Dust Mitigation Plan related to Closure Construction for RMC Pacific Materials (CEMEX) in Davenport, CA

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1 Introduction

On October 2, 2018, the Central Coast Water Board provided conditional approval for a plan outlined by Adams and Hillyard (2018) to perform closure on land currently occupied by the North Cement Kiln Dust (CKD) Area Landfill created during operation of the cement plant which was discontinued in 2010. The below description briefly describes the closure of the CKD landfill ("Closure Project"):

- The North CKD Area Landfill contains ~ 848,000 cubic yards (cy) of CKD, most of which is in a stable concrete-like state. The existing piles are, therefore, immune to windblown dust suspension until there is a disturbed surface created during construction . The Closure Project will leave the majority of the material in place.
- Drainage improvements for the surface water run-on and runoff will be constructed to direct run-on around the North CKD Area. Once the CKD project site has been filled and graded to reach final elevations, the perimeter ditches, French Drain and other ditches will receive final grading.
- An outcrop of CKD will be regraded and moved to lower its overall height to an elevation and slope that approximates the adjacent topography.
- The steep area on the lower portion of the southwest face will be reinforced with soil nails for slope stability and covered with a 6-inch thick steel-reinforced permanent shotcrete wall for erosion control and to deter infiltration. Slope stability is not considered an issue for this area as described in the closure plan and covered in detail in the Final Geotechnical Design Report, Appendix C.
- Residual coal on the ground surface in the vicinity of the Retention Pond and sediment deposited in the Retention Pond will be excavated as part of remedial activities in the area. Soil and sediment excavated from in and around the Retention Pond will be placed into the CKD Landfill prior to placement of the final cap.
- A low permeability cap and protective soil layer that extends below the perimeter drainage ditches will be installed on CKD areas. The low permeability cap will consist of a polyethylene liner overlain by a geo-composite drainage net that is in turn overlain by a compacted 18-inch protective cover soil (PCS) and an 8-inch vegetative soil layer.
- Seeding/planting of vegetation will occur on the surface of the capped Landfill.

As described above, some digging, grading, mixing, and vehicle movement will be associated with the Closure Project. Figure 1-1 shows the location of the proposed activity and indicates locations for some of the emission control measures. Figure 1-2 provides a more detailed picture of the locations where potential dust emissions might occur.

The planned closure activities create a potential for off-site transport of suspended particulate matter (PM) from fugitive dust. PM covers a broad range of particle sizes that affect their suspension, transport, inhalation, and deposition properties. Visible deposition of PM will be monitored. The PM values are denoted in this report with subscripts denoting the size fraction of the material.

This plan describes monitoring and best practices to prevent dust that might be transported beyond the plant property perimeter and onto occupied properties in the plant vicinity. This plan is meant to be a living document that may change as knowledge is gained on the interactions of activity, meteorology, and dust transport, longer-term measures can be implemented during this two-year project to minimize the potential for off-site dust transport.

The plan consists of two parts: (1) dust prevention measures to eliminate dusting prior to its development; and (2) a real-time monitoring network will be established to determine locations and times when off-site dust transport might occur so that dust-generating activities and control measures can be optimized.

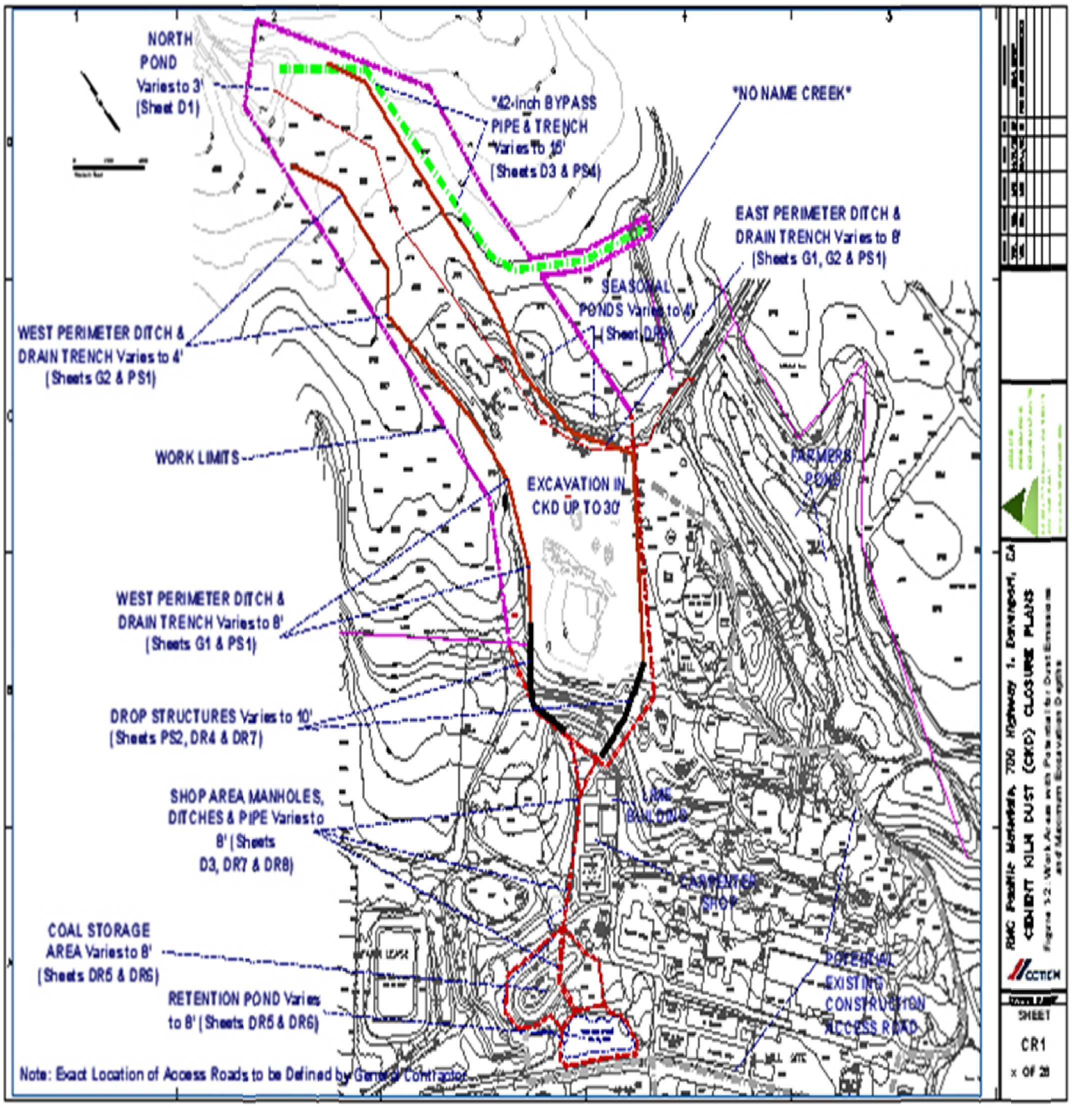
Best Management Practices that will be implemented during the project are described in Section 5. These measures will be continuously applied throughout the project, with locations and intensities of application informed by the monitoring program.

The monitoring network is further described in Sections 3 and 4 and will take advantages of recent developments in light-scattering microsensors that can be located in source and receptor areas to detect dust emissions. These instruments are internet connected so they can be accessed and provide notifications using smartphones, such that the on-site personnel can be alerted to potential dust events. This information will complement, rather than replace, human detection of visible plumes, as not all off-site transport is detected by human observers. With this real-time information, immediate actions can be taken to remediate specific dust generating events without requiring a complete stoppage of work in most instances. Information obtained from the monitoring network will be shared with the Monterey Bay Air Resources District (MBARD).

Objectives of the measurement network are:

- Obtain data before the project starts to develop a meteorology and PM air quality baseline.
- Provide real-time feedback for managing earth-moving activities and minimize off-site movement of dust.
- Develop an understanding of relationships between activities, meteorology, and off-site transport to re-deploy resources that minimize off-site dust movement.
- Together, the Best Management Practices and monitoring network will concurrently work to prevent dust from being transported outside of the property boundary.

Figure 1-1. CEMEX cement plant and surrounding communities. The red square indicates the area for the Closure Project activity that is enlarged in Figure 1-2.



NORTH POND Varies to 3' (Sheet D1)
"42-Inch BYPASS PIPE & TRENCH Varies to 15' (Sheets D3 & PS4)
"NO NAME CREEK"
EAST PERIMETER DITCH & DRAIN TRENCH Varies to 8' (Sheets G1, G2 & PS1)
WEST PERIMETER DITCH & DRAIN TRENCH Varies to 4' (Sheets G2 & PS1)
SEASONAL PONDS Varies to 4' (Sheet D5)
WORK LIMITS
EXCAVATION IN CKD UP TO 30'
FARMERS POND
WEST PERIMETER DITCH & DRAIN TRENCH Varies to 8' (Sheets G1 & PS1)
DROP STRUCTURES Varies to 10' (Sheets PS2, DR4 & DR7)
SHOP AREA MANHOLES, DITCHES & PIPE Varies to 8' (Sheets D3, DR7 & DR8)
COAL STORAGE AREA Varies to 8' (Sheets DR5 & DR6)
RETENTION POND Varies to 8' (Sheets DR5 & DR6)
CARPENTER SHOP
POTENTIAL EXISTING CONSTRUCTION ACCESS ROAD
Note: Exact Location of Access Roads to be Defined by General Contractor
RMC Pacific Materials, 700 Highway 1, Davenport, CA
CEMENT KILN DUST (CKD) CLOSURE PLANS
Figure 1-2: Work Areas with Potential for Dust Emissions and Maximum Excavation Depths
CEMEX
SHEET
CR1
x OF 28

2 Fugitive Dust Characteristics

The goal of this plan is to prevent fugitive dust prior to its occurrence through BMPs described in Section 5. Fugitive dust at the CEMEX site will most likely occur from paved and unpaved roads excavation sites, and storage piles. Activities in these areas will be closely monitored to ensure immediate action is taken to minimize or eliminate dust issues. The varied and specifically selected Best Management Practices (BMP) applied in this project reflect the highly variable dependence of fugitive dust emissions on site-dependent activities. Fugitive dust transport also depends on meteorological condition. Appropriate corrective measures will be implemented when visible plumes and off-site transport are detected. These corrective measures are detailed in Section 5. Their effectiveness is based on an understanding of dust suspension and transport processes as described here.

