesian Grid: A grid containing 50-meter spaced receptors extending approximately 1 km from the fenceline
- 100-meter Cartesian Grid: A grid containing 100-meter spaced receptors extending from 1 km to 2 km from the fenceline, exclusive of the receptors in the 50-meter grid
- 250-meter Cartesian Grid: A grid containing 250-meter spaced receptors extending from 2 km to 5 km from the fenceline, exclusive of the receptors in the 100-meter grid
- 500-meter Cartesian Grid: A grid containing 500-meter spaced receptors extending from 5 km to 10 km from the fenceline, exclusive of the receptors in the 250-meter grid
- 1000-meter Cartesian Grid: A grid containing 1000-meter spaced receptors extending from 10 km to 50 km from the fenceline, exclusive of the receptors in the 500-meter grid

Figure 1 in Appendix A displays the receptor grid layout. Figure 2 in Appendix A provides a zoomed-in view of the base model setup, which includes the existing fenceline that was part of the initial model.

Variable Emission Factors

Due to the nature of the 1-hour NO_2 and 24-hour $PM_{2.5}$ standards, which are probabilistic standards, certain emission sources were removed or adjusted in the modeling, as they are intermittent sources. Based on US Environmental Protection Agency (EPA) guidance[2], intermittent sources can be excluded from compliance demonstrations of probabilistic standards. Lawncare activities at the facility will only occur every six weeks in a period from May to October, which would count these emissions as extremely intermittent, only happening around four to five times in a year. For the 1-hour NO_2 demonstration, these emissions were omitted completely from the model, while for the 24-hour $PM_{2.5}$ demonstration, a variable emission factor was applied to the model to only consider emissions from lawncare activities between May and October.

Modeling Parameters

Per CDPH guidance, as Green Era's location is within four miles of Lake Michigan and south of East and West 63rd Street, meteorological data was based on the Hammond, Indiana DEM monitor. In addition, for background concentration, the "Southeast" background concentrations based on the Washington HS monitor (AQS ID: 17-031-0022) were used for the 24-hour PM_{10} and $PM_{2.5}$ NAAQS demonstrations and the "Southeast" seasonal hourly ambient NO_2 concentrations from the Gary, Indiana monitor (AQS ID: 18-089-022) were used for the 1-hour NO_2 NAAQS demonstration as provided by the CDPH.

Modeling Results

Initial models were run to compare to the Significant Impact Levels (SIL) and results are shown in Table 1.

Table 1. Initial SIL Modeled Results

Modeled Pollutant	Averaging Period	Modeled Impact (µg/m³)	SIL Threshold (µg/m³)
PM_{10}	24-hr	21.911	5
$PM_{2.5}$	24-hr	13.680	1.2
	Annual	0.043	0.3

[2] "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard", EPA Office of Air Quality Planning and Standards to Regional Air Division Directors.

These model results show that for the $PM_{2.5}$ annual averaging period, the Chicago facility is modeling below the SIL thresholds, and no further modeling is needed for that averaging period. Once a SIL analysis was complete, a NAAQS analysis was also run for the 1-hour NO_2, 24-hour PM_{10}, and 24-hour $PM_{2.5}$ standards to compare the Chicago facility's impact to the NAAQS standards without the additional impact of nearby sources.

Table 2. Initial NAAQS Modeled Results

Modeled Pollutant	Averaging Period	Modeled Impact[3] (µg/m³)	Background Concentration[4] (µg/m³)	Total Impact (µg/m³)	NAAQS Threshold (µg/m³)
$PM_{2.5}$	24-hr	9.074	25	34.074	35
PM_{10}	24-hr	16.463	61	77.463	150
NO_2	1-hr	40.988	Variable	40.988	188

These results show that the Chicago facility does not exceed the NAAQS threshold for 24-hour PM_{10}, 24-hour $PM_{2.5}$, and 1-hour NO_2 and that no further analysis is needed.

