AMERICAN FORK CITY PLANNING COMMISSION
APRIL 22, 2020
NOTICE OF ELECTRONIC MEETING
REGULAR SESSION

Notice is hereby given that the American Fork City Planning Commission will meet in regular session on April 22, 2020, commencing at 7:00 pm. Pursuant to changes in the Utah Open and Public Meetings Act and Covid-19 Guidelines, this meeting will be conducted electronically. Citizens may submit comments via email at *zoompubliccomment@afcity.net* prior to 5:00 pm the day of the meeting and access a YouTube live stream of the meeting at afcity.org.
The agenda shall be as follows:

1. Pledge of Allegiance

2. Review and action on a commercial site plan for American Eagle Ready Mix, located in the area of 1700 South 500 East in the I-1 Industrial zone

3. Other Business

4. Site Plan Committee Report

5. Review and action on the minutes of the April 8, 2020 Planning Commission Regular Session

6. Adjournment

John H. Woffinden, P.G.
Planning Commission Chairman

AMERICAN FORK CITY
PLANNING COMMISSION

MEETING DATE: March 18, 2020
STAFF PRESENTATION: Adam Olsen

AGENDA TOPIC: Review and action on a commercial site plan for American Eagle Ready Mix, located in the area of 1700 South 500 East, in the I-1 (Industrial) zone.

ACTION REQUESTED: Approval of the site plan.

BACKGROUND INFORMATION		
Location:		Approximately 1700 S. 500 E.
Applicants:		Doug Clements
Existing Land Use:		Vacant/Agriculture
Proposed Land Use:		Industrial
Surrounding Land Use:	North	Planned Industrial
	South	Vacant/Agriculture
	East	Industrial
	West	Agriculture
Existing Zoning:		I-1 (Industrial)
Proposed Zoning:		N/A
Surrounding Zoning:	North	PI-1 (Planned Industrial)
	South	I-1 (Industrial)
	East	I-1 (Industrial)
	West	I-1 (Industrial)

Background

American Eagle Ready Mix proposes an operation at approximately 1700 S. 500 E. The site is within the proposed Lakeland Industrial Park subdivision. The property was recently annexed, and improvements initially constructed without formal site plan approval. The facility was required to shutter operations until such approval occurred. The applicant submitted a site plan, which is now before the Planning Commission for review.

Uses and site plan requirements within the I-1 zone are covered in Sections 17.4.503 and 17.6.101, respectively, of the City's Development Code. 17.4.503.B.1(a & b) states that "structures and areas used for the manufacturing, compounding, processing, fabrication and warehousing of goods and materials" are allowed within the zone, provided that "none of the activities carried out on the premises shall produce any noxious odor or any fumes, smoke, noise, vapor, vibration, glare or similar condition which is harmful to persons or which is readily discernable beyond the boundary of the zone or create an adverse visual impact readily discernable from the public roads". From the application materials, it is

unclear how the above issues will be addressed. The Planning Commission may request the applicant address the items as outlined in the Code, mitigation efforts to take place and how they will apply to the site.

The site plan illustrates a proposed structure toward the north end of the property, south of 1700 South. The I-1 zone requires a 30' front setback for structures. Verification of front setback is required. Verification of adherence to landscape requirements is also unclear and should be addressed. Specifically, the following: (1) landscape islands adequately sized at the end of all parking rows, (2) shade trees provided at the ratio of 1 tree per 6 parking stalls and 1 shrub per 25 sq. ft. of landscape island, (3) 6' wide parking perimeter landscape area, and (4) a 14' wide landscape area adjacent to a street frontage with 1 tree provided for every 40' of street frontage.

Section 17.6.101.B of the Development Code

Application for site plan approval shall be submitted on forms provided by the City and shall be accompanied by maps and drawings showing the following:

a. The location of all existing and proposed buildings and structures on the site, with full dimensions showing the distance between buildings and distances from buildings to adjacent property lines.

   Full dimensions are not provided; specifically, distances between buildings and from buildings to adjacent property lines.

b. The location of all parking spaces, driveways, and points of vehicular ingress and egress.

   The location of driveways and points of vehicular ingress and egress has been illustrated.

c. A landscaping plan showing the location, types and initial sizes of all planting materials to be used together with the location of fences, walls, hedges, and decorative materials.

   A landscape plan is provided; however, it does not appear to address specifics required by the City's landscape requirements. Revision is needed to ensure compliance.

d. Preliminary elevations of main buildings showing the general appearance and types of external materials to be used.

   An existing structure, while inoperable, is in place. Elevations and renderings of the existing and proposed structures have been provided in the submittal materials.

e. The location of solid waste receptacles and trash pick-up areas.

This has not been illustrated on the site plan.

POTENTIAL MOTIONS

The following potential motions are offered for consideration. If the Planning Commission feels clarification/more information is needed, a motion to table the application is prudent.

APPROVAL

Mr. Chairman, I move that we approve the site plan for the American Eagle Ready Mix, subject to any findings, conditions and modifications listed in the Engineering Report.

DENIAL

Mr. Chairman, I move that we deny the site plan for the American Eagle Ready Mix.

TABLE

Mr. Chairman, I move that we table action on the site plan for American Eagle Ready Mix.

AMERICAN FORK CITY ENGINEERING DIVISION
STAFF REPORT

Planning Commission Meeting Date: 3/18/2020

This report is a summary of the American Fork City Engineering Division plan review comments regarding the subject plan as submitted by the applicant for American Fork City Land Use Authority approval:

Project Name: American Eagle ready Mix

Project Address: 1700 South 500 East

Developer / Applicant's Name: Doug Clements

Type of Application:

- ☐ Subdivision Final Plat
- ☐ Subdivision Preliminary Plan
- ☐ Annexation
- ☐ Code Text Amendment
- ☐ General Plan Amendment
- ☐ Zone Change
- ☒ Commercial Site Plan
- ☐ Residential Accessory Structure Site Plan

Engineering Division Recommendation: The Engineering Division recommends APPROVAL of the proposed development subject to the following findings and conditions:

1. All Standard Conditions of Approval and items denoted as "Plan Modification(s) Required" in the 3/18/2020 Engineering Division Staff Report for the City Land Use Authority shall be addressed on all final project documents.

Project Map:



STANDARD CONDITIONS OF APPROVAL

Standard Conditions of Approval:

APPLICANT is responsible and shall submit/post/obtain all necessary documentation and evidence to comply with these Standard Conditions of Approval prior to any platting, permitting, or any other form of authorization by the City including plat recording or other property conveyance to the City and prior to scheduling a pre-construction meeting. All recording shall take place at the Utah County Recorder's Office.

1. **Water Rights:** Submit evidence that all the required water rights have been conveyed to American Fork City.
2. **Performance Guarantee:** Post a performance guarantee for all required public and essential common improvements.
3. **Easements and Agreements:** Submit/record a long-term Storm Water Pollution Prevention Maintenance Agreement signed and dated by the property owner and any required easement documentation.
4. **Land Disturbance Permit:** Obtain a Land Disturbance Permit.
5. **Compliance with the Engineering Division Plan Review Comments:** All plans and documents shall comply with all the Technical Review Committee comments and the City Engineer's final review.
6. **Sensitive Lands:** Record all applicable documents required for compliance with the City's Sensitive Lands Ordinance.
7. **Utility Notification Form:** Submit a Subdivision Utility Notification Form.
8. **Professional Verification:** Submit final stamped construction documentation by all appropriate professionals.
9. **Fees:** Payment of all development, inspection, recording, street light, and other project related fees.

Plan Modifications Required:

1. Final approval and construction of 1700 South roadway improvements and culinary water line shall be completed prior to or in conjunction with development.
2. The current culinary water system was modeled with the addition of this development. The results of the model show velocities are higher than allowable per city standard and differential pressures between peak hour and peak day are greater than 15 psi as prescribed in the master plan. These present issues unless master planned water main lines are installed prior to or in conjunction with this development. If the City commits to building these water lines, then we recommend approval. If the City cannot commit to building these water lines, then we strongly recommend denial.

MCDONALD FIELDING PLLC
2100 W. PLEASANT GROVE BLVD., SUITE 250
PLEASANT GROVE, UTAH 84062
PHONE: 801-610-0010

DANIEL J. MCDONALD E-MAIL: dan@mcdonaldfielding.com

March 16, 2020

American Fork City Planning Commission
c/o Adam Olsen, Senior Planner
Via Email: aolsen@afcity.net

RE: American Eagle Ready Mix Site Plan Application
American Fork City Planning Commission Regular Session – March 18, 2020

Honorable Members of the Planning Commission:

This firm represents Roderick Enterprises, which owns the Catalyst Business Park consisting of nine Class A buildings totaling over 1.2 million square feet located immediately north and across the street from the proposed American Eagle Ready Mix operation. *See* **Exhibit 1.** The Planning Commission should deny the site plan application for the reasons set forth below.

I. Concrete Batching Plants are Illegal in the I-1 Industrial Zone

The American Eagle site is located in the City's I-1 Industrial Zone. As the following subsections show, concrete batching plants such as American Eagle's violate the intent and express provisions of the I-1 Industrial Zone according to I-1 zoning regulations found in Section 17.4.503 of the City Code.