2.1 Mechanical and Windblown Dust Suspension

Mechanical and windblown suspension processes create fugitive dust (Kok et al., 2012; Neuman, 1993; Shao, 2008; Valance et al., 2015). Mechanical suspension refers to the manmade disturbance of a surface. Mechanical suspension at the CEMEX site may result from drilling, materials handling, such as scooping, dumping, dozing, grading, and conveying. Mechanical suspension and off-site transport will be successfully controlled by lowering drop heights, suppressing emissions with water sprays, cleaning road surfaces, covering haul trucks where possible, and minimizing track out.

Windblown, or "aeolian", suspension occurs when wind vectors parallel to the surface create a shear force that lifts particles after a "threshold" velocity is achieved. The relationship between PM suspension and wind speed is highly variable. Figure 2-1 compares PM_{10} concentrations near a disturbed surface with those from an undisturbed desert crust. Dust suspension for the disturbed surface appears to commence at a wind speed of ~16 mph, but it does not reach high values until hourly wind speeds exceed ~24 mph. In contrast, the undisturbed surface does not evidence suspension until speeds of ~25 mph are attained, and even then it seems that the dust reservoir is quickly depleted. Figure 2-2 provides additional evidence of the large variability in threshold velocities, as well as the effects of very high wind speeds on the dust reservoir. These results indicate that a single "threshold velocity" is not a sufficient indicator of the amount of dust suspended. This implies that site-specific PM and wind measurements are needed to determine windblown suspension and transport potential.

2.2 Particle Size and Composition

PM covers a large range of particle sizes. A typical PM size distribution is illustrated in Figure 2-3, which also shows the dominant sources in each of the regulated and non-regulated size fractions. The $PM_{2.5}$ size fraction is dominated by combustion-related contributions, such as those from engine exhaust and biomass burning. Gaseous emissions, such as sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and ammonia (NH_3), convert to particles after atmospheric aging, constituting large fractions of California's $PM_{2.5}$ concentrations (Watson et al., 1991). Although some geological dusts contribute to $PM_{2.5}$, they mostly occupy the coarse ($PM_{10-2.5}$) fraction, as well as constituting some of the larger particles associated with deposition.

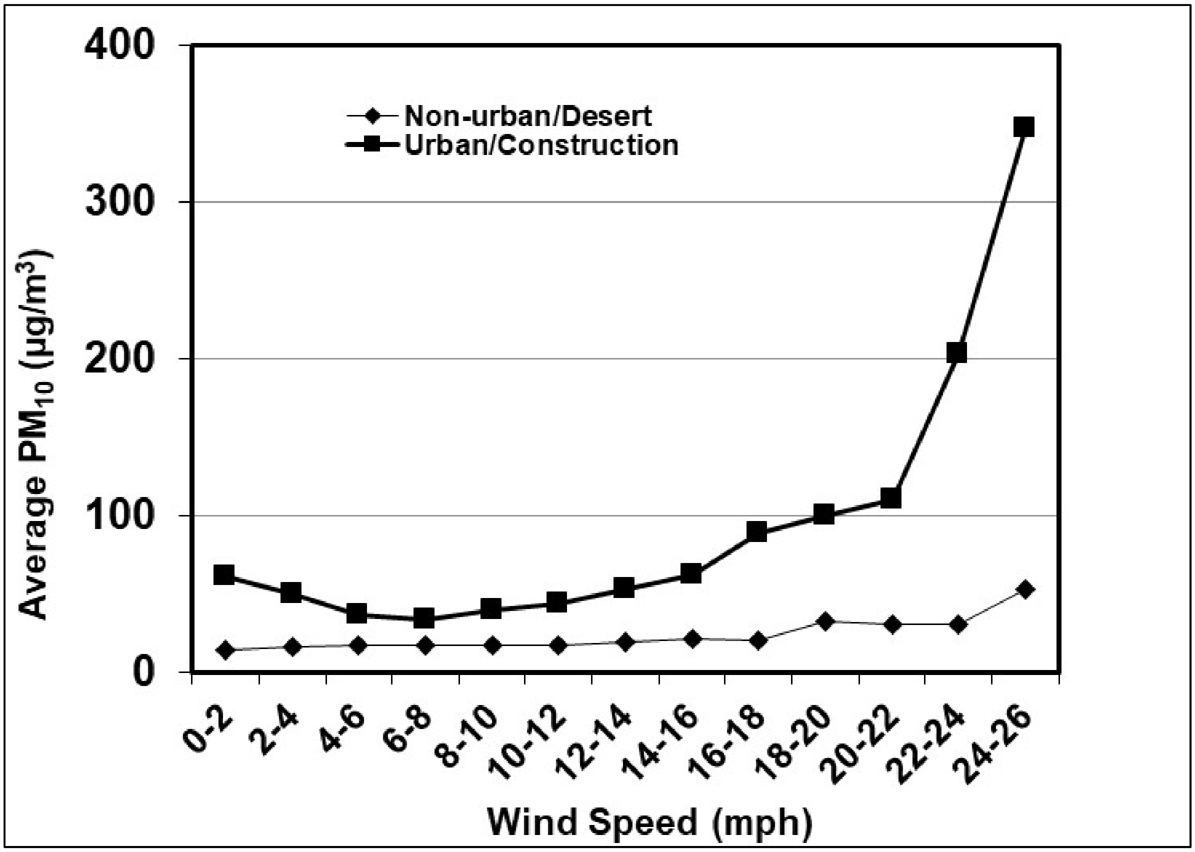


Figure 2-1. Average PM_{10} concentrations for different wind speed categories (mph=miles per hour) measured near a graded construction site and undisturbed desert near Las Vegas, NV (Watson et al., 2000)with a beta attenuation monitor (BAM).

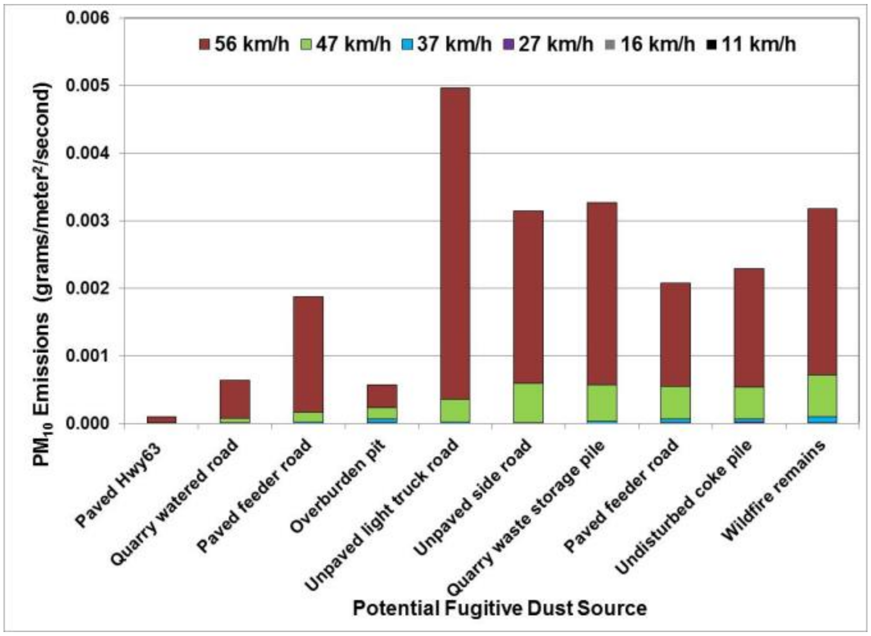
2.3 Dust Deposition and Transport

PM suspension from a surface is not a public nuisance if the suspended dust falls out near its origin or impacts on nearby obstructions and does not go beyond the property's fence line. Figure 2-4 shows the cumulative horizontal emission fluxes at different elevations above ground level for unpaved road emission tests involving mechanical suspension. The most noticeable feature from this plot is that 60% to 80% of the emissions flux is detected at elevations less than 1 to 2 meters above ground level.

While simple in concept, deposition velocities are highly variable, depending on the pollutant composition, its uniformity of mixing throughout the atmosphere, atmospheric turbulence, and the nature of the surface to which it deposits. Figure 2-5, based on gravitational setting velocities that apply to particles with aerodynamic diameters >~1 µm, shows that half of the 10 µm particles mixed within the first meter are removed after ~3.5 minutes, and that half of the 2.5 µm particles in this layer are gone after an hour. Figure 2-5 also shows that residence time increases with the mixing depth.

Obstructions on the upwind or downwind side of an exposed surface have two effects on PM emissions and transport. Upwind obstructions lower wind speeds and turbulence near the ground. This lowers the probability of achieving a suspension threshold velocity at the surface, minimizes the upward lift of particles that are suspended mechanically or by wind, and limits the downwind transport distance of suspended particles because the wind speed is lower. Downwind obstructions continue to attenuate wind speeds, and therefore transport distances, but obstructions provide more surfaces for deposition of suspended particles.

Surfaces with low windblown fugitive dust suspension potential



Surfaces with high windblown fugitive dust suspension potential

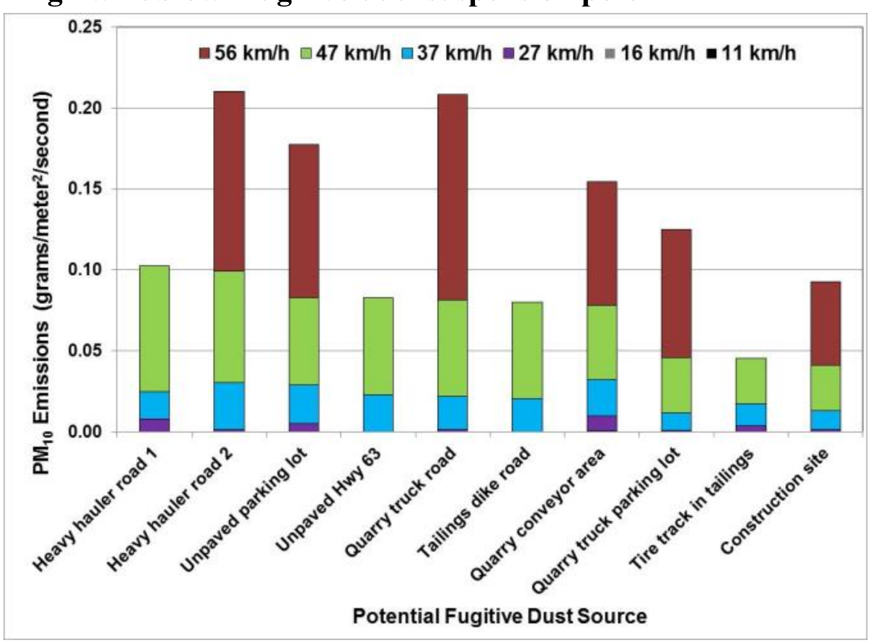


Figure 2-2. Windblown fugitive dust suspension potential measured with a portable wind tunnel in and around industrial operations in Canada’s oil sands region of northern Alberta (Wang et al., 2015). The difference in suspension potential depends more on the frequency and intensity of surface disturbances rather than on the type of surface. It is also evident that higher wind speeds increase the reservoir size in addition to adding energy to the suspension process.