[3] Modeled impact for NO_2 already includes the variable background concentrations.

[4] Per CDPH Ambient Air Background Concentrations.

Appendix A. Figures

Figure 1. Receptor Grid

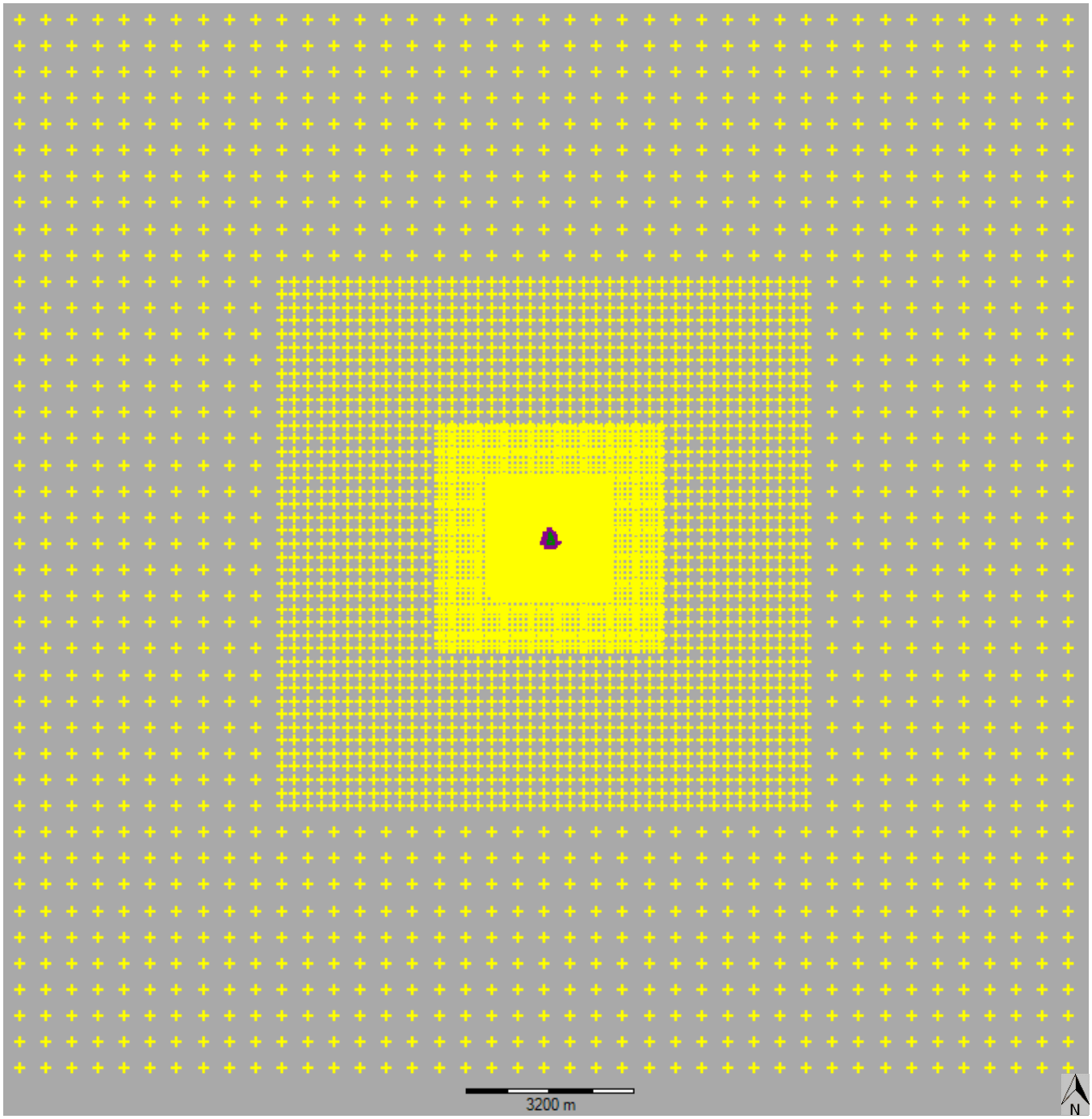
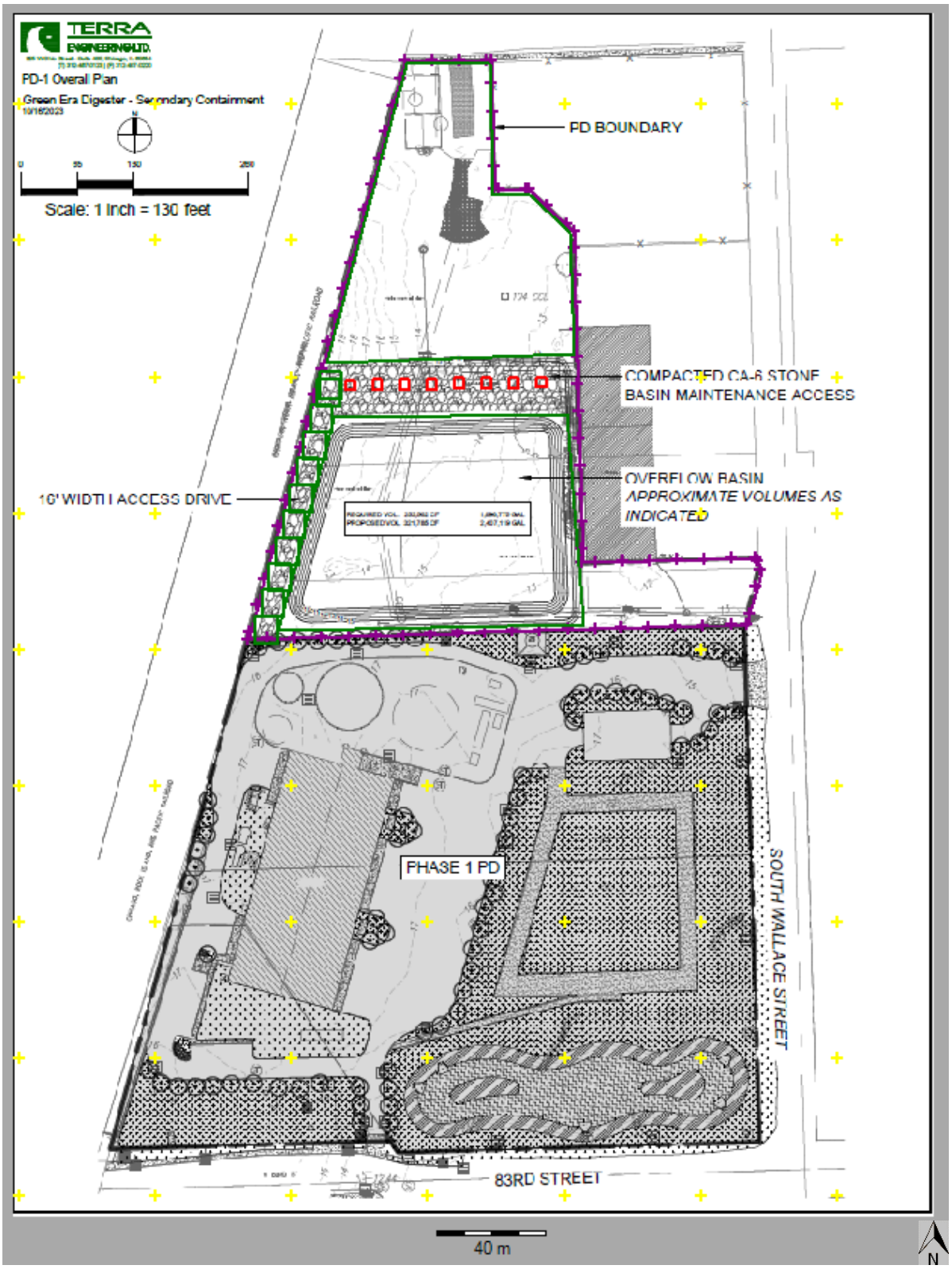