A. American Eagle's proposed operation violates the intent of the zone.

The American Eagle operation violates the stated intent of the I-1 Industrial Zone. The intent of this zone is explained in the City Code as follows:

> "The I-1 light industrial zone has been established for the purpose of providing a place where firms engaged in the ***light*** manufacturing, processing, warehousing and fabrication of goods and materials can locate ***with minimum conflict or deleterious effect on surrounding properties*** and uses and with a high degree of protection from encroachment of residential, retail commercial and other incompatible uses….
>
> ….
>
> Representative of the uses within the zone are structures utilized for ***light*** manufacturing, fabrication, processing, storage, warehousing and wholesale

> distribution, ***under conditions which limit the generation of noise, vibration, smoke, odor, dust***, fumes, or hazard from explosion."

City Code § 17.4.503.A (emphasis added).

As explained more fully below, American Eagle's operation could not by any stretch of the imagination be characterized as "light" industrial. Moreover, **it is well documented in both the regulatory and scientific literature that such operations generate substantial noise, vibration and dust that migrates to neighboring properties**.

B. American Eagle's operation violates express zoning provisions.

Section 17.4.503.B. of the I-1 zoning ordinance provides, "[t]he following buildings, structures and uses of land shall be permitted upon compliance with the standards and requirements set forth in this code[,]" but **the code does not expressly list a concrete batching plant as a permitted or conditional use**. City Code § 17.4.503.B

"Uses of land which are not expressly permitted within a zone are hereby declared to be expressly prohibited therein, except as may be permitted by action of the planning commission or city council, pursuant to express authority given under terms of this code." City Code § 17.1.200. Nothing in the City Code gives the planning commission the authority to rewrite the law so that concrete batching plants are authorized.

The closest the I-1 zoning ordinance comes to allowing anything remotely similar to a batching plant is the description found in Section 17.4.503.B.1 of "[s]tructures and areas used for the manufacturing, compounding, processing[,] fabrication and warehousing of goods and materials[.]" Admittedly, this is a fairly broad category. However, the very next subsection further refines the type of uses allowed by providing, "***[n]one of the activities carried out on the premises shall produce any noxious odor or any fumes, smoke, noise, vapor, vibration, glare or similar condition which is harmful to persons*** or which is readily discernible beyond the boundary of the zone ***or create an adverse visual impact readily discernible from the public roads***." *Id.* § 17.4.503.B.1.a (emphasis added).

As explained more fully below, **American Eagle's operation produces noise, vibration, fugitive dust and toxic particulates that are harmful to persons. It also creates an eyesore that is readily discernible from E 1700 South Street.**

Finally, American Eagle's proposed operation violates the "special provisions" section of the I-1 zoning ordinance, which provides, "***All uses shall be conducted within a fully enclosed building***, except those uses deemed by the city to be customarily and appropriately conducted in the open." City Code § 17.4.503.I.1 (emphasis added). "All materials and vehicles used in the conduct of the business activity shall be stored ***within an enclosed building*** or within an area designated for such use as shown on the approved site plan." *Id.* § 17.4.503.I.2 (emphasis added).

American Eagle's operation will not be conducted within a fully-enclosed building and cannot be appropriately conducted in the open without violating the intent of the I-1

zoning regulations due to the fugitive dust, noise and vibrations the operation will created, as explained more fully below.

II. It is Globally Recognized That Operations Such as American Eagle's Create Fugitive Dust, Particulate Matter, Noise and Vibrations, Which are Incompatible With the I-1 Zoning Regulations.

The fact that operations such as American Eagle's concrete batching plant cause fugitive dust, toxins, particulate matter (PM), noise and vibrations is globally recognized by regulatory agencies, governments and scholars.

EPA's Cement Manufacturing Enforcement Initiative

For example, the United States Environmental Protection Agency's Cement Manufacturing Enforcement Initiative (found at https://www.epa.gov/enforcement/cement-manufacturing-enforcement-initiative), attached as **Exhibit 2**, states as follows:

> **Cement plants are a significant source of sulfur dioxide, nitrogen oxide and carbon monoxide**, which are associated with the following health and environmental impacts:
>
> - Nitrogen oxide (NOx) can cause or contribute to a variety of health problems and adverse environmental impacts, such as **ground-level ozone, acid rain, global warming, water quality deterioration, and visual impairment**. Affected populations include children, people with lung diseases such as asthma, and exposure to these conditions can cause **damage to lung tissue** for people who work or exercise outside.
>
> - Sulfur dioxide (SO2) in high concentrations **can affect breathing** and may **aggravate existing respiratory and cardiovascular disease**. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. SO2 is also **a primary contributor to acid deposition, or acid rain**.
>
> - Carbon monoxide (CO) can cause harmful health effects by **reducing oxygen delivery to the body's organs and tissues**, as well as adverse effects on the cardiovascular and central nervous systems. CO also **contributes to the formation of smog (ground-level ozone)**, which can cause respiratory problems.

Ex. 2 (emphasis added). The EPA is actively prosecuting cement plants for Clean Air Act violations due to the hazards and dangers these operations pose to the environment and human health and safety. *See id.*

EPA's Emission Factor Documentation for Concrete Batching Plants

The EPA's Emission Factor Documentation for AP-42 Section 11.12 – Concrete Batching – Final Section (found at https://www3.epa.gov/ttn/chief/ap42/ch11/index.html), attached hereto as **Exhibit 3**, has documented that **concrete batching plants cause the dissemination of particulate matter and other contaminants such as arsenic, lead and mercury**. *See, e.g., id.* at pp. 24-48. "Particulate matter, consisting primarily of cement and pozzolan dust but including some aggregate and sand dust emissions, is the primary pollutant of concern. In addition, there are emissions of metals that are associated with this particulate matter. All but one of the emission points are fugitive in nature…." *Id.* at p. 2. The fugitive nature of PM means that it will migrate into Utah Lake, surrounding farms, Roderick Enterprises' property and elsewhere.

OSHA Warnings

The United States Occupational Safety and Health Administration has recognized "[e]ye, skin and respiratory tract irritation from exposure to cement dust" as a known hazard for workers in concrete manufacturing. *See* **Exhibit 4.** According to OSHA, "[e]xposure to cement dust can irritate eyes, nose, throat and the upper respiratory system. Skin contact may result in moderate irritation to thickening/cracking of skin to severe skin damage from chemical burns. **Silica exposure can lead to lung injuries including silicosis and lung cancer**." *Id.*

Scholarly Research

A recent review of the scholarly literature published in the *Journal of Physics: Conference Series* reviewed the worldwide research on cement production and processing and notes, "**Emissions from cement industries include heavy metals, CO_2, NOx, SO_2, VOCs, PM, noise, dust and bad odor** …." (Emetere and Dania, 2019) (emphasis added), attached as **Exhibit 5,** at p. 4 (citing (Zimwara et al., 2012)). "Particulate matter (PM), a mix of solid and liquid droplets are high from cement plants and affects humans greatly…. **Most components of these aerosols are cytotoxic and carcinogenic**." *Id.* (citing McNeill, 2019) (emphasis added). Another study notes, "Enormous quantities of air pollutants are emitted from cement production, including SO_2, NOx, CO, and PM, and result in significant regional and global environmental problems." (Lei, et al., 2011), attached as **Exhibit 6**.

"The direct effects of cement dust pollution are the **alkanization of the ecosystem and the changing of the chemical composition of soils**." (Bilen, 2010 (citing Mandre, 1995)) (emphasis added), attached as **Exhibit 7**. "The pollutant particles can enter into soil as dry, humid or occult deposits and can undermine its physicochemical properties." *Id.* (citing Lay and Sellegri, 2003). Soil microorganism activity is negatively affected by fugitive cement dust. *See id.* at p. 2423.

This research on the ecological and biological impact of cement dust pollution is particularly appropriate because, of course, the American Eagle project site is immediately adjacent to the shoreline of Utah Lake, which the City has already recognized, in its SP Shoreline Preservation Zone ordinance is "generally unsuited for general development and environmentally fragile[.]" City Code § 17.4.604.A. While we realize that this property was recently re-zoned

from SP to I-1 that doesn't change the geographic and environmental realities previously recognized in the code. Specifically, the code recognized that "[u]ses which tend to produce a hazardous condition or otherwise degrade or militate against the preservation of the shoreline are not permitted" and "uses within the zone are limited to uses which will not significantly degrade the environment of the lake shore area." *Id.* Moreover, even the current I-1 zoning designation provides that the intent of the I-1 zone is that uses have "***minimum conflict or deleterious effect on surrounding properties***." City Code § 17.4.503.A (emphasis added). Obviously, the negative effects of cement dust pollution and the release of heavy metal toxins from American Eagle into Utah Lake will not change simply because the zoning designation has been altered.

According to a meta-analysis of scholarly research contained in the Utah Physicians for a Healthy Environment's 2019 Report on Air Pollution and Health Research, attached as **Exhibit 8**, "increases of just 1 µg/m3 of PM2.5 chronic exposure **increases community death[] rates about 1%**." *Id.* at p. 1, n.3 (emphasis added) (citing Pope CA, et al., *Fine Particulate Air Pollution and Human Mortality: 25+ Years of Cohort Studies*, Environmental Research). Pollution particles contaminate human brain tissue, embed in the lining of blood vessels and even placentas of pregnant mothers. *Id.* at p. 2. One study found "that 99% of the deaths related to air pollution occur in populations where the air pollution meets the EPA's standards[,]" suggesting that EPA and governmental regulatory standards should not be used as the benchmark for assessing adverse impacts to human health and safety. *Id.* at p 3.