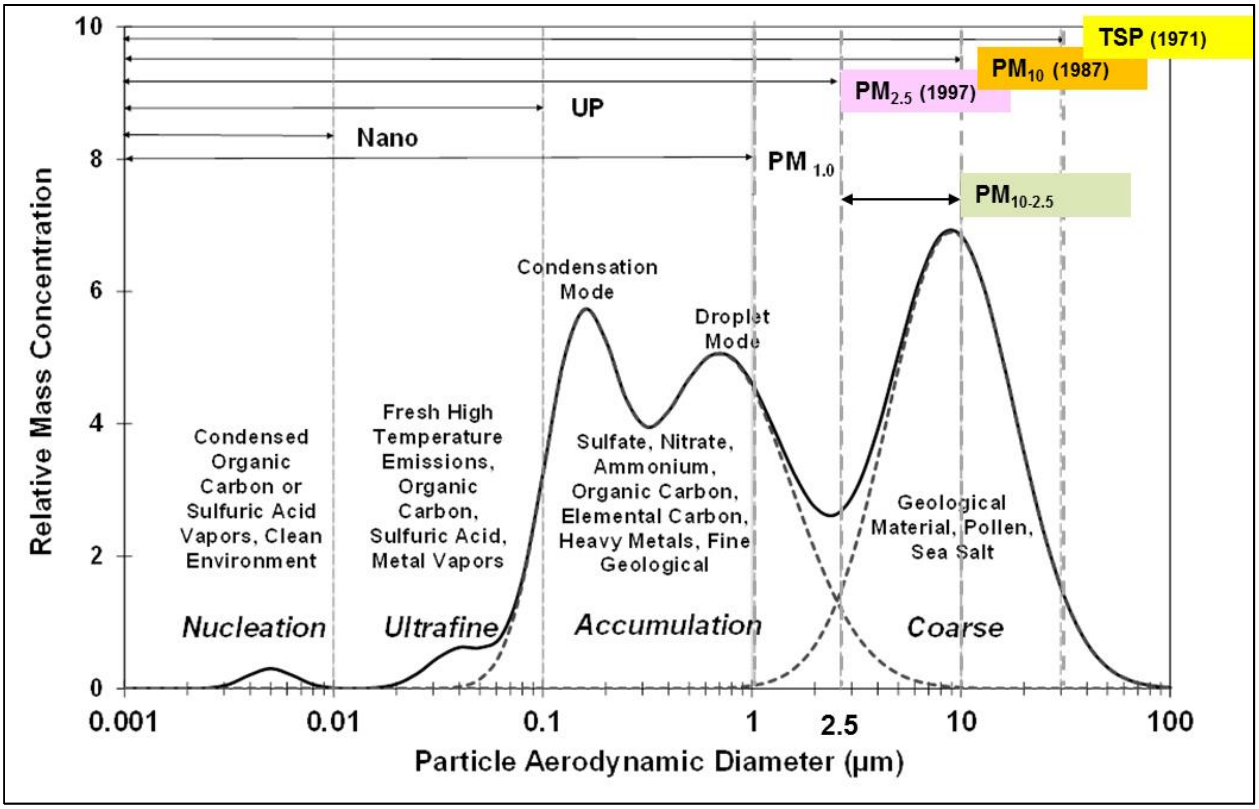


Figure 2-3. Illustration of different modes in a typical atmospheric particle size distribution. Nucleation and Aitken modes often overlap. Note that the tail (dotted line) of the accumulation mode penetrates into sizes <0.1 µm, as does the coarse mode into the accumulation mode. Sources and processes that affect each mode are indicated. Based on Chow (1995) and Watson (2002). The years in which U.S. ambient air quality standards for each size indicator are noted parenthetically.

2.4 Wind Speeds and Directions at Davenport, CA

Figure 2-6 demonstrates daytime and nighttime winds in the Davenport area for part of 1998 during a deposition study (Watson et al., 1999). The directions illustrate the classic land/sea breeze pattern, wherein daytime heating of the nearby terrain reduces the air density, pulling marine air upslope, followed by nighttime terrain cooling and denser air that causes off-shore flow.

Wind speeds are higher during the daytime than at night, with only a few exceeding 15 mph. This indicates that windblown dust from disturbed surfaces is unlikely to occur at night after landfill closure activities have ceased for the day.

Table 2-1 summarizes occurrences of wind speeds exceeding 15 mph, showing that most of the highest wind speeds occur later in the year, probably associated with storms. The upslope/downslope flows are overwhelmed by the synoptic winds that are predominately from the SSE in the November 30, 1998 situation. Since these storms are accompanied by precipitation, there is an attenuation effect of potential dust-emitting surfaces owing to suppression by the added soil moisture. Most of the landfill closure work will be done during the non-winter period and would be curtailed during strong precipitation events. These historical data indicate that wind speeds are unlikely to reach threshold velocities and are mostly from the NW to NWW directions. Figure 1-1 shows that landfill closure activities will be conducted to the NW of Davenport, which will also minimize potential transport to nearby populations. Since the complex terrain may affect wind flows, several wind stations can be deployed to verify this.

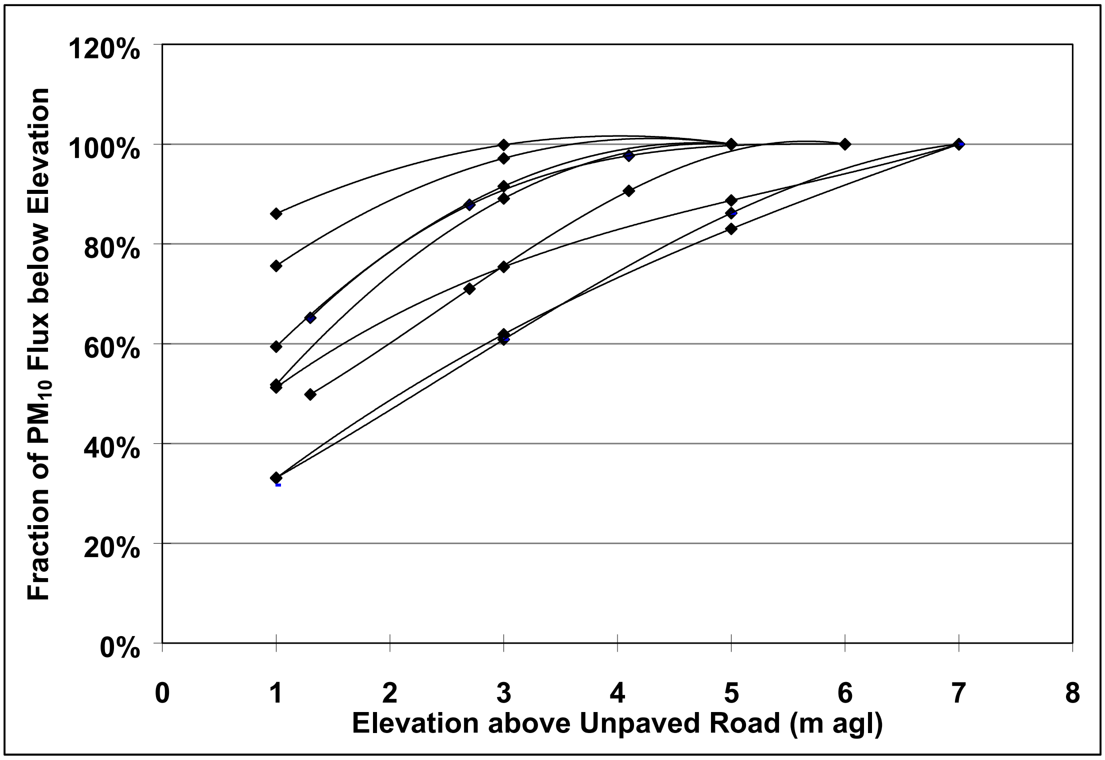


Figure 2-4. Cumulative horizontal PM_{10} flux at different downwind elevations above different unpaved roads (Watson et al., 2000).

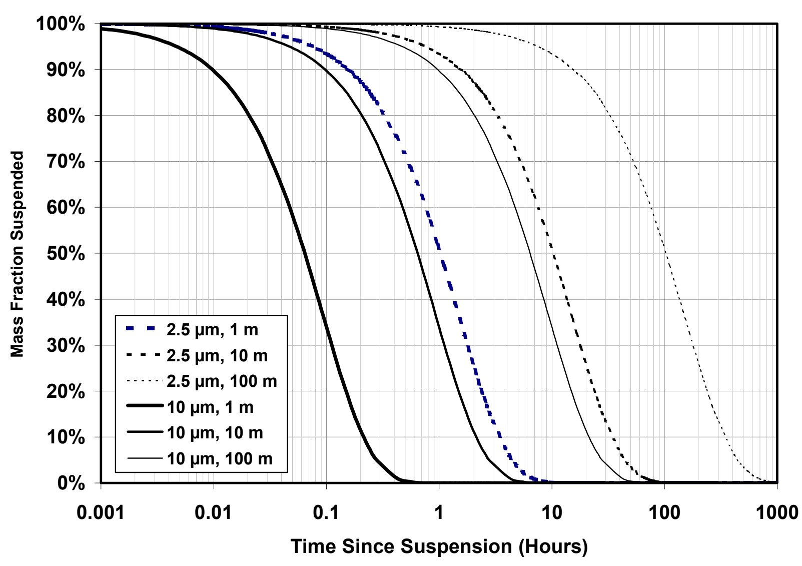


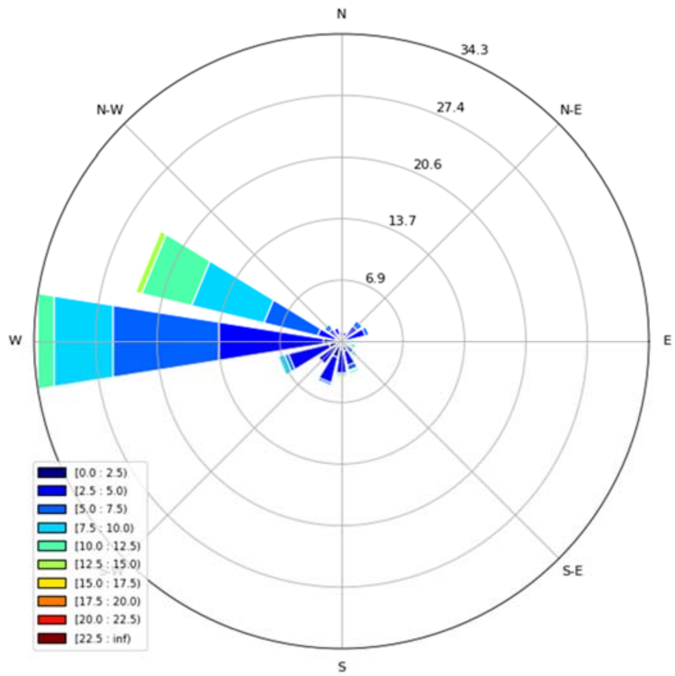
Figure 2-5. Attenuation of mass concentrations for 2.5 and 10 µm aerodynamic diameter particles with time and vertical mixing height (1 to 100 m). This assumes a stirred tank model (Hinds, 1999) in which particles are homogeneously redistributed throughout the mixed layer at each time step and gravitational settling velocities.