Figure 2. Modeled Facility Layout

+: Discrete Receptors +: Boundary Receptors : Area Sources : Volume Sources



Appendix B. Modeled Sources

Table 3. Green Era Modeled Source Inventory

Model ID	Description	Source Type
ARD1	Access Drive	Rectangular Area
ARD2	Access Drive	Rectangular Area
ARD3	Access Drive	Rectangular Area
ARD4	Access Drive	Rectangular Area
ARD5	Access Drive	Rectangular Area
ARD6	Access Drive	Rectangular Area
ARD7	Access Drive	Rectangular Area
ARD8	Access Drive	Rectangular Area
ARD9	Access Drive	Rectangular Area
ARD10	Access Drive	Rectangular Area
ARD11	Access Drive	Rectangular Area
BASIN1	Basin	Polygon Area
LAWN1	Lawncare	Polygon Area
RD12	Access Drive	Volume
RD13	Access Drive	Volume
RD14	Access Drive	Volume
RD15	Access Drive	Volume
RD16	Access Drive	Volume
RD17	Access Drive	Volume
RD18	Access Drive	Volume
RD19	Access Drive	Volume

Appendix C. Emission Calculations

Green Era Chicago, Illinois
CDPH Modeling

		Source Specific Modeling Emission Factor (lb/hr)		
		Lawncare	Access Drive	Erosion[1]
$PM_{2.5}$	24-Hr	0.011	8.45E-04	-
	Annual	1.25E-04	8.08E-05	-
PM_{10}	24-Hr	0.012	8.446E-03	-
NO_2	1-Hr	0.314	7.12E-05	

[1]Emission factor due to wind erosion is 0 because the threshold friction velocity is greater than the maximum friction velocity based on wind speed data from the Nation Centers for Environmental Information for Chicago Midway Airport. See tables 1-H and 1-I for detailed calculations.

Green Era Chicago, Illinois
CDPH Modeling

Table 1-A. Lawncare Annual Emission Factor

Annual Emission Factor								
Emission Unit	Pollutant	MOVES Emission Factor (g/hp-hr)[2]	Emission Rate (g/hr)	# of events per year[1]	Hours per event[1]	Total hours per year	Total Yearly Emissions (g)	Modeling Emission rate (lb/hr)
Tractor 50 (hp)[1]	Exhaust PM_{10}	0.0783	3.92	4.00	4.00	16.00	62.68	1.58E-05
	Exhaust $PM_{2.5}$	0.0760	3.80	4.00	4.00	16.00	60.80	1.53E-05
Weed Wacker 3.87 (hp)[3]	Exhaust PM_{10}	7.64	29.55	4.00	4.00	16.00	472.85	1.19E-04
	Exhaust $PM_{2.5}$	7.03	27.19	4.00	4.00	16.00	435.02	1.09E-04

[1]Information provided by Green Era

[2]Per CDPH MOVES Non-Road Lookup Table. For selecting an emission factor, the project year of 2024 was used, the tractor fell under the "Tractors/Loaders/Backhoes" category, and the weed wacker fell under the "Trimmers/Edgers/Brush Cutter (com)" category.

[3]Conservatively based on the highest powered weed wacker commercially available.