The Planning Commission should seriously consider the research accumulated by the UPHE. In a recent report by the Utah Department of Health, Bureau of Epidemiology's Environment Epidemiology Program (EEP), attached as **Exhibit 9**, the Bureau of Epidemiology commented, "we applaud the work done by UPHE. They have been able to address concerns much more broadly than the EEP has been authorized to do. We encourage policymakers to consider their work in parallel with ours." *Id.* at p. 13.

That same EEP report concluded, after undergoing its own meta-analysis of the scholarly literature on rc-silica, "Based on our literature review, the EEP cannot state that exposure to rc-silica is 'safe.' Indeed, long-term exposures at or above 1000 µg/m^3-year have an increasing risk approximately twice that of an unexposed community." *Id.* at p. 16.

Documented Noise Levels of Concrete Batching Plants and Equipment

The United States Department of Transportation Federal Highway Administration's Roadway Construction Noise Model (RCNM) Construction Noise Handbook[1] and FHWA Roadway Construction Noise Model User's Guide, **Exhibit 10**, measured the specified/anticipated and actual emission levels for various construction operations, including concrete batch plants, concrete mixers, and concrete pump trucks, based on hundreds of emission measurements from the nation's largest road project. The RCNM is "the most comprehensive

[1] This document can be found at the following link:
https://www.fhwa.dot.gov/ENVIRONMENT/noise/construction_noise/handbook/handbook09.cfm

noise specification ever developed in the United States" and its noise prediction calculations are intended to "benefit other state and local governments[.]" *Id.* at p. 1.

According to the RCNM Noise Emission Reference Levels and Usage Factors, *id.* at p. 3, and the Construction Noise Handbook, *see* n. 1, concrete batch plants, concrete mixer trucks, and concrete pump trucks, operate at an A-weighted decibel spec level of 83, 85 and 82 dBA, respectively. Ex. 10 at p. 3. To give you an idea of how loud that it is, according to the very same noise prediction model, these machines should be expected to come within the same noise range as chain saws, compressors, jackhammers, and pneumatic tools. *See id.* The actual measured noise range of mixer trucks and pump trucks were 79 and 81 dBA, respectively, which is in the same actual measured range as air compressors, drill rig trucks, drum mixers, front end loaders, generators, rivet buster/chipping guns, and rock drills. *See id.*

Anecdotal and Documentary Evidence

The *Guide to Air Quality Permitting for Concrete Batch Plants*, attached as **Exhibit 11**, published by the University of Texas School of Law Environmental Clinic, notes that "[n]eighbors most commonly complain about dust and particulate matter (PM) emissions from concrete batch plants." *Id.* at p. 4. Other reported issues include the following:

> Noise: Noise is sometimes a problem for concrete plant neighbors. Large concrete trucks, those with the roughly cone-shaped mixing barrels on their backs, often arrive before dawn to pick up loads of concrete to take to construction sites, and the idling of these early-morning arrivals and their reverse warning sounds can be noisy, in addition to spreading diesel fumes throughout the neighborhood.
>
> ….
>
> Polluted wastewater runoff: The site stockpiles and dusty roads can contribute sediment to rain that falls on them, causing muddy runoff to the nearby neighborhood, if the runoff is not well-controlled by the plant.

Id. at p. 5.

These are not just academic, speculative or remote concerns. In fact, a recent site visit by Roderick Enterprises to American Eagle's concrete batching plant in Magna demonstrates how American Eagle's proposed operation will violate the I-1 zoning regulations.

Exhibits 12-15 show American Eagle's Magna Facility. As you can see, **American Eagle will stockpile large amounts of product in outdoor containment areas, which will inevitably lead to migrating dust and PM**. Additionally, there will be constant operation of heavy machinery and equipment, as well as idling cement mixer vehicles. Finally, there will be constant noise from the rotary distributors, conveyor belts, telescopic chutes, aeration blowers, and air compressor, which are all part of the Erie Strayer MP-11T & C shown in American Eagle's site plan and depicted in the Exhibits 12-15.

Other Considerations

In a good economy, concrete batching plants **can operate 24 hours a day, 7 days a week**, resulting in potentially huge traffic and road impacts for the city and its residents. The fact that American Eagle has not submitted any type of traffic impact study to support its application is reason, alone, to deny to the application. Further, **heavy equipment such as concrete trucks will further burden and impact the roads in and around the batching plant, causing road damage, increased road repairs and other impacts for the city.** Such heavy equipment will emit diesel fuel.

Finally, concrete recycling businesses are usually operated in tandem with concrete batching plants. In fact, it is our understanding that Dunn Recycling is in the preliminary stages of reviewing with city staff a concrete recycling facility right next door to American Eagle's operation. Approval of American Eagle's application would set a precedent and **open the floodgates for heavy industrial processing and crushing businesses** like American Eagle and Dunn Recycling to operate in portions of unincorporated Utah County to be annexed into the city. The planning commission should set the tone for what it will allow and not allow with this application because it is sure to have long-ranging implications and repercussions for the city and its residents.

IV. Impact upon Roderick Enterprises

Roderick's various Business Park along the Wasatch Front (Logan to Springville) are designed to attract Fortune 500 companies and other large local companies that demand best in class facilities that portray a very high end professional image.

Roderick has already delivered this strategy to American Fork City with 3 buildings consisting of 372,977 square feet in the North Pointe Business Park as shown on Exhibit 1. Corporate Tenants secured by Roderick in North Pointe include Seagull Books / Covenant Communications (Corporate HQ/Division of LDS Church) Ancestry- (DNA Depository Lab) Vivint Solar-Better Body Foods- KT- Tape (Corp HQ)- CED (600 unit Electrical Supply company.) Goodman (national HVAC supply house headquartered in Japan)

In 2019 these 3 buildings generated $315,470 in property tax revenue as well as millions in taxable sales.

Catalyst Business Park upon completion of all buildings will generate approximately $1.1mm in property taxes, millions in taxable sales and will generate approximately 3000 jobs.

For a complete list of Roderick Projects and Corporate Tenants please visit www.roderickrealty.com .

If this batch plant is approved, **Roderick Enterprises will likely lose the top-end tenants it usually attracts due to the dirty, hazardous and unsightly operation of the American Eagle batch plant right across the street**. Compare the beautiful projects

constructed by Roderick Enterprises in Exhibit 1 with the unsightly operations of American Eagle in Exhibit 18. Roderick's tenants will take one look at the concrete batching plant and realize that they will constantly be disturbed by noise dust and toxic particles. Roderick has many contacts in the technology, medical and food services industries. These industries will likely not even consider this site if the batch plant is allowed. Obviously, what American Eagle plans to introduce "***create[s] an adverse visual impact readily discernible from the public roads***." City Code § 17.4.503.B.1.a (emphasis added).

Instead of looking out at the beautiful Utah Lake, Roderick's tenants will have an unsightly view of the concrete batching plant. And each day as they leave work the tenants will have to dust off their cars from the particulate matter (PM), silica, dust and other toxic chemicals that will settle on their vehicles due to American Eagle's operations and wonder if their constant inhalation of this dust day after day is causing them damage. In short, the concrete batching plant is a huge deterrent to potential tenants and the type of clientele that Roderick Enterprises usually attracts.

V. American Eagle Cannot Be Trusted to Maintain Mitigating Measures

Undoubtedly, American Eagle will try to convince the Planning Commission that it can implement mitigating measures such as a dust control plan. First, there is no good science or documentation presented that any such mitigating measures work. If they did, concrete batch plants wouldn't be on the EPA's watch list and among its enforcement priorities. Second, American Eagle cannot be trusted to maintain compliance with the law. For example, **American Eagle constructed its facility prior to ever seeking a building permit or zoning clearance from the City and only stopped its operations after being red-tagged by the City's code enforcement officers**.

American Eagle constructed everything you see in **Exhibits 16-18** without a building permit or zoning clearance. These pictures were taken from 1700 South and demonstrate the adverse visual impact readily discernible from the public roads. If American Eagle tried to fly under the radar when it came into the City, what will it do if the Planning Commission approves its site plan? Unfortunately, American Eagle has already demonstrated that it refuses to play by the rules and cannot be trusted to comply with them. Thus any mitigating measure imposed by the Planning Commission are likely to be ignored and ineffective.

VI. Conclusion

The Planning Commission should deny American Eagle's site plan for at least the following reasons:

- American Eagle's operation violates City Code § 17.4.503.A because it is not engaged in "light" manufacturing and processing "with minimum conflict or deleterious effect on surrounding properties"

- American Eagle's operation violates City Code § 17.4.503.A because it does not operate "under conditions which limit the generation of noise, vibration, smoke, odor, dust, fumes, or hazard"
- American Eagle's operation violates City Code §§ 17.4.503.B and City Code § 17.1.200 because the code does not expressly list a concrete batching plant as a permitted or conditional use—it is a prohibited use
- American Eagle's operation violates City Code § 17.4.503.B.1.a because it produces noxious odors, fumes, smoke, noise, vapors, vibrations, and conditions which are harmful to persons
- American Eagle's operation violates City Code § 17.4.503.B.1.a because it creates an adverse visual impact readily discernible from the public roads
- American Eagle violates City Code § 17.4.503.I.1 because most of its operations are not conducted within a fully enclosed building and its outdoor uses cannot be customarily and appropriately conducted in the open

Due to the significant, multi-million-dollar investment Roderick Enterprises has made in reliance upon the City's zoning laws, it will do what is necessary to ensure that American Eagle complies with the law. Roderick Enterprises will exhaust any and all administrative remedies that it has under the City Code and seek relief on appeal in the district court, if necessary, pursuant to Utah Code Ann. § 10-9a-801(3)(b)-(c) based upon the fact that, among other things, any approval of American Eagle's project would be "illegal" and "not supported by substantial evidence in the record." Accordingly, we respectfully request that you deny American Eagle's application.