The data reported in Table 2-1 and Figure 2-6 are limited to the hourly averages available from the schoolhouse monitoring site during a portion of 1998. There may be situations of higher winds at other locations and for shorter durations. For this reason, it will be important to examine data acquired from the proposed network to better understand the meteorological conditions that might lead to off-site dust transport and refine the real-time reporting algorithm accordingly.

Table 2-1. Occurrences of hourly wind speeds >15 mph between 6/13/1998 and 11/30/1998. PM_{scat} is a light scattering indicator of PM_{10} measured with a model 8520 DustTrak.

Date	Hour (PST)	Wind Direction (degrees)	Wind Speed (mph)	PM_{scat} ($\mu g/m^3$)
7/16/98	15	286	15.4	58
9/17/98	13	286	15	23
11/23/98	12	167	15.5	40
11/30/98	3	144	16.1	23
11/30/98	4	142	17.1	21
11/30/98	5	149	19.9	21
11/30/98	6	154	20.1	21
11/30/98	7	159	24	23
11/30/98	8	163	24.2	26
11/30/98	9	224	17.2	30

Daytime Windrose (0600-1800 PST)



Nighttime Windrose (1800-0600 PST)

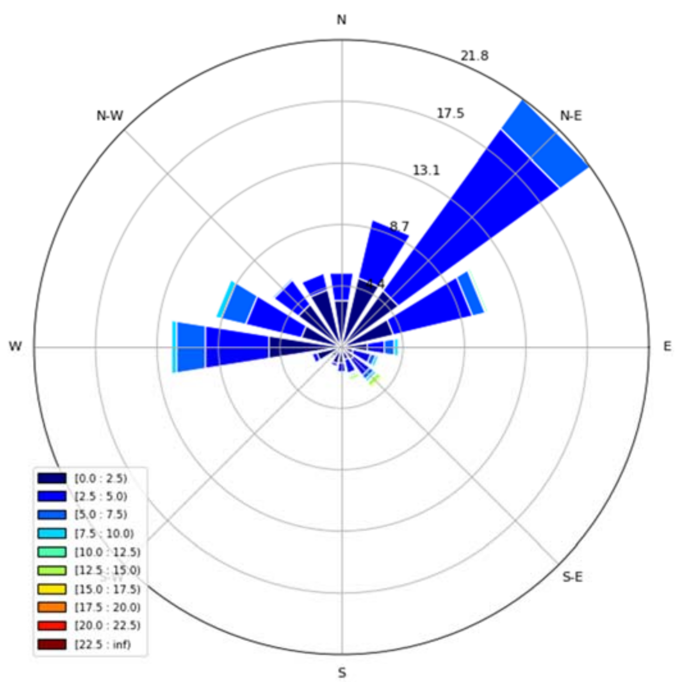


Figure 2-6. Daytime and nighttime windroses for the period of 6/13/1998 through 11/30/1998. Hourly averages were acquired at the Davenport school during this period.

3 Dust Monitoring for Air Quality Management

If selected BMPs are not effective in preventing dust transport because of the difficulty in predicting movement of fugitive dust on this site as described in Section 2, visible observations, PM measurements, and wind speed and direction measurements will identify dust events that might result in substantial off-site transport. CEMEX will use multiple PM and wind sensors, with the capability for real-time data readings to (1) identify activities and meteorological events that result dust transport and (2) identify specific BMPs that effectively prevent dust transport. More is described below.

3.1 Visible Dust Plumes

MBARD's Rule 400 (2012) specifies "A person shall not discharge into the atmosphere from any emission source whatsoever any air contaminant for a period or periods aggregating more than three minutes in any one hour, which is as observed using the appropriate test method referenced in Section 4.1: 3.1.1 as dark or darker in shade as that designated as No. 1 on the Ringelmann Chart, as published by the United States Bureau of Mines; or 3.1.2 of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in Subsection 3.1.1 above." CEMEX understands that MBARD may apply Rule 400 throughout the operations, with appropriate notifications of potential violations.

3.2 Light Scattering Sensors

Light scattering methods take advantage of the fact that smaller particles, such as those in the $PM_{2.5}$ fraction, scatter light nearly equally in all directions, while particles larger than ~ 1 µm scatter more light in the direction of the incident light (forward scattering). Figure 3-2 illustrates how light scattering efficiencies are related to mass concentrations and how much they vary depending on the size distributions for major components found in $PM_{2.5}$ and PM_{10}. Chow et al. (2006) show highly correlated relationships between light scattering and $PM_{2.5}$ throughout central California. To emphasize this, Table 2-1 uses the term PM_{scat}, although the instrument reported results as PM_{10}. The good correlation between PM_{scat} and PM mass, however, allows these instruments to detect relative increments of nearby emissions, such as those from fugitive dust.

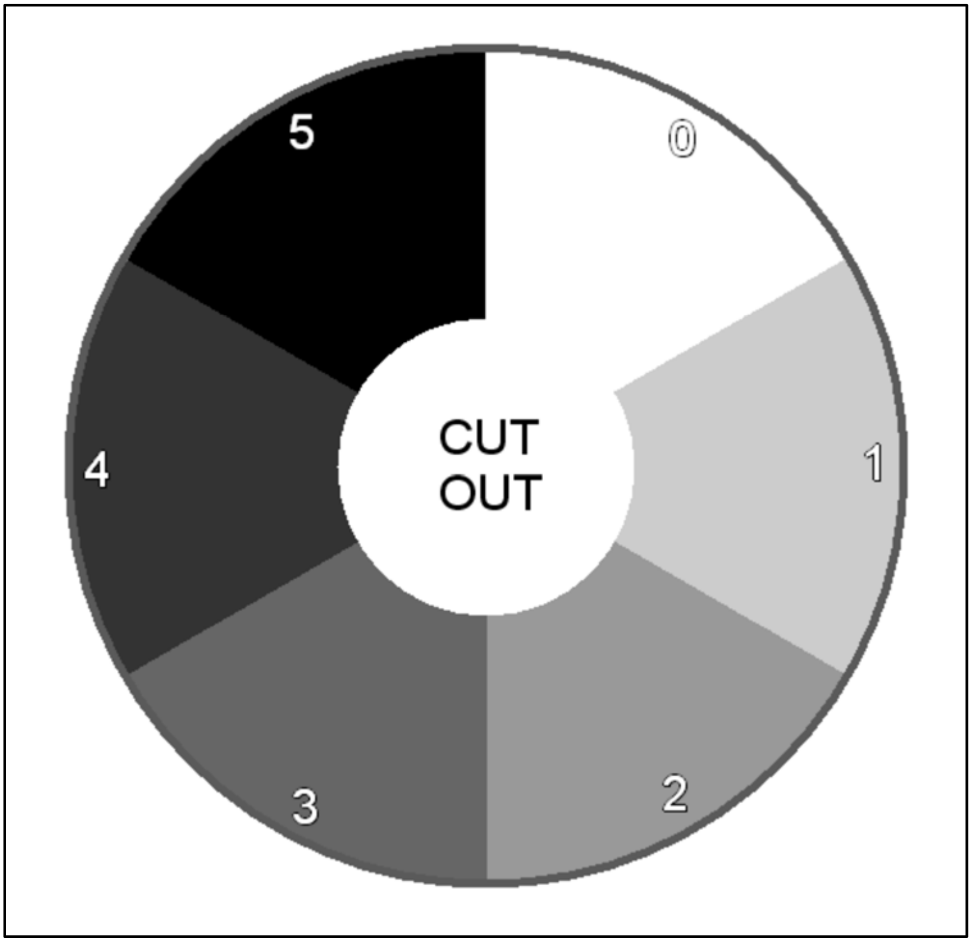


Figure 3-1. Example of a Ringelmann smoker reader chart (Hughes, 2010). The plume is viewed through the cutout and the opacity is compared with the numbered shades on the outer diameters.

Portable PM light-scattering systems are being used throughout California to better estimate exposures and to determine off-site transport of industrial emissions. To be effectively used for the network at Davenport, the following characteristics are desired:

- Detects short-duration (~1 to 2 min) dust plumes.
- Communicates remotely (e.g., WiFi, BlueTooth) to a central data base with real-time and historical data recording.
- Has small dimensions and can be quickly attached to a variety of places close to and distant from as well as upwind and downwind of potential emitters.
- Can be protected from dust deposition and weather.
- Has output consistency among like devices so that comparisons can be made among simultaneous measurements at different locations.
- Has a user-friendly interface.

The PurpleAir sensor (Figure 3-3)seems to have captivated California agencies, with hundreds currently operating, including in Monterey and Santa Cruz counties, and hundreds more scheduled for deployment within the next few years in support of California's AB 617 (Garcia, 2017)). Figure 3-4 shows a recent deployment of PurpleAirs in the study area. PurpleAir uses the Plantower 5003 optical sensor (PlanTower, 2016) which was developed in China. As shown in

Figure 3-5, PurpleAir couples this sensor with a WiFi enabled microcontroller, clock, and SD memory card.