Table 1-B. Lawncare 24-Hr Emission Factor

24-Hr Emission Factor						
Emission Unit	Pollutant	MOVES Emission Factor (g/hp-hr)[2]	Emission Rate (g/hr)	Hours per event[1]	Total Daily Emissions (g)	Modeling Emission rate (lb/hr)
Tractor 50 (hp)[1]	Exhaust PM_{10}	0.0783	3.92	4.00	15.67	1.44E-03
	Exhaust $PM_{2.5}$	0.0760	3.80	4.00	15.20	1.40E-03
Weed Wacker 3.87 (hp)[3]	Exhaust PM_{10}	7.64	29.55	4.00	118.21	0.011
	Exhaust $PM_{2.5}$	7.03	27.19	4.00	108.76	9.99E-03

[1]Information provided by Green Era.

[2]Per CDPH MOVES Non-Road Lookup Table. For selecting an emission factor, the project year of 2024 was used, the tractor fell under the "Tractors/Loaders/Backhoes" category, and the weed wacker fell under the "Trimmers/Edgers/Brush Cutter (com)" category.

[3]Conservatively based on the highest powered weed wacker commercially available.

Table 1-C. Lawncare 1-Hr Emission Factor

1-Hr Emission Factor			
Emission Unit	Pollutant	MOVES Emission Factor (g/hp-hr)[2]	Modeling Emission rate (lb/hr)
Tractor 50 (hp)[1]	Exhaust NOx	2.70	0.30
Weed Wacker 3.87 (hp)[2]	Exhaust NOx	1.86	0.016

[1]Information provided by Green Era.

[2]Per CDPH MOVES Non-Road Lookup Table. For selecting an emission factor, the project year of 2024 was used and the tractor fell under the "Tractors/Loaders/Backhoes" category, and the weed wacker fell under the "Trimmers/Edgers/Brush Cutter (com)" category.

Green Era Chicago, Illinois
CDPH Modeling

AP 42 Section 13.2.2 Unpaved Roads eq. 1a:

$$E = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

Description of Constants/Variables:

E = size-specific emission factor (lb/VMT)
k = empirical constant
s = surface material silt content (%)
W = mean vehicle weight (tons)
a = empirical constant
b = empirical constant

Emission Unit	Pollutant	k (lb/VMT)[1]	Silt Content (%)[2]	a[1]	W (tons)[3]	b[1]	E[1] (lb/VMT)	Access drive length (feet)[3]	Vehicle Miles Traveled Per Trip (VMT)	Emissions per trip (lb)
Maintenance Truck	$PM_{2.5}$	0.15	7.10	0.90	2.53	0.45	0.09	617.5	0.23	0.02
	PM_{10}	1.50	7.10	0.90	2.53	0.45	0.87	617.5	0.23	0.20

[1] Per eq. 1a found in AP 42 Section 13.2.2 Unpaved Roads.
[2] Used Taconite mining and processing service road silt content found in Table 13.2.2-1 of AP 42 Section 13.2.2.
[3] https://vehq.com/average-size-of-half-ton-truck/#google_vignette%20for%20half-ton%20truck%20dimensions.

AP 42 Section 13.2.2 Unpaved Roads eq. 2:

$$E_{ext} = E\left[\frac{365 - P}{365}\right]$$

Description of Constants/Variables:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT
E = emission factor from Equation 1a or 1b
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation

Table 1-D. Access Drive Annual Emission Factor

Annual Emission Factor					
Emission Unit	Pollutant	E_{ext} (lb/VMT)	Trips per year[1]	Total Yearly Emissions (lb)	Modeling Emission rate (lb/hr)
Maintenance Truck	$PM_{2.5}$	0.06	52.00	0.71	8.08E-05
	PM_{10}	0.58	52.00	7.08	8.08E-04

[1]Provided by Green Era.