Sincerely,

MCDONALD FIELDING

Daniel J. McDonald

Enclosures

Ex. 1 – Aerial Map
Ex. 2 – EPA's Cement Manufacturing Enforcement Initiative
Ex. 3 – EPA's Emmission Factor Documentation – Concrete Batching
Ex. 4 – OSHA Concrete Manufacturing Pamphlet
Ex. 5 – Scholarly research – *Journal of Physics: Conference Series*
Ex. 6 – Scholarly research – *Atmospheric Environment*
Ex. 7 – Scholarly research – *African Journal of Microbiology Research*
Ex. 8 – UPHE 2019 Report on Air Pollution and Health Research
Ex. 9 – Utah Dept. of Health, Burea of Epidemiology Assessment – Silicosis and Lung Cancer
Ex. 10 – FHWA Roadway Construction Noise Model User's guide
Ex. 11 - Scholarly research – University of Texas School of Law
Ex. 12 – Image 1 – American Eagle's Magna Facility
Ex. 13 – Image 2 – American Eagle's Magna Facility
Ex. 14 – Image 3 – American Eagle's Magna Facility
Ex. 15 – Image 4 – American Eagle's Magna Facility
Ex. 16 – Image 1 – Illegally-constructed American Fork Facility
Ex. 17 – Image 2 – Illegally-constructed American Fork Facility
Ex. 18 – Image 3 – Illegally-constructed American Fork Facility

Exhibit 1

Roderick Enterprises
North Pointe Class 'A' Business Park
±400,000 SF

Roderick Enterprises
Catalyst Class 'A' Business Park
+1.2 Million SF



American Eagle
Proposed Batch Plant

S-500-E-St
S-Auto-Mall-Dr
Veterans'-Memo
W-6800-N
E-1100-S-St
E-Bromley-Dr
S-300-E-St
E-1300-S-St
N-5300-W-St
S-W-St
N-2800-N
Pleasant-Grove-Blvd
W-6400-N
S-580-E
N-505
2600-W
W-6200-N
100-W
E-1700-S

100 East

1500 South

BLDG 9
145,364 SF

150 East

BLDG 8
139,984 SF

BLDG 2
136,436 SF

400 East

BLDG 1
169,948 SF

500 East

1600 South

BLDG 7
90,627 SF

BLDG 6
96,401 SF

BLDG 5
136,502 SF

BLDG 4
162,545 SF

BLDG 3
154,689 SF

1700 South

aeurbia
architects and engineers


SIGNAGE
CATALYST
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Exhibit 2

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Cement Manufacturing Enforcement Initiative

The cement manufacturing industry was an EPA New Source Review/Prevention of Significant Deterioration (NSR/PSD) national enforcement initiative in fiscal years 2008-2010 and was continued as a Reducing Air Pollution from the Largest Sources national enforcement initiative for fiscal years 2011-2013. The cement sector is the third largest industrial source of pollution, emitting more than 500,000 tons per year of sulfur dioxide, nitrogen oxide, and carbon monoxide. Beginning in 2008, EPA has pursued a coordinated, integrated compliance and enforcement strategy to address Clean Air Act New Source Review compliance issues at the nation's cement manufacturing facilities.

On this page:

- Health and Environmental Effects of Cement Plant Emissions
- Cement Plant Settlements
- Cement Plant Lawsuit

Health and Environmental Effects of Cement Plant Emissions

Cement plants are a significant source of sulfur dioxide, nitrogen oxide and carbon monoxide, which are associated with the following health and environmental impacts:

- Nitrogen oxide (NO_x) can cause or contribute to a variety of health problems and adverse environmental impacts, such as ground-level ozone, acid rain, global warming, water quality deterioration, and visual impairment. Affected populations include children, people with lung diseases such as asthma, and exposure to these conditions can cause damage to lung tissue for people who work or exercise outside.
- Sulfur dioxide (SO_2) in high concentrations can affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. SO_2 is also a primary contributor to acid deposition, or acid rain.

- Carbon monoxide (CO) can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues, as well as adverse effects on the cardiovascular and central nervous systems. CO also contributes to the formation of smog (ground-level ozone), which can cause respiratory problems.

Cement Plant Settlements

- Lone Star Industries, Inc. (Buzzi) (8/01/16)
- Cemex, Inc., (07/27/16)
- Ash Grove (6/19/13)
- Holcim Hagerstown Maryland (7/11/13)
- Cemex Inc. (Lyons) (4/19/13)
- Essroc Cement Company (12/29/11)
- California Portland Cement Company (12/15/11)
- CEMEX Fairborn Plant (2/10/11)
- Lafarge North America, Inc. (1/21/10)
- Cemex (California) (1/15/09)
- St. Mary's Cement (Illinois) (9/08/08)

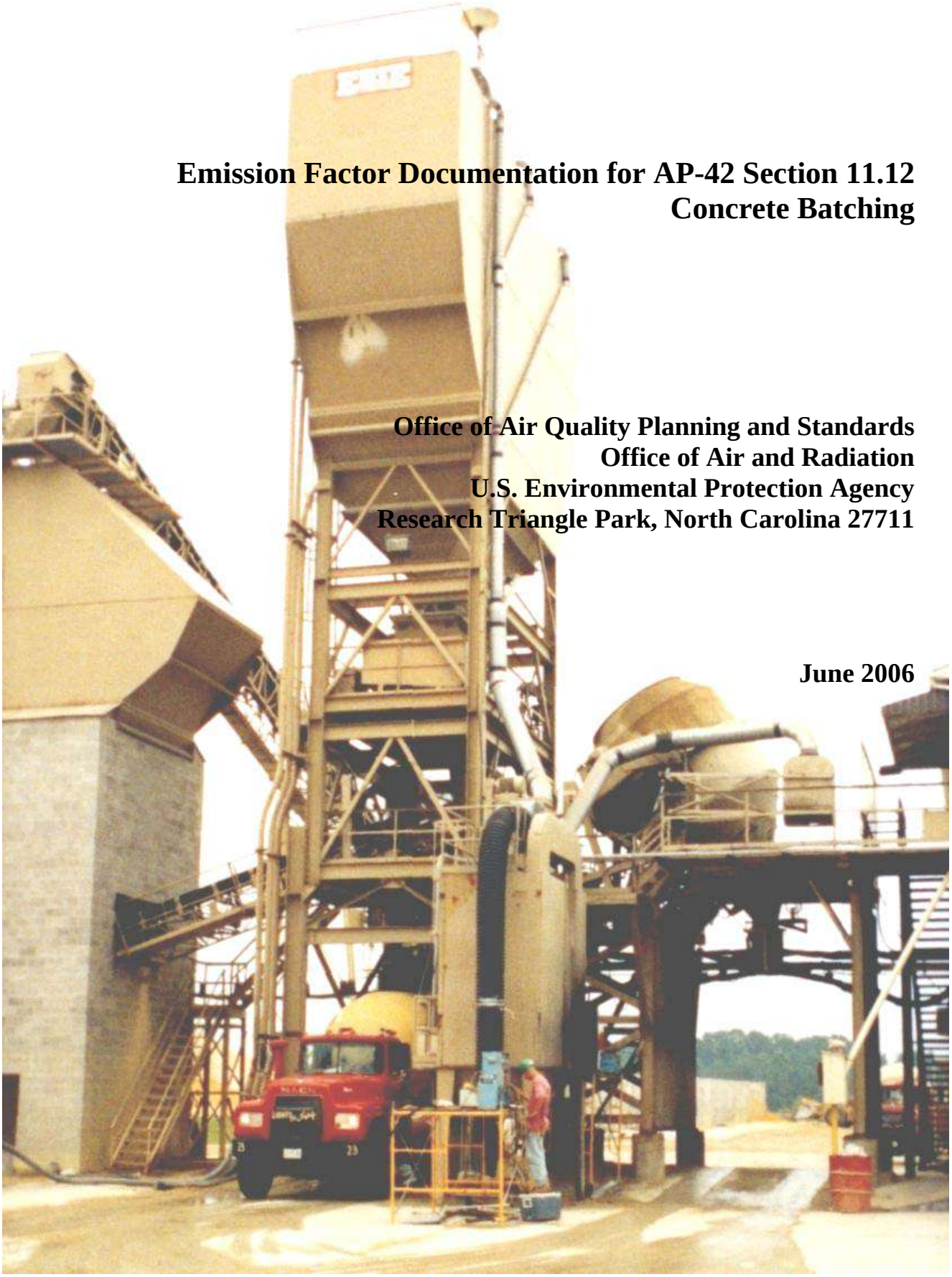
Cement Plant Lawsuits

- Cemex Complaint

LAST UPDATED ON AUGUST 14, 2019

Exhibit 3

Emission Factor Documentation for AP-42 Section 11.12 Concrete Batching



Office of Air Quality Planning and Standards
Office of Air and Radiation
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

June 2006

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1. INTRODUCTION

The document "Compilation of Air Pollutant Emissions Factors" (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, state and local air pollution control programs and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. With differing levels of accuracy, the uses of the emission factors reported in AP-42 include:

- Estimates of area-wide emissions;
- Estimates of emissions from a specific facility; and
- Evaluation of emissions relative to ambient air quality.