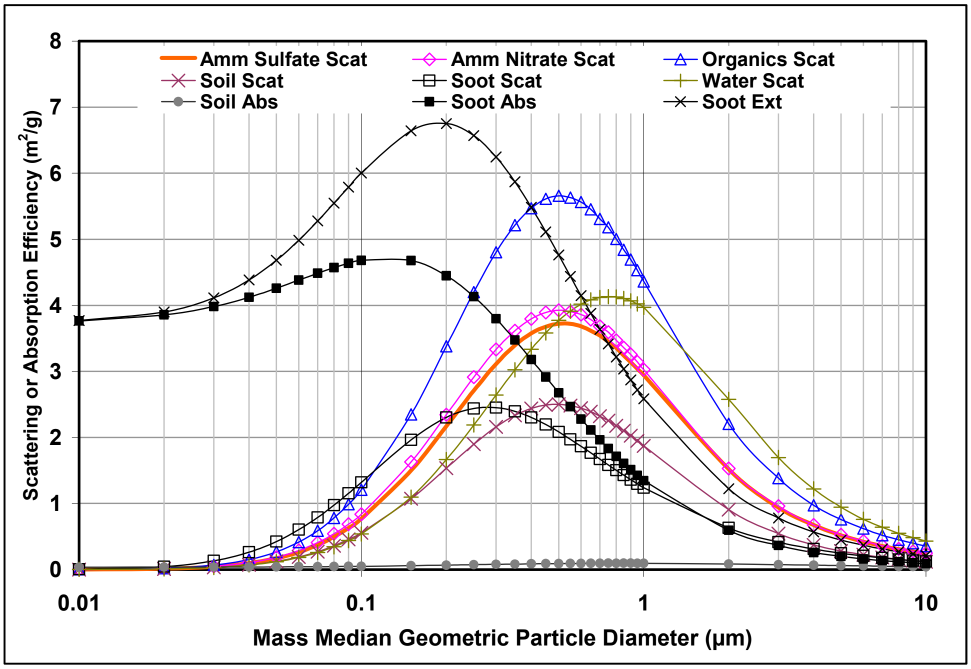


Figure 3-2 Particle scattering efficiencies as a function of size distribution for different particle compositions (Watson, 2002). The geological scattering efficiency (Soil Scat) is lower than that for other PM chemical components and decreases rapidly with particle size.

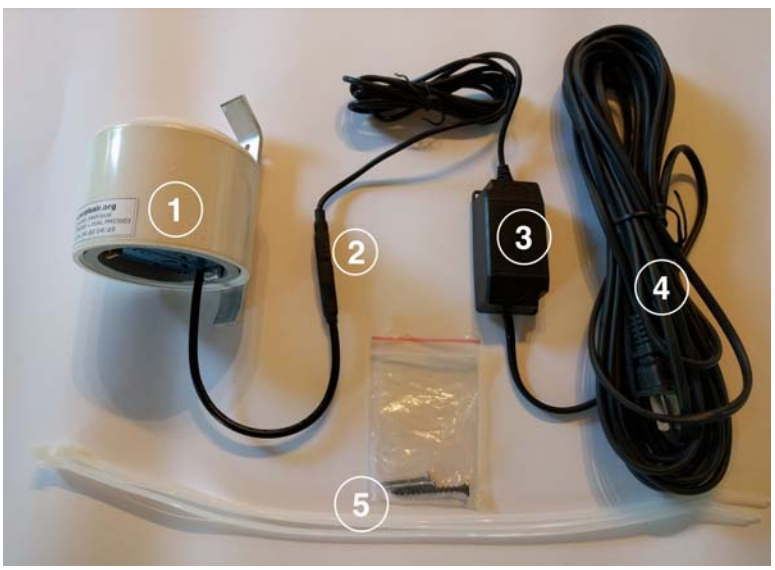


Figure 3-3. The PurpleAir (2019) microsensor that is being used throughout California and other states for citizen science and implementation of AB 617 (Garcia, 2017). The package includes the sensor in protective cover (1), micro-USB cable (2), 5V power supply (3), 120 V line cord (4), and mounting screw and zip-ties.

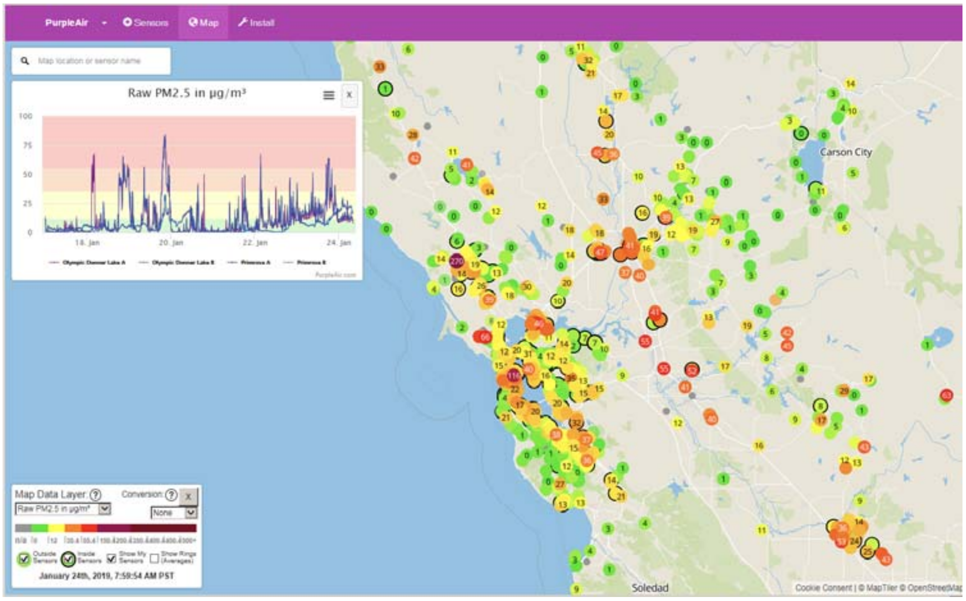


Figure 3-4. Recent map of PurpleAir deployments in the study area. Colors indicate the intensity of the PM concentrations.

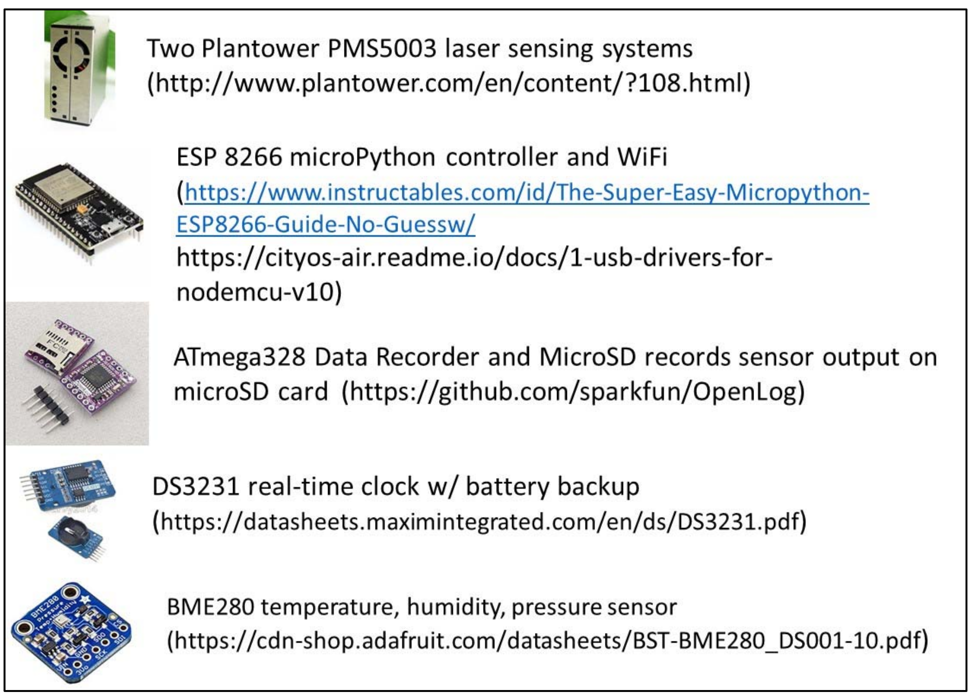


Figure 3-5. PupleAir components that apply a time stamp, measure atmospheric temperature, pressure and relative humidity, store data on an SD card, and provide WiFi interface to the PurpleAir web site.

The Plantower output includes data labeled as PM_1, $PM_{2.5}$, and PM_{10}, as well as particle numbers in various size ranges, but these labels are misleading. As Figure 3-6 shows, the internal configuration is very simple, with a red diode laser (~650 nm) and a photodetector perpendicular to the laser light beam, similar the construction of the nephelometer (Beuttell and Brewer, 1949) that has long been used to quantify light scattering.