Table 1-E. Access Drive 24-Hr Emission Factor

24-Hr Emission Factor				
Emission Unit	Pollutant	E (lb/VMT)	Emissions per trip (lb)	Modeling Emission rate (lb/hr)
Maintenance Truck	$PM_{2.5}$	0.09	0.02	8.45E-04
	PM_{10}	0.87	0.20	8.45E-03

Green Era Chicago, Illinois
CDPH Modeling

Table 1-F. On-Network Maintenance Truck 1-Hr NO_x Emission Factor

1-Hr Emission Factor				
Emission Unit	Pollutant	MOVES Emission Factor (g/mi)[1]	Vehicle Miles Traveled (VMT)[2]	Total Emissions per trip (lb)
Maintenance Truck	NO_x	0.14	0.23	7.12E-05

[1]Per CDPH MOVES On-Road Lookup Table. For selecting an emission factor, the project year of 2024 was used and the maintenance truck fell under the "Light Commercial Truck" category.

[2]Information provided by Green Era.

Green Era Chicago, Illinois
CDPH Modeling

Wind Erosion - Emission Factor Equation[a]				
$k\sum_{i=1}^{N} P_i$ $\qquad P = 58(u^* - {u_t}^*)^2 + 25(u^* - {u_t}^*)$				
where:	**PM_{10}**	**$PM_{2.5}$**	**Units**	**Data Source**
k = particle size multiplier for particle size range and units of interest	0.50	0.08		AP-42, Section 13.2.5.3
N = number of disturbances per year	52.00			Site Estimated
u^+ = fastest mile of wind speed at anemometer height	18.01		m/s	National Climatic Data Center Publication[b]
z = Anemometer Height at Station	10.00		m	OEPA Engineering Guide 69
$u_{10}{}^+$ = fastest mile of wind speed at a reference height of 10 m	18.01		m/s	AP-42, Section 13.2.5-3, Equation 5[c]
u* = maximum friction velocity	**0.95**		m/s	AP-42, Section 13.2.5-3, Equations 6 & 7[d]
u_t* = threshold friction velocity	**1.02**		m/s	AP-42, Table 13.2.5-2[e]
P = max daily erosion potential	-		g/m^2-disturbance	AP-42, Section 13.2.5-3, Equation 3[f]
E = daily particulate emission factor	**-**	**-**	**g/m^2**	**E_{daily} = k * (daily erosion potential)**
E = annual particulate emission factor	**-**	**-**	**g/m^2**	**E_{annual} = k * (total erosion potential) * N**

[a] AP-42, Section 13.2.5.3, eq 2 and 3.

[b] Maximum daily wind speed data from the National Climatic Data Center for each day from 2018-2023. Data based on wind speeds monitored by the Chicago Midway International Airport Monitoring Station. Maximum daily wind speed is based on sustained wind speed in a 2-minute duration.

[c] Assumes a typical roughness height of 0.5 cm (0.005 m).

[d] Friction Velocity = 0.053*$u_{10}{}^+$

[e] Threshold friction velocity data based on use of a material similar to overburden.

[f] If the threshold friction velocity is greater than the maximum friction velocity, the erosion potential is 0.

Green Era Chicago, Illinois
CDPH Modeling

Table 1-H. Wind Erosion Annual Emission Factor

Annual Emission Factor						
Emission Unit	Pollutant	Site area (ft^2)[1]	Site area (m^2)	Erosion Emission Factor (g/m^2)[2]	Total emissions per year (g)	Modeling Emission rate (lb/hr)
Wind Erosion	$PM_{2.5}$	585.00	54.35	-	-	-

[1] Based on site plot plan.

[2]AP-42, Section 13.2.5.3, eq 2 and 3.

Table 1-I. Wind Erosion 24-Hr Emission Factor

24-Hr Emission Factor						
Emission Unit	Pollutant	Site area (ft^2)[1]	Site area (m^2)	Erosion Emission Factor (g/m^2)[2]	Total emissions per day (g)	Modeling Emission rate (lb/hr)
Wind Erosion	$PM_{2.5}$	585.00	54.35	-	-	-
	PM_{10}	585.00	54.35	-	-	-

[1] Based on site plot plan.

[2]AP-42, Section 13.2.5.3, eq 2 and 3.