The purpose of this report is to document the development of the emission factors presented in AP-42 Section 11.12 Concrete Batching.

2. AP-42 DESCRIPTION OF THE CONCRETE BATCHING INDUSTRY

AP-42 11.12-1 Process Description [1-5]

Concrete is composed essentially of water, cement, sand (fine aggregate) and coarse aggregate. Coarse aggregate may consist of gravel, crushed stone or iron blast furnace slag. Some specialty aggregate products could be either heavyweight aggregate (of barite, magnetite, limonite, ilmenite, iron or steel) or lightweight aggregate (with sintered clay, shale, slate, diatomaceous shale, perlite, vermiculite, slag pumice, cinders, or sintered fly ash). Supplementary cementitious materials, also called mineral admixtures or pozzolan minerals may be added to make the concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete properties. Typical examples are natural pozzolans, fly ash, ground granulated blast-furnace slag, and silica fume, which can be used individually with portland or blended cement or in different combinations. Chemical admixtures are usually liquid ingredients that are added to concrete to entrain air, reduce the water required to reach a required slump, retard or accelerate the setting rate, to make the concrete more flowable or other more specialized functions.

Approximately 75 percent of the U.S. concrete manufactured is produced at plants that store, convey, measure and discharge these constituents into trucks for transport to a job site. At most of these plants, sand, aggregate, cement and water are all gravity fed from the weight hopper into the mixer trucks. The concrete is mixed on the way to the site where the concrete is to be poured. At some of these plants, the concrete may also be manufactured in a central mix drum and transferred to a transport truck. Most of the remaining concrete manufactured are products cast in a factory setting. Precast products range from concrete bricks and paving stones to bridge girders, structural components, and panels for cladding. Concrete masonry, another type of manufactured concrete, may be best known for its conventional 8 x 8 x 16-inch block. In a few cases concrete is dry batched or prepared at a building construction site. Figure 11.12-1 is a generalized process diagram for concrete batching.

The raw materials can be delivered to a plant by rail, truck or barge. The cement is transferred to elevated storage silos pneumatically or by bucket elevator. The sand and coarse aggregate are transferred to elevated bins by front end loader, clam shell crane, belt conveyor, or bucket elevator. From these elevated bins, the constituents are fed by gravity or screw conveyor to weigh hoppers, which combine the proper amounts of each material.

11.12-2 Emissions and Controls [6-8]

Particulate matter, consisting primarily of cement and pozzolan dust but including some aggregate and sand dust emissions, is the primary pollutant of concern. In addition, there are emissions of metals that are associated with this particulate matter. All but one of the emission points are fugitive in nature. The only point sources are the transfer of cement and pozzolan material to silos, and these are usually vented to a fabric filter or “sock”. Fugitive

sources include the transfer of sand and aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion from sand and aggregate storage piles. The amount of fugitive emissions generated during the transfer of sand and aggregate depends primarily on the surface moisture content of these materials. The extent of fugitive emission control varies widely from plant to plant. Particulate emission factors for concrete batching are give in Tables 11.12-1 and 11.12-2.

Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, and the like. A major source of potential emissions, the movement of heavy trucks over unpaved or dusty surfaces in and around the plant, can be controlled by good maintenance and wetting of the road surface.

Predictive equations that allow for emission factor adjustment based on plant specific conditions are given in the Background Document for Chapter 11.12 and Chapter 13. Whenever plant specific data are available, they should be used with these predictive equations (e.g. Equations 11.12-1 through 11.12-3) in lieu of the general fugitive emission factors presented in Table 11.12-1, 11.12-2, and 11.12-5 through11.12-8 in order to adjust to site specific conditions, such as moisture levels and localized wind speeds.

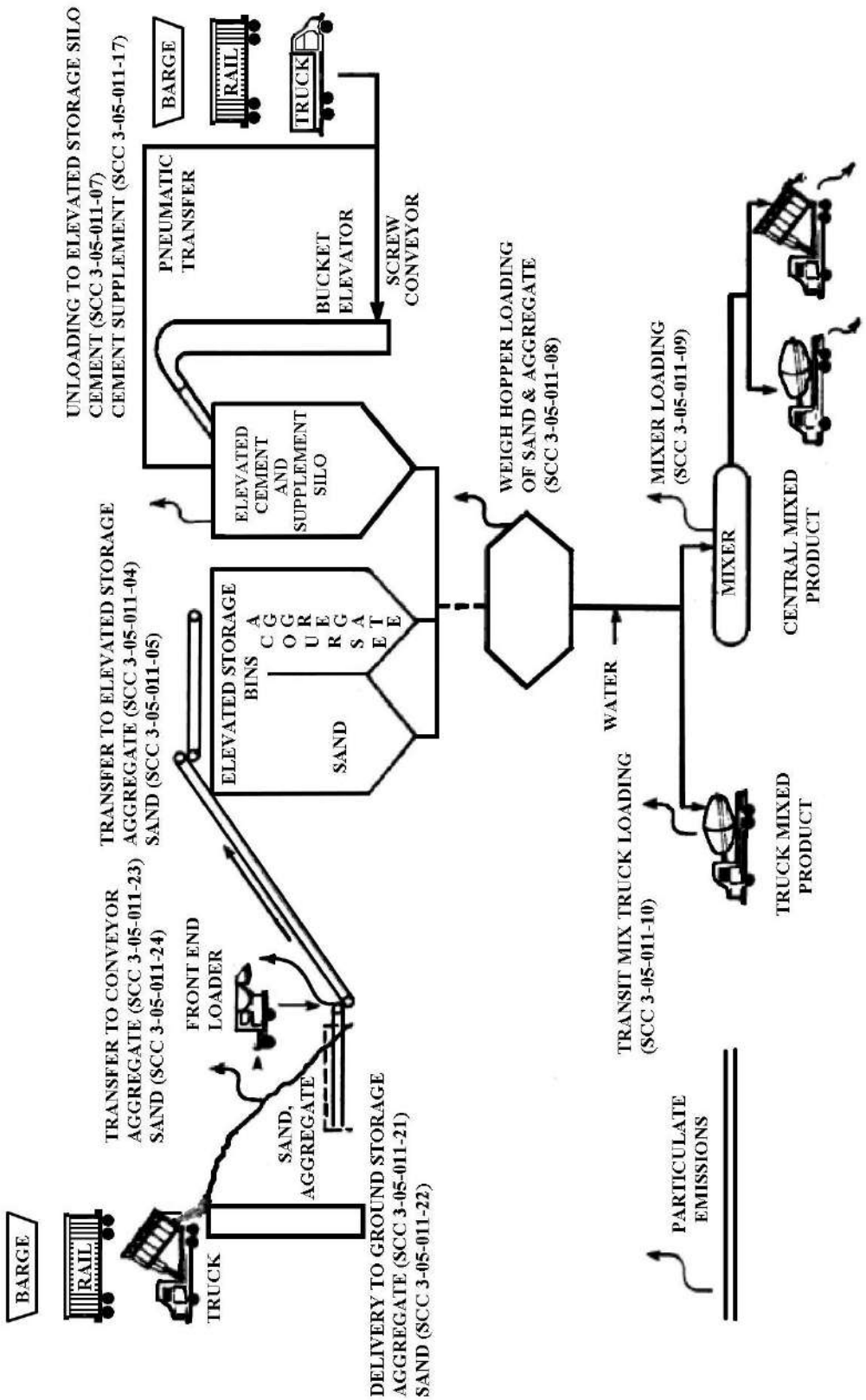


Figure 11.12-1. Typical Concrete Batching Process.

References for Section 11.12

1. *Air Pollutant Emission Factors,* APTD-0923, U.S. Environmental Protection Agency, Research Triangle Park, NC, April 1970

2. *Air Pollution Engineering Manual,* 2nd Edition, AP-40, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1974. Out of Print.

3. Telephone and written communication between Edwin A. Pfetzing, PEDCo Environmental., Inc., Cincinnati, OH, and Richards Morris and Richard Meininger, National Ready Mix Concrete Association, Silver Spring, MD, May 1984.

4. *Development Document for Effluent Limitations Guidelines and Standards of Performance, The Concrete Products Industries, Draft,* U.S. Environmental Protection Agency, Washington, DC, August 1975.

5. Portland Cement Association. (2001). Concrete Basics. Retrieved August 27, 2001 from the World Wide Web: http://www.portcement.org/cb/

6. *Technical Guidance for Control of Industrial Process Fugitive Particulate Emissions,* EPA-450/3-77-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1977

7. *Fugitive Dust Assessment at Rock and Sand Facilities in the South Coast Air Basin,* Southern California Rock Products Association and Southern California Ready Mix Concrete Association, Santa Monica, CA, November 1979.

8. Telephone communication between T.R. Blackwood, Monsanto Research Corp., Dayton, OH, and John Zoller, PEDCo Environmental, Inc., Cincinnati, OH, October 18, 1976.