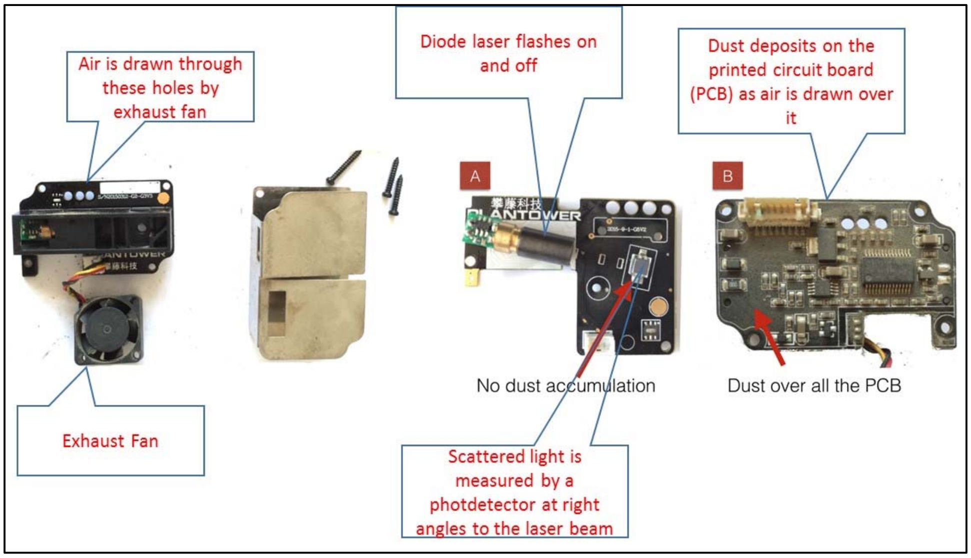


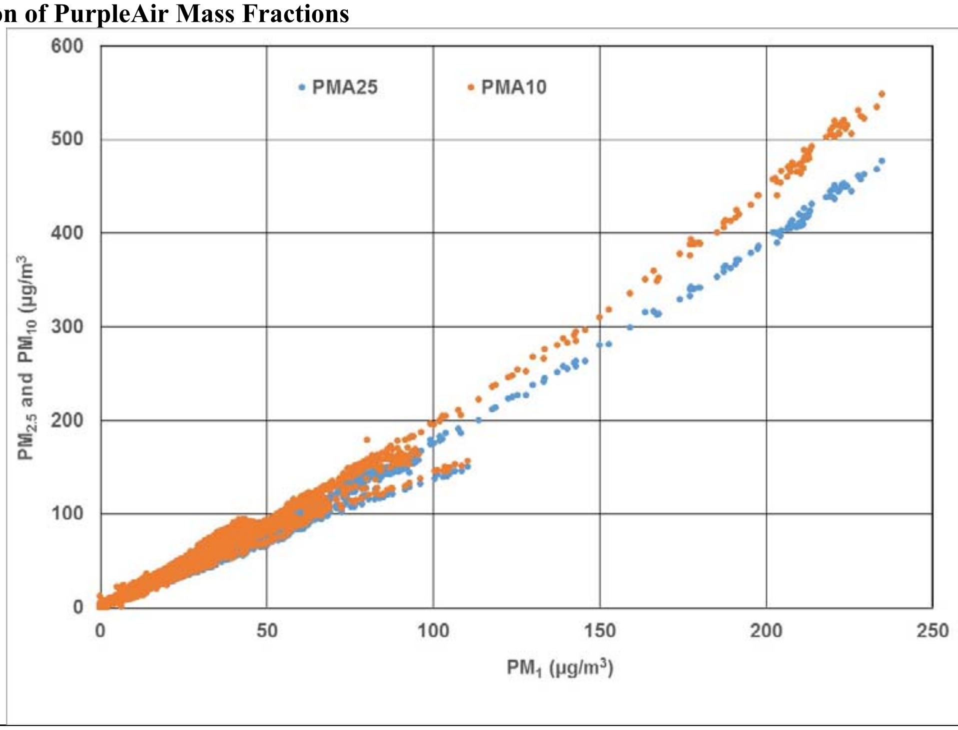
Figure 3-6. Internal configuration of the Plantower 5003 particle sensor (https://aqicn.org/sensor/pms5003-7003).

The lack of size specificity is illustrated by Figure 3-7, which compares the labeled particle sizes and number concentrations with the smallest size fractions. There is an exact correlation and slope, despite the fact that these collocated measurements experienced a variety of aerosol exposures, including dust suspension created with a leaf blower Figure 3-7 also demonstrates that one of the sensors calibration differs from the others, emphasizing the importance of collocated sampling for a period prior to deployment and that periodic comparisons with a "reference" sensor should be conducted. Figure 3-6 also shows that dust can accumulate within the unit, although most of it is deposited outside of the detection and optics area. This accumulation can cause the sensitivity to PM levels to change with time. Since PurpleAir includes two sensors in each unit, it is possible to monitor their deviations from one another over time that will indicate these sensitivity changes. Since any of the reported size fractions can be derived from any other, the $PM_{2.5Scat}$ value will be monitored in real time for this network.

Figure 3-8 shows an example of how a sensor network would be operated during a potential dust generating event. The Dust and Background sensors track the neighborhood-scale concentrations within a tight tolerance, even when separated by ~30 m between the front and back yards. PM generated by the mower indicates the increment over background created by the dust raising activity. By placing a reference sensor away from the landfill closure project, neighborhood-scale contributions from other sources, such as sea salt, fires, or general background can be accounted for in a similar manner for the Davenport area.

Water soluble particles, such as sodium chloride, sulfates, and nitrates, absorb water when relative humidities exceed ~70%. Higher humidities cause these particles to grow into size ranges that scatter light more effectively, as represented by the IMPROVE formula used to determine visibility improvement in national parks (Watson, 2002). This effect is demonstrated in Figure 3-9, where the instrument response nearly doubles as relative humidity (RH) approaches 100%. Since the RH is not expected to spatially vary by important amounts, referencing the on-site monitors to the reference monitor, as illustrated in Figure 3-8, will compensate for this.

Comparison of PurpleAir Mass Fractions



Comparison of PurpleAir Number Counts

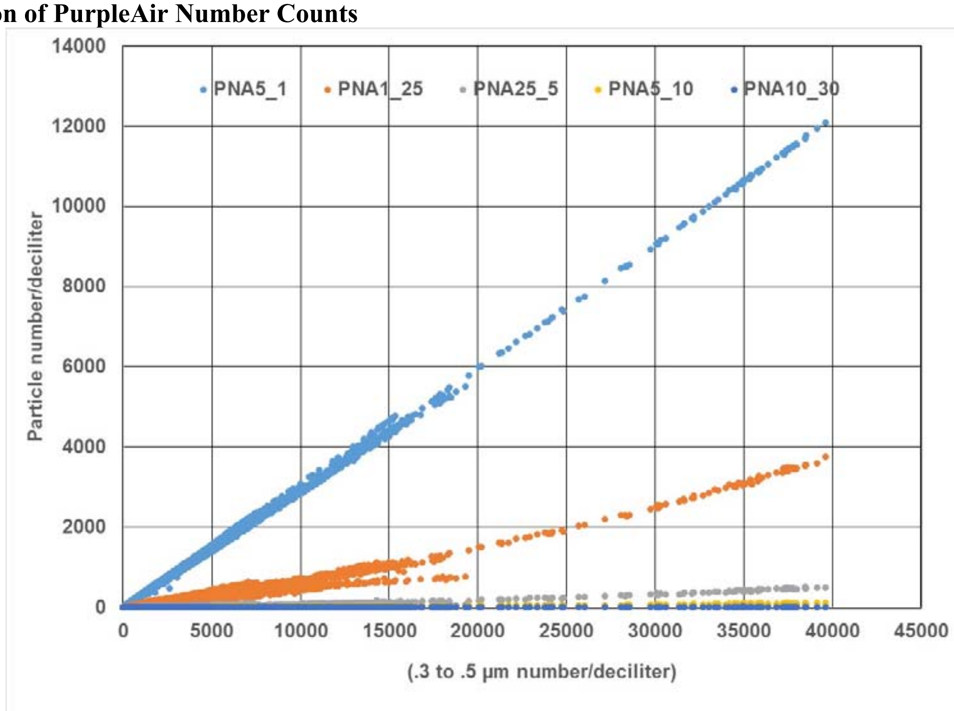


Figure 3-7. Comparison among five collocated PurpleAir sensors for the reported size fractions compared with the smallest size fractions. The manufacturers have apparently included constant multipliers to estimate the different size fractions from the light scattering output of the sensor.

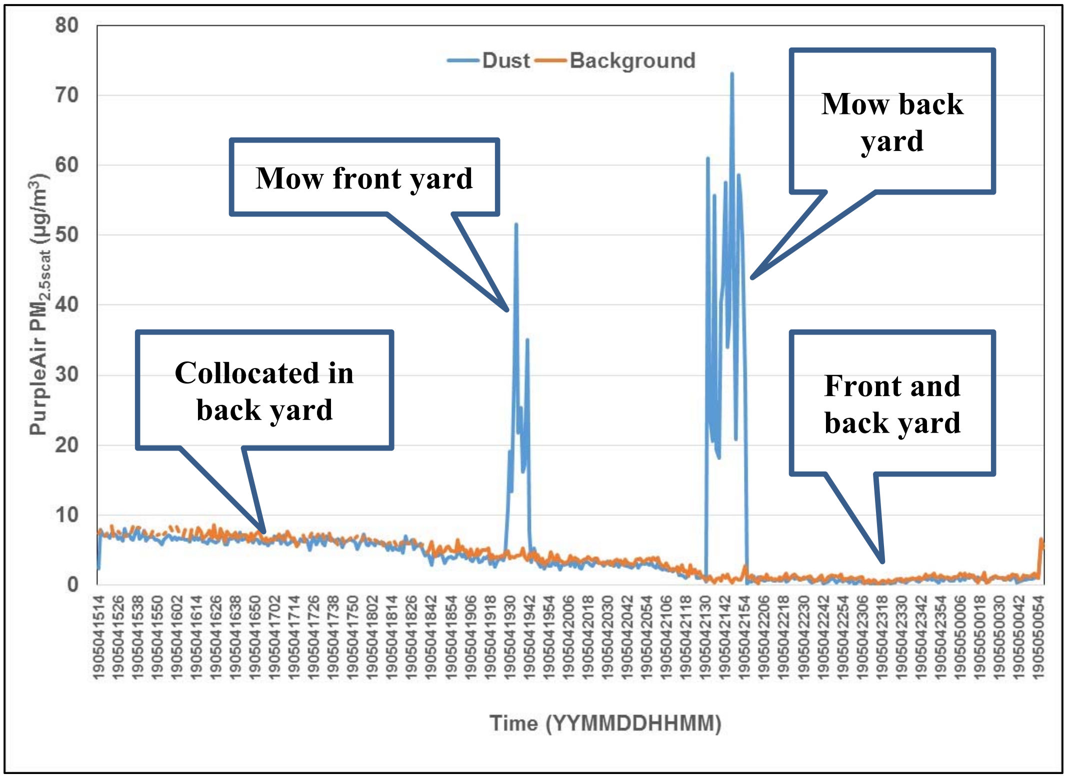


Figure 3-8. Example of dust detection over background. The Dust sensor was placed on a lawnmower after being collocated with the Background sensor. Dust generated by the mower is evident over background. The mower remained in the front yard, then was used to mow the backyard and parked next to the Background monitor.