9. *Final Test Report for USEPA* [sic] *Test Program Conducted at Chaney Enterprises Cement Plant,* ETS, Inc., Roanoke, VA April 1994

10. *Final Test Report for USEPA* [sic] *Test Program Conducted at Concrete Ready Mixed Corporation,* ETS, Inc., Roanoke, VA April 1994

11. *Emission Test for Tiberi Engineering Company,* Alar Engineering Corporation, Burbank, IL, October, 1972.

12. *Stack Test "Confidential"* (Test obtained from State of Tennessee), Environmental Consultants, Oklahoma City, OK, February 1976.

13. Source Sampling Report, Particulate Emissions from Cement Silo Loading, Specialty Alloys Corporation, Gallaway, Tennessee, Reference number 24-00051-02, State of Tennessee, Department of Health and Environment, Division of Air Pollution Control, June 12, 1984.

14. Richards, J. and T. Brozell. "*Ready Mixed Concrete Emission Factors, Final Report*" Report to the Ready Mixed Concrete Research Foundation, Silver Spring, Maryland. August 2004.

3. QUALITY RATING SYSTEMS

3.1 Emission Data Quality System

The rating system specified by the Emission Factor and Inventory Group (EFIG) for preparing AP-42 sections was used as a general guide in rating the emission data used in this report. The rating system is as follows:

A Multiple tests that were preformed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B Tests that were preformed by a generally sound methodology but lack enough detail for adequate validation.

C Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.
2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted method, the deviations are well documented. When this occurred, an evaluation was made of the extent to which such alternative procedures could influence the test results
3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operations are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and were given a lower rating.
4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculation was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the report.

3.2 Emission Factor Quality Rating System

The quality rating of each of the final emission factors was guided by the following general criteria:

A Excellent: Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized

B Above Average: Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

C Average: Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D Below Average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

References for Section 3

1. *Procedures for Preparing Emission Factor Documents*, EPA-454/R-95-015, Office of Air Quality Planning Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1997.

4. EMISSION FACTOR DEVELOPMENT

Six emission test reports were used to develop emission factors for AP-42 Section 11.12, Concrete Batching. Two of the tests (References 1 and 2) were sponsored by EPA in order to add PM_{10} emission factors and to improve the quality of the other concrete batching emission factors. The third test report (Reference 3) was produced by a company that sold a control device for silo filling operations. The fourth test report (Reference 4) was produced by a consulting firm to determine whether a facility was in compliance with Oklahoma regulations. The fifth test report (Reference 5) was produced by a State agency to evaluate the performance of a non commercial silo filling emissions control device. Information from AP-42 Section 13.2.4, *Aggregate Handling And Storage Piles* was used to provide the basis for material transfer operations that occur at but were not measured at concrete batch plants. The sixth set of test reports (Reference 6) were sponsored by The Ready Mixed Concrete Research Foundation (RMC Research Foundation) at six ready mixed concrete facilities located in North Carolina, Virginia, and South Carolina. The purpose of the RMC Research Foundation project was to improve concrete batching plant emissions factors for total particulate matter, PM_{10}, $PM_{10-2.5}$, $PM_{2.5}$, and arsenic from truck mix and central mix process operations at ready mixed concrete plants.

4.1 Reference 1

This report (Reference 1 presents the results of emission testing on a typical concrete batching operation performed at Chaney Enterprises in Waldorf, Maryland. This reference includes measurements of the amounts of PM, PM_{10} and then select metals that were released during truck mix loadings, central mix loadings, and silo fillings. In addition, tests were conducted on process material samples and road surface samples.

Several kinds of tests and test methods were used:

- EPA Reference Test Method 201A was used to collect emissions released during the truck loadings and the silo fillings. In addition to the usual recovering and weighing of collected PM_{10}, larger particulate (greater than ten micrometers) collected in the probe and the cyclone was also recovered and weighed.
- Sieve and moisture analyses were conducted on the process materials (aggregates) and the road materials.
- Laboratory tests were conducted on the emissions collected during the tests as well as the material collected for the sieve analysis to determine the amount of each of the ten metals that were contained in these materials.

Emissions resulting from the truck mix and central mix loadings were controlled with a shroud connected to a centrally located pulse-jet type baghouse (C & W Model No. RA 140-S). In order to develop both controlled and uncontrolled emission factors, tests were conducted at both the inlet and outlet of the dust collector. Also, visual estimates of the capture efficiency of the control device were made during the individual truck mix loadings and central mix operations. This information made it possible to estimate the emission not captured during the test.

Emissions due to the loading of silos were also controlled by the central dust collector. As a consequence of the frequency of the truck loadings, only one test run captured emissions due solely to silo fillings. In the other silo emission tests, an attempt was made to subtract out the emissions from the truck loadings. Unfortunately, the resulting values are significantly different from the silo only emission test and therefore are not used for emission factor development.

Most of the emission data that were used to develop the controlled and the uncontrolled PM and PM_{10} emission factors for truck mix loading and central mix loading warrant an A rating. However, the methodology used to estimate the capture efficiencies of the control device is qualitative rather than quantitative. This issue is significant since the uncontrolled and controlled emission factors for truck loading depend significantly on the capture efficiency estimates. Due to the subjective nature of the capture efficiency estimates, the emission data set for the truck loading emission factors is **rated B**.

The emission data from run number 7 that were used to develop the usable controlled and uncontrolled, PM, PM_{10} and metal emission factors for cement silo fillings are generally of the same quality as the aforementioned test data. However, since only one test run was used to develop each of these emission factor types, this test data set is **rated C**

The data sets used to develop the emission factors for batching by central mixing are **rated A**, since the methodology used to collect the data was sound and the dependence on capture efficiency estimates are minimal.

The following tables present the data that were used to develop the emission factors for Reference 1 as well as the emission factors themselves (with the exception of the data and emission factors associated with traversing paved and unpaved roads and for loading aggregate and sand to elevated bins). The layouts of the tables make the methods used to develop these emission factors largely self-evident (see the technical notes in Appendix A for more information).

Note that “fines” stands for cement, cement supplement, and the silt from sand and course aggregate.

Reference 1
Emission Factor Tables

Tables	Emission Factor Types
1.1 - 1.3	PM_{10} Emission Factors
2.1 - 2.3	Controlled PM_{10} Emission Factors
3.1 - 3.3	PM Emission Factors
4.1 - 4.3	Controlled PM Emission Factors
5.1 - 5.5	Metal Emission Factors
6.1 - 6.5	Controlled Metal Emission Factors

Table 1.1

PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM-10 per hour IN INLET (lb)	TIME (min)	PM-10 IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM-10 (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM-10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE (lb)	SILT FROM AGGR. ** (lb)	PM-10 per 1000 lb Solid Raw Material (lb)	PM-10 per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING																	
RUN 2	4.013	30.2	2.020	72	2.805	41.5	0.06760	16,950	0.16551	12,250	0.09607	59,950	1,343.94	130,020	320.69	0.01280	0.09089
RUN 4	2.970	30.0	1.485	79	1.880	54.0	0.03481	27,840	0.06752	0	0.06752	73,600	1,649.94	173,150	427.07	0.00685	0.06283
RUN 9	1.588	30.1	0.797	78	1.021	69.0	0.01480	39,110	0.02611	0	0.02611	104,910	2,351.84	218,940	540.02	0.00281	0.02432
RUN 14	4.971	22.1	1.831	56	3.270	41.0	0.07975	19,180	0.17047	10,220	0.11121	54,120	1,213.24	127,300	313.99	0.01551	0.10572
RUN 15	4.477	30.0	2.239	64	3.498	59.5	0.05878	32,650	0.10713	3,100	0.09784	80,240	1,798.79	187,330	462.05	0.01153	0.09202
RUN 16	3.470	30.0	1.735	58	2.991	41.5	0.07208	22,010	0.13591	0	0.13591	57,510	1,289.24	133,660	329.67	0.01403	0.12660
AVG.				**68**			**0.05464**		0.11211		**0.08911**					0.01059	0.08373
STD. DEV.				**10**			**0.02490**		0.05698		**0.03805**					0.00482	0.03580
CENTRAL MIX LOADING																	
RUN 10	1.529	30.1	0.767	90	0.850	45.0	0.01890	16,280	0.05224	13,900	0.02818	68,130	1,527.32	143,470	353.87	0.00352	0.02652
RUN 11	1.622	30.2	0.816	84	0.972	49.8	0.01952	22,340	0.04351	8,870	0.03114	70,770	1,586.50	158,600	391.19	0.00373	0.02929
RUN 12	0.309	30.2	0.156	99	0.157	45.0	0.00349	22,130	0.00710	9,300	0.00500	59,080	1,324.44	141,640	349.36	0.00068	0.00475
RUN 13	3.422	29.9	1.705	99	1.723	44.0	0.03915	19,240	0.08953	8,770	0.06150	66,750	1,496.38	138,830	342.42	0.00737	0.05771
RUN 17	6.708	27.2	3.041	99	3.072	72.0	0.04266	30,950	0.09925	13,900	0.06849	104,850	2,350.49	228,760	564.24	0.00812	0.06431
AVG.				**94**			**0.02474**		0.05832		**0.03886**					0.00468	0.03651
STD. DEV.				**7**			**0.01614**		0.03718		**0.02603**					0.00306	0.02441