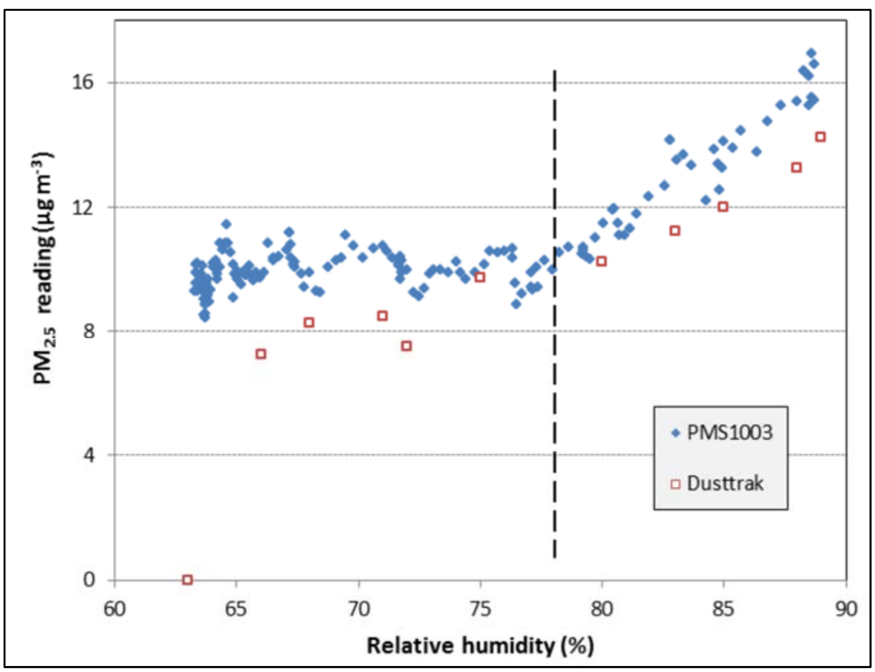


Figure 3-9. Relationship between Plantower reading and relative humidity in a controlled laboratory experiment (Jayaratne et al., 2018). The same effect is demonstrated for the DustTrak (Wang et al., 2009), another light scattering detector.

Although the PurpleAir units report values for $PM_{2.5}$ and PM_{10}, these cannot be used for $PM_{2.5}$ or PM_{10} compliance purposes. Figure 3-10 shows $PM_{2.5}$ readings of 3 to 4 times those from collocated compliance measurements. These relationships will vary depending on the size and composition of the sampled aerosol, as shown in Figure 2-2. Compliance can only be determined using a Federal Reference of Equivalent method.

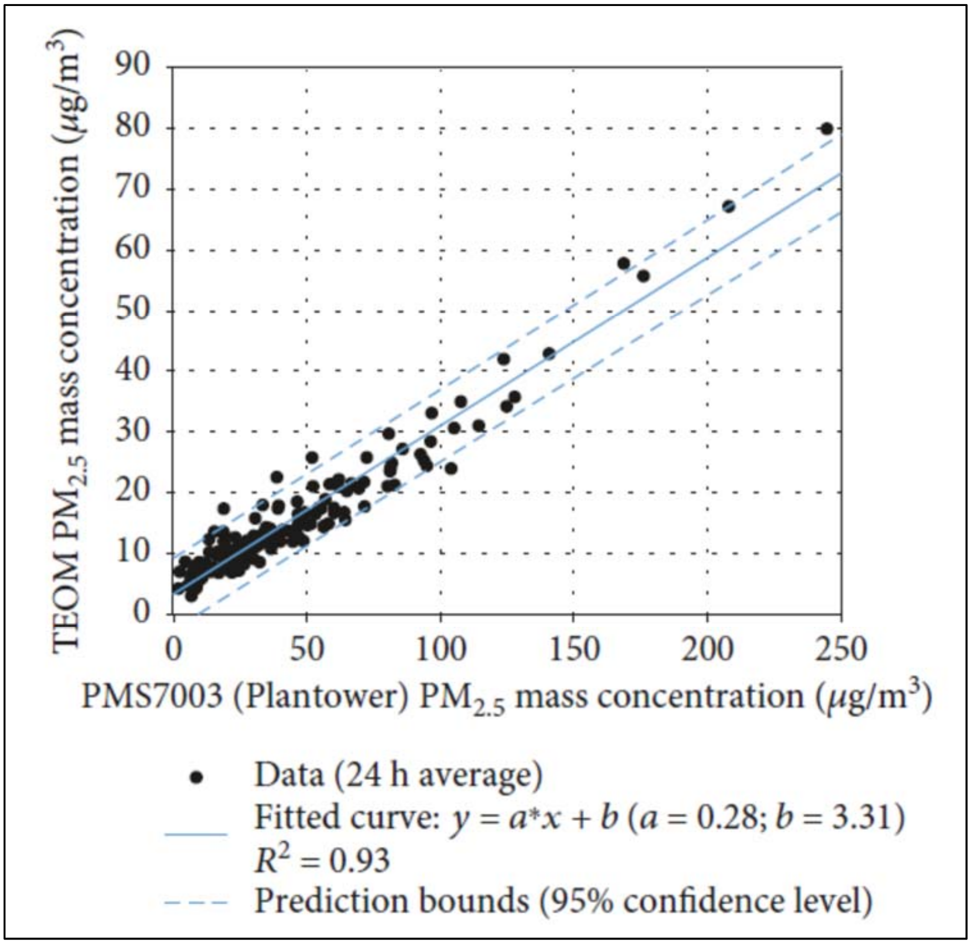


Figure 3-10. Comparison of a Plantower unit (slightly different from but comparable to that used in the PurpleAir) with a TEOM Federal Equivalent Method used for compliance monitoring (Badura et al., 2018). The Plantower is highly correlated, but reads 3.5 times higher than the compliance measurement.

The sampler siting also does not meet the criteria for a compliance determination. U.S.EPA (1997) designates sites near emissions sources as "special purpose monitors" that are excluded from use for compliance. It is also the case that $PM_{2.5}$ and PM_{10} compliance determinations require at least three years of monitoring, longer than the expected duration of this project.

3.3 Wind Speed and Wind Direction Measurements

As noted in Section 2, wind speed and direction measurements are needed to associate PM concentrations with windblown suspension potential and to determine the likelihood of off-site transport to populated areas, Wind speed and direction data from close to potential emitters is not currently available at in Davenport or near the Closure Project area, so these measurements will be collocated with the PM detectors.

Proximity to the coast, the uphill terrain, and changing surface roughness during earth moving activities require more than one set of measurements. Desired characteristics of meteorology measurements include:

- Portability to be close to potential erosion sources, locations of which will change during the project.
- Communicates remotely (e.g., WiFi) to a central data base with real-time and historical data recording.
- Does not require line-power or frequent recharging.
- Is resistant to dust deposition and weather.
- Has output consistency among like devices so that comparisons can be made among simultaneous measurements.
- Has a user-friendly interface.
- Can be easily oriented with respect to true north.
- Light-weight for mounting on extendable masts.

The Ambient Weather instrument is made for residential market, but is versatile and durable (Figure 3-11). The sensor operates on solar power with battery backup and transmits to a line-powered base station that can be located within ~35 m of the sensor. Its wind speed threshold is ~0.25 m/s, so it does not detect dispersion in calm conditions, but that is not an issue for fugitive dust, which requires higher wind speeds. The bearings of more sensitive anemometers have been found to clog in dusty environments (Watson et al., 2011). It can be interfaced to WiFi with data acquired and made available on a Smartphone app that can be examined along with the PM data to determine: 1) when wind speeds are excessive near the earthmoving activities; and 2) when transport is likely to carry dust to surrounding communities.

Figure 3-11. The Ambient Weather (2018) solar-powered WiFi-enabled station.

4 Monitor Locations, Data Review, and Action Levels

4.1 Monitor Locations

In order to best detect the occurrence of fugitive dust, Figure 4-1 shows potential locations for the monitors. PurpleAir, and wind stations are collocated each location except Site D. Site A is placed between the earthmoving area (see Figure 2-6) and Davenport and Site C is between the earthmoving area and Newtown. Site B will be close to, but not interfering with, the earthmoving activities. Site D is the reference monitor against which the others will be compared, as in Figure 3-8. It is tentatively placed near the coast to determine impacts of sea salt and fogs, but these may attenuate rapidly with inland transport. Some initial tests will be necessary to obtain an appropriate reference location.

Since the location of potential dust-generating activities will change throughout the project, the Site A sampler can be moved to follow them. It will have a moveable mounting and battery power to facilitate this movement. The purpose of this unit is to detect dust suspension events that can be correlated with measurements at the more distant monitors. There may be PM spikes due to other sources (e.g., a passing truck on CA-1, local windblown dust, agricultural erosion) that do not correspond to spikes detected at Site A and Site B. Separate wind stations are collocated with these as winds are expected to vary in complex terrain. As noted in Section 3, all of these are interface via WiFi, which will be available throughout the worksite. Range extenders can be used to cover a greater area, if necessary.

4.2 Data Acquisition, Analysis, and Alerts

A dedicated computer in the project operations center will be programmed to download data from the PurpleAir and AmbientWeather websites at 10-minute intervals. The program will: 1) write downloaded data into a continuous archive; 2) calculate five minute averages and synchronize measurements for all monitors; 3) implement decision criteria; 4) send text messages to the Project Director and his/her designees at different action levels; and 5) create and transmit graphical displays to support remediation decisions. Downloaded data from the PurpleAir monitors at the site will be shared with MBARD.

Although PurpleAir PM data are available for and will be archived for ~90 sec averages, 5 minute averages will be calculated and compared among monitors to synchronize the timing. Five-minute averages have been shown to reasonably detect nearby sources while attenuating the effect of spurious signals from electronic noise. Useful displays will include multi-site time series, wind roses, and pollution roses.

Data acquired prior to and during the first weeks of earthmoving activities will be analyzed to develop decision criteria for further actions. Typical analyses will include:

- Examination of spikes at Site B to determine the frequency and intensity of mechanical suspension. Low frequencies and intensities will indicate that current practices and controls are effective. High frequencies and intensities may indicate further need to modify activities or increase watering. This will be further evaluated, if it occurs, and a suitable plan will be developed.
- Examination of correspondence between dust events from Site A with off-site transport detection at Sites B and C. No correspondence indicates that most of the mechanical suspension remains within the property.

- Creating pollution roses at Sites A, B, C, and D. A large average concentration in the direction of the activity would indicate potential off-site transport.
- Creating threshold plots such as Figure 2-1 to determine wind speeds that might cause windblown suspension and a need to modify activities.

With the real-time data, the on-site personnel will have several options to limit off-site transport: Activities might be modified, such as moving earthmoving to another part of the waste pile or re-routing traffic. Dust suppression methods, such as surface watering and water sprays, could be enhanced or re-directed. Ceasing operations would be a last resort and might not be as effective as these other options.

An action level would involve a significant increase in $PM_{2.5Scat}$ over the reference sampler from the wind direction indicated. Notification criteria will be set initially after baseline conditions are evaluated and will be adjusted as the project progresses and as data are acquired and analyzed.

Should a work stoppage be deemed by the Project Director to reduce fugitive dust from becoming a concern for the community, he/she will be fully empowered to make the decision to stop the work until all the available remedial actions have been implemented. In addition, the Project Director or designee will receive citizen complaints and have authority to stop work due to citizen complaints. All complaints will be responded to within two business days of receipt.

4.3 Quality Control (QC) and Quality Assurance (QA)

Since these monitors are not used for compliance, the standard QC and QA procedures applicable to compliance stations do not apply. The light-scattering signals are used relative to one another rather than as an absolute output. For this reason, it is important to demonstrate that the sensors are equivalent to one another. The PurpleAir has a built-in QC in that each unit contains two Plantower 5003 light scattering devices. These typically return equivalent values, but when they begin to deviate, it is time to replace one or more of the sensors. These results from single sensors will be compared throughout the project period.

Prior to deployment of the sensors, they will be collocated for one week to determine that they are returning equivalent values. Figure 3-8 and collocated tests made by others (Jayaratne et al., 2018; Kelly et al., 2017; Zheng et al., 2018) indicate that these sensors return reasonably uniform results.

A fourth PurpleAir sensor will be rotated among the three sites each month to assure that the equivalence is not changed though degradation of the laser or detector of obscuration of the internal optics by the sampled PM.

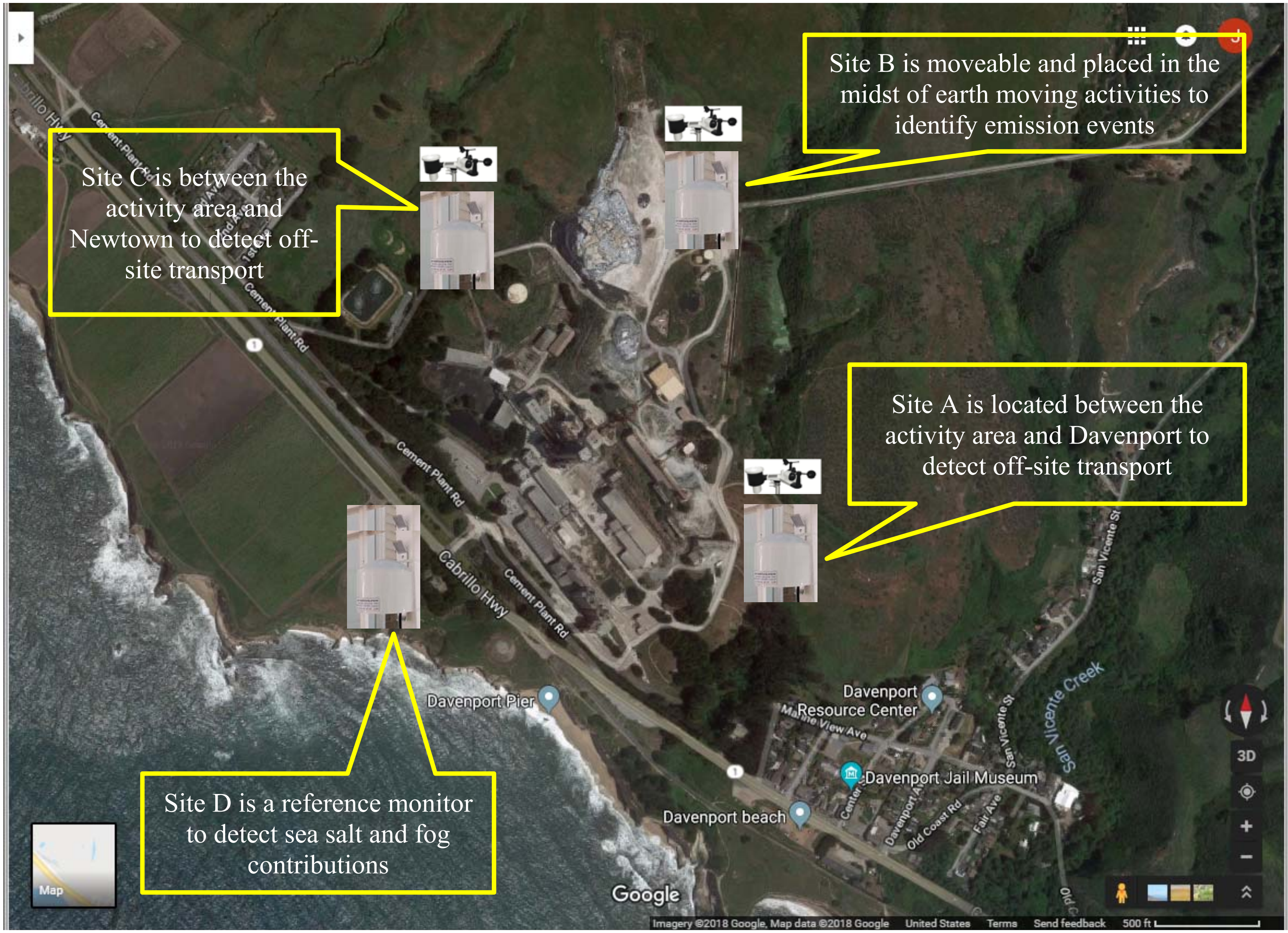


Figure 4-1. Potential locations for PM and wind sensors.

5 Best Management Practices

Best management practices for dust control (Amato et al., 2010; Watson et al., 2000) appropriate for this project include signage, watering, sweeping, truck washing, and load covers. It is not always clear where and when these measures should be applied, and in some cases they can be counter-productive. A well-known example is the effect of applying too much water as a suppressant, which creates mud that adheres to vehicles that can be tracked out onto public roadways. Excess water can also adversely impact the Geotechnically related activities and materials.

Appropriate best management practices are summarized in Table 5-1 and will be applied as needed during earth-moving operations as required by the Project Director or his designee. Feedback to the Project Director or designee will be immediately provided by the measurement network described in Section 4. This will enable the Project Director or designee to immediately adjust best management practices to avoid dust issues. As explained in Section 2, dust suspension and transport are complicated processes that depend on suspension mechanisms, surface characteristics, meteorology, particle size, and composition. Since quantitative values for these variables are unknown, real-time monitoring of PM levels and winds will provide empirical evidence of conditions that might result in off-site transport and require dust remediation actions to be taken. In addition, the project manager or his designee will also be able to review weather forecast and on site meteorological data to adjust earth moving activities accordingly to minimize or eliminate fugitive dust. As mentioned in Section 1, this plan will be amended as more is learned about the project activities and onsite monitoring data relationship.

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Table 5-1. Summary of dust control measures applicable to activities associated with the CEMEX Davenport remediation effort.

ID	Activity	Control Measure	Description	Frequency	Responsible Party	Comments
1	Worksite vehicle movement	15 mph maximum speed limit signage throughout the worksite.	Post speed limit signs and issue warnings to drivers exceeding them on both paved and unpaved surfaces.	Throughout the project	Contractor/Project Director or designee	Even slower speeds will be observed with visible plume behind a vehicle.
2	Materials movement, truck loading and unloading	Freeboard limited to 6 inches for transport over paved surfaces. Load covers for offsite transport.	Keeping material below the load bed prevents windblown suspension of the top layer, especially at on-site speed limits. Load covers for transport off-site prevent suspension due to eddies at higher on-road speeds.	Throughout the project	Contractor/Project Director or designee	Loader and conveyor drops into open trucks will be made as close as possible to the bed walls to minimize material loss. Operations will be moved to a more sheltered location or curtailed during windy periods.
3	Short-term digging, grading, and construction.	Water is applied in appropriate amounts to stabilize exposed surfaces.	Water sprays from trucks or cannons are directed onto dust-generating surfaces indicated by the monitoring network or visual observations. Water will not be applied in such quantities that create mud that adheres to vehicles for trackout.	Throughout the project	Contractor/Project Director or designee	Since fresh and potentially suspendable dust is exposed during operations a temporary, but frequent, application of water suppressant is needed.
4	Long-term surface stabilization.	Appropriate suppressants or vegetation are applied to surfaces that are not disturbed during prolonged downtime.	A variety of suppressants are available that can be used when there is evidence of erodible material after a portion of the project has been completed.	Throughout the project	Contractor/Project Director or designee	Long-term suppressants are not effective if there is ongoing activity that exposes new surfaces.
5	Spillage Control.	Require workers to remediate spills when they occur.	Signage reminds workers of their responsibilities. Brooms, dustpans, and vacuums will be provided for small spills. Larger	Throughout the project	Contractor/Project Director or designee	This is most important on the paved section prior to leaving the worksite onto public roadways.

ID	Activity	Control Measure	Description	Frequency	Responsible Party	Comments
			spills require notification for the sweeper or water application.			
6	Sweeping of paved surfaces.	An air quality appropriate sweeper removes deposited dust from paved surfaces.	The vacuum/suction type sweeper is more effective than a brush sweeper that creates a dust cloud.	Throughout the project	Contractor/Project Director or designee	Sweeping is most effective to minimize trackout onto public paved roads.
7	Wind erosion of exposed surfaces and piles.	Watering, suppressants, surface roughness, and barriers	Storage piles will be oriented to increase surface roughness and minimize exposure to wind. Water and chemical suppressants will be applied as appropriate. Portable wind fences may be constructed if prolonged exposure to winds is expected.	Throughout the project	Contractor/Project Director or designee	Analysis of monitoring network data will provide guidance on the effects of wind on suspension and transport and will guide the appropriate application of these control measures.
8	Dust track out onto paved public roads.	Truck washing, and sweeping.	Washing removes dust. Sweeping of paved surfaces prior to exit onto public paved roads minimizes additional trackout.	Throughout the project	Contractor/Project Director or designee	Most of the materials movement is confined to the worksite. Traffic will be directed through the paved area of the cement plant, away from neighboring communities, to the extent practical.
9	Visible plumes	Direct watering and/or sweeping to suppress the plume. Warn workers to modify activities.	Visible plumes are the first indication of the need for remedial action. Directing water to the source is the most effective immediate control. Lower speeds and drop heights may also be effective.	Throughout the project	Contractor/Project Director or designee	MBARD Rule 400 indicates that they can serve a notice of violation when visible plumes exceed <20% opacity for 3 minutes within an hour when observed from a designated vantage point.
10	Community perception of nuisance	Signs are posted indicating who to call if a nuisance is perceived.	After questioning the nature of the perception (i.e., visible plume or off-site dust deposition), control efforts described above will be directed as appropriate	Throughout the project	Contractor/Project Director or designee	These perceptions and reporting should be minimal when the other control measures are successfully implemented.

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