* AVG. % SILT CONTENT OF SAND : **2.2418**

** AVG. % SILT CONTENT OF AGGREGATE : **0.2467**

Table 1.2

PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM-10 per hour IN INLET (lb)	TIME (min)	PM-10 IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM-10 (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM-10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND (lb)	COURSE AGGRE-GATE (lb)	SILT FROM AGGR. (lb)	PM-10 per 1000 lb Solid Raw Material (lb)	PM-10 per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING & CEMENT SILO FILLING																	
RUN 1	8.655	56.8	8.193	71	11.548	95.0	0.12156	48,620	0.23752	11,240	0.19292	135,290	3,032.89	281,640	694.67	0.02422	0.18161
RUN 3	16.990	30.0	8.495	70	12.136	50.0	0.24271	27,880	0.43528	0	0.43528	67,530	1,513.87	157,500	388.47	0.04798	0.40748
RUN 8	17.574	27.8	8.143	72	11.309	27.0	0.41886	14,170	0.79811	0	0.79811	36,030	807.71	86,430	213.18	0.08277	0.74447
AVG.				**71**			0.26104		0.49030		0.47544					0.05166	**0.44452**
STD. DEV.				**1**			0.14950		0.28432		0.30459					0.02945	**0.28325**
CEMENT SILO FILLING																	
RUN 7	14.608	30.2	7.353	100	7.353			37,775	0.19465								
RUN 1 EST.					6.224			40,299	0.15444								
RUN 3 EST.					9.642			34,268	0.28138								
RUN 8 EST.					10.037			31,722	0.31641								
AVG.									**0.23672**								
STD. DEV.									**0.07502**								
TRUCK MIX LOADING & NEWCEM SILO FILLING																	
RUN 5	41.768	30.1	20.954	79	26.524	51.0	0.52007	11,340	2.33894	0	2.33894	26,550	595.19	158,280	390.40	0.13521	2.15191
RUN 18	23.287	29.9	11.605	65	17.853	5.0	3.57067	1,800	9.91854	2,380	4.27114	7,260	162.75	16,570	40.87	0.63739	4.07274
AVG.				**72**			2.04537		6.12874		3.30504					0.38630	**3.11233**
STD. DEV.				**10**			2.15710		5.35959		1.36627					0.35510	**1.35823**
NEWCEM SILO FILLING																	
RUN 5 EST.					25.492					30,096	0.84701						
RUN 18 EST.					17.486					39,276	0.44522						
AVG.											**0.64611**						
STD. DEV.											**0.28411**						

*	AVG. % SILT CONTENT OF SAND :	**2.2418**	**	AVG. % SILT CONTENT OF AGGREGATE : **0.2467**

Table 1.3

PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM-10 per hour IN INLET (lb)	TIME (min)	PM-10 IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM-10 (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM-10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE (lb)	** SILT FROM AGGR. (lb)	PM-10 per 1000 lb Solid Raw Material (lb)	PM-10 per 1000 lb ``FINES" (lb)
GENERAL																	
SILO FILLING																	
RUN 7	14.608	30.2	7.353	100	7.353			37,775		0	0.19465						
RUN 1 EST.					6.224			40,299		0	0.15444						
RUN 3 EST.					9.642			34,268		0	0.28138						
RUN 5 EST.					25.492			0		30,096	0.84701						
RUN 8 EST.					10.037			31,722		0	0.31641						
RUN 18 EST.					17.486			0		39,276	0.44522						
AVG.											**0.37318**						
STD. DEV.											**0.25341**						

Table 2.1

CONTROLLED PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM-10 per hour IN INLET (lb)	PM-10 per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM-10 ESCAPED INLET (lb)	PM-10 OUT OUTLET (lb)	TOTAL PM-10 RELEASED (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM-10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. ** (lb)	PM-10 per 1000 lbs Solid Raw Material (lb)	PM-10 per 1000 lbs ``FINES'' (lb)
TRUCK MIX LOADING																			
RUN 2	4.013	0.00450	30.2	72	0.78551	0.00227	0.78777	41.5	0.01898	16,950	0.04648	12,250	0.02698	59,950	1,344	130,020	321	0.00359	0.02552
RUN 4	2.970	0.00450	30.0	79	0.39475	0.00225	0.39700	54.0	0.00735	27,840	0.01426	0	0.01426	73,600	1,650	173,150	427	0.00145	0.01327
RUN 9	1.588	0.00450	30.1	78	0.22470	0.00226	0.22695	69.0	0.00329	39,110	0.00580	0	0.00580	104,910	2,352	218,940	540	0.00063	0.00540
RUN 14	4.971	0.00450	22.1	56	1.43863	0.00166	1.44029	41.0	0.03513	19,180	0.07509	10,220	0.04899	54,120	1,213	127,300	314	0.00683	0.04657
RUN 15	4.477	0.00450	30.0	64	1.25916	0.00225	1.26141	59.5	0.02120	32,650	0.03863	3,100	0.03528	80,240	1,799	187,330	462	0.00416	0.03319
RUN 16	3.470	0.00450	30.0	58	1.25638	0.00225	1.25863	41.5	0.03033	22,010	0.05718	0	0.05718	57,510	1,289	133,660	330	0.00590	0.05327
AVG.				**68**					**0.01938**		0.03958		**0.03142**					0.00376	0.02954
STD. DEV.				**10**					**0.01245**		0.02608		**0.01979**					0.00242	0.01860
CENTRAL MIX LOADING																			
RUN 10	1.529	0.00450	30.1	90	0.08334	0.00226	0.08560	45.0	0.00190	16,280	0.00526	13,900	0.00284	68,130	1,527	143,470	354	0.00035	0.00267
RUN 11	1.622	0.00450	30.2	84	0.15551	0.00227	0.15777	49.8	0.00317	22,340	0.00706	8,870	0.00506	70,770	1,586	158,600	391	0.00061	0.00475
RUN 12	0.309	0.00450	30.2	99	0.00157	0.00227	0.00384	45.0	0.00009	22,130	0.00017	9,300	0.00012	59,080	1,324	141,640	349	0.00002	0.00012
RUN 13	3.422	0.00450	29.9	99	0.01723	0.00224	0.01947	44.0	0.00044	19,240	0.00101	8,770	0.00070	66,750	1,496	138,830	342	0.00008	0.00065
RUN 17	6.708	0.00450	27.2	99	0.03072	0.00204	0.03276	72.0	0.00045	30,950	0.00106	13,900	0.00073	104,850	2,350	228,760	564	0.00009	0.00069
AVG.				**94**					**0.00121**		0.00291		**0.00189**					0.00023	0.00178
STD. DEV.				**7**					**0.00130**		0.00305		**0.00205**					0.00025	0.00193

* AVG. % SILT CONTENT OF SAND **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE : **0.24665**

Table 2.2

CONTROLLED PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM-10 per hour IN INLET (lb)	PM-10 per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM-10 ESCAPED INLET (lb)	PM-10 OUT OUTLET (lb)	TOTAL PM-10 RELEASED (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM-10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. ** (lb)	PM-10 per 1000 lbs Solid Raw Material (lb)	PM-10 per 1000 lbs ``FINES'' (lb)
TRUCK MIX LOADING & CEMENT SILO FILLING																			
RUN 1	8.655	0.00450	56.8	71	3.35473	0.00426	3.35899	95.0	0.03536	48,620	0.06909	11,240	0.05611	135,290	3,033	281,640	695	0.00705	0.05282
RUN 3	16.990	0.00450	30.0	70	3.64071	0.00225	3.64296	50.0	0.07286	27,880	0.13067	0	0.13067	67,530	1,514	157,500	388	0.01440	0.12232
RUN 8	17.574	0.00450	27.8	72	3.16657	0.00209	3.16866	27.0	0.11736	14,170	0.22362	0	0.22362	36,030	808	86,430	213	0.02319	0.20859
AVG.				**71**					**0.07519**		**0.14112**		**0.13680**					**0.01488**	**0.12791**
STD. DEV.				**1**					**0.04105**		**0.07779**		**0.08392**					**0.00808**	**0.07803**
CEMENT SILO FILLING																			
RUN 7	14.608	0.00450	30.2	100	0.00000	0.00227	0.00227			37,775	0.00006								
RUN 1 EST.							1.48084			40,299	0.03675								
RUN 3 EST.							2.76330			34,268	0.08064								
RUN 8 EST.							2.71997			31,722	0.08574								
AVG.											**0.05080**								
STD. DEV.											**0.04035**								
TRUCK MIX LOADING & NEWCEM SILO FILLING																			
RUN 5	41.768	0.00450	30.1	79	5.56995	0.00226	5.57221	51.0	0.10926	11,340	0.49138	0	0.49138	26,550	595	158,280	390	0.02840	0.45208
RUN 18	23.287	0.00450	29.9	65	6.24868	0.00224	6.25092	5.0	1.25018	1,800	3.47273	2,380	1.49544	7,260	163	16,570	41	0.22317	1.42597
AVG.				**72**					**0.67972**		**1.98205**		**0.99341**					**0.12579**	**0.93903**
STD. DEV.				**10**					**0.80676**		**2.10814**		**0.70998**					**0.13772**	**0.68864**
NEWCEM SILO FILLING																			
RUN 5 EST.							5.20815					30,096	0.17305						
RUN 18 EST.							6.12144					39,276	0.15586						
AVG.													**0.16445**						
STD. DEV.													**0.01216**						

* AVG. % SILT CONTENT OF SAND **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE : **0.24665**

Table 2.3

CONTROLLED PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM-10 per hour IN INLET (lb)	PM-10 per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM-10 ESCAPED INLET (lb)	PM-10 OUT OUTLET (lb)	TOTAL PM-10 RELEASED (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM-10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	PM-10 per 1000 lbs Solid Raw Material (lb)	PM-10 per 1000 lbs ``FINES'' (lb)
GENERAL																			
SILO FILLING																			
RUN 7	14.608	0.00450	30.2	100	0.00000	0.00227	0.00227			37,775		0	0.00006						
RUN 1 EST.							1.48084			40,299		0	0.03675						
RUN 3 EST.							2.76330			34,268		0	0.08064						
RUN 5 EST.							5.20815			0		30,096	0.17305						
RUN 8 EST.							2.71997			31,722		0	0.08574						
RUN 18 EST.							6.12144			0		39,276	0.15586						
AVG.													**0.08868**						
STD. DEV.													**0.06672**						

Table 3.1

PM EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM per hour IN INLET (lb)	TIME (min)	PM IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE (lb)	SILT FROM AGGR. ** (lb)	PM per 1000 lb Solid Raw Material (lb)	PM per 1000 lb ``FINES'' (lb)
TRUCK MIX LOADING																	
RUN 2	5.358	30.2	2.697	72	3.746	41.5	0.09026	16,950	0.22098	12,250	0.12828	59,950	1,343.94	130,020	320.69	0.01709	0.12136
RUN 4	4.112	30.0	2.056	79	2.603	54.0	0.04820	27,840	0.09348	0	0.09348	73,600	1,649.94	173,150	427.07	0.00948	0.08699
RUN 9	3.583	30.1	1.797	78	2.304	69.0	0.03340	39,110	0.05892	0	0.05892	104,910	2,351.84	218,940	540.02	0.00635	0.05487
! RUN 14	144.524	22.1	53.233	56	95.059	41.0	2.31851	19,180	4.95615	10,220	3.23330	54,120	1,213.24	127,300	313.99	0.45090	3.07363
RUN 15	40.027	30.0	20.014	64	31.271	59.5	0.52556	32,650	0.95777	3,100	0.87472	80,240	1,798.79	187,330	462.05	0.10310	0.82269
RUN 16	15.351	30.0	7.676	58	13.234	41.5	0.31888	22,010	0.60125	0	0.60125	57,510	1,289.24	133,660	329.67	0.06208	0.56006
AVG.				**70**			**0.20326**		0.38648		**0.35133**					0.03962	0.32919
STD. DEV.				**9**			**0.21384**		0.38504		**0.36679**					0.04200	0.34422
CENTRAL MIX LOADING																	
RUN 10	2.154	30.1	1.081	90	1.198	45.0	0.02662	16,280	0.07359	13,900	0.03969	68,130	1,527.32	143,470	353.87	0.00495	0.03737
RUN 11	6.320	30.2	3.181	84	3.787	49.8	0.07604	22,340	0.16952	8,870	0.12134	70,770	1,586.50	158,600	391.19	0.01453	0.11411
RUN 12	14.119	30.2	7.107	99	7.178	45.0	0.15952	22,130	0.32437	9,300	0.22839	59,080	1,324.44	141,640	349.36	0.03092	0.21684
RUN 13	4.600	29.9	2.292	99	2.315	44.0	0.05262	19,240	0.12035	8,770	0.08267	66,750	1,496.38	138,830	342.42	0.00991	0.07757
RUN 17	8.274	27.2	3.751	99	3.789	72.0	0.05262	30,950	0.12242	13,900	0.08448	104,850	2,350.49	228,760	564.24	0.01001	0.07932
AVG.				**94**			**0.07349**		0.16205		**0.11131**					0.01407	0.10504
STD. DEV.				**7**			**0.05117**		0.09688		**0.07155**					0.01001	0.06815

* AVG. % SILT CONTENT OF SAND : **2.2418**

** AVG. % SILT CONTENT OF AGGREGATE : **0.2467**

! Test Run 14 is not used to calculate the means or standard deviations because it is a statistical outlier (see Appendix A).

Table 3.2

PM EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM per hour IN INLET (lb)	TIME (min)	PM IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE (lb)	SILT FROM AGGR. ** (lb)	PM per 1000 lb Solid Raw Material (lb)	PM per 1000 lb ``FINES'' (lb)
TRUCK MIX LOADING & CEMENT SILO FILLING																	
RUN 1	10.020	56.8	9.486	71	13.369	95.0	0.14073	48,620	0.27498	11,240	0.22334	135,290	3,032.89	281,640	694.67	0.02804	0.21025
RUN 3	19.456	30.0	9.728	70	13.897	50.0	0.27794	27,880	0.49846	0	0.49846	67,530	1,513.87	157,500	388.47	0.05495	0.46662
RUN 8	31.730	27.8	14.702	72	20.419	27.0	0.75625	14,170	1.44099	0	1.44099	36,030	807.71	86,430	213.18	0.14945	1.34415
AVG.				**71**			**0.39164**		**0.73814**		**0.72093**					**0.07748**	**0.67368**
STD. DEV.				**1**			**0.32313**		**0.61886**		**0.63858**					**0.06376**	**0.59463**
CEMENT SILO FILLING																	
RUN 7	18.004	30.2	9.062	100	9.062			37,775	0.23990								
RUN 1 EST.					--			40,299	--								
RUN 3 EST.					--			34,268	--								
RUN 8 EST.					15.418			31,722	0.48604								
AVG.									**0.36297**								
STD. DEV.									**0.17405**								
TRUCK MIX LOADING & NEWCEM SILO FILLING																	
RUN 5	72.339	30.1	36.290	79	45.937	51.0	0.90072	11,340	4.05086	0	4.05086	26,550	595.19	158,280	390.40	0.23417	3.72695
RUN 18	91.223	29.9	45.459	65	69.938	5.0	13.98753	1,800	38.85424	2,380	16.73149	7,260	162.75	16,570	40.87	2.49688	15.95430
AVG.				**72**			**7.44412**		**21.45255**		**10.39118**					**1.36552**	**9.84062**
STD. DEV.				**10**			**9.25377**		**24.60970**		**8.96656**					**1.59998**	**8.64605**
NEWCEM SILO FILLING																	
RUN 5 EST.					41.879					30,096	1.39152						
RUN 18 EST.					68.495					39,276	1.74394						
AVG.											**1.56773**						
STD. DEV.											**0.24920**						

* AVG. % SILT CONTENT OF SAND : **2.2418**

** AVG. % SILT CONTENT OF AGGREGATE : **0.2467**

Table 3.3

PM EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM per hour IN INLET (lb)	TIME (min)	PM IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE (lb)	SILT FROM AGGR. ** (lb)	PM per 1000 lb Solid Raw Material (lb)	PM per 1000 lb ``FINES'' (lb)
GENERAL																	
SILO FILLING																	
RUN 7	18.004	30.2	9.062	100	9.062			37,775		0	0.23990						
RUN 1 EST.					--			40,299		0	--						
RUN 3 EST.					--			34,268		0	--						
RUN 5 EST.					41.879			0		30,096	1.39152						
RUN 8 EST.					15.418			31,722		0	0.48604						
RUN 18 EST.					68.495			0		39,276	1.74394						
AVG.											**0.96535**						
STD. DEV.											**0.71737**						

Table 4.1

CONTROLLED PM EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

		PM per hour IN INLET (lb)	PM per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM ESCAPED INLET (lb)	PM OUT OUTLET (lb)	TOTAL PM RELEASED (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	PM per 1000 lb Solid Raw Material (lb)	PM per 1000 lb ``FINES'' (lb)
TRUCK MIX LOADING																					
RUN 2		5.358	0.00850	30.2	72	1.04878	0.00428	1.05306	41.5	0.02537	16,950	0.06213	12,250	0.03606	59,950	1,343.94	130,020	320.69	0.00480	0.03412
RUN 4		4.112	0.00850	30.0	79	0.54653	0.00425	0.55078	54.0	0.01020	27,840	0.01978	0	0.01978	73,600	1,649.94	173,150	427.07	0.00201	0.01841
RUN 9		3.583	0.00850	30.1	78	0.50698	0.00426	0.51124	69.0	0.00741	39,110	0.01307	0	0.01307	104,910	2,351.84	218,940	540.02	0.00141	0.01217
!	RUN 14	144.524	0.00850	22.1	56	41.82593	0.00313	41.82906	41.0	1.02022	19,180	2.18087	10,220	1.42276	54,120	1,213.24	127,300	313.99	0.19841	1.35250
RUN 15		40.027	0.00850	30.0	64	11.25759	0.00425	11.26184	59.5	0.18927	32,650	0.34493	3,100	0.31502	80,240	1,798.79	187,330	462.05	0.03713	0.29628
RUN 16		15.351	0.00850	30.0	58	5.55812	0.00425	5.56237	41.5	0.13403	22,010	0.25272	0	0.25272	57,510	1,289.24	133,660	329.67	0.02609	0.23541
AVG.					**70**					**0.07326**		0.13853		**0.12733**					0.01429	0.11928
STD. DEV.					**9**					**0.08330**		0.15109		**0.14483**					0.01634	0.13575
CENTRAL MIX LOADING																					
RUN 10		2.154	0.00850	30.1	90	0.11740	0.00426	0.12167	45.0	0.00270	16,280	0.00747	13,900	0.00403	68,130	1,527.32	143,470	353.87	0.00050	0.00379
RUN 11		6.320	0.00850	30.2	84	0.60592	0.00428	0.61020	49.8	0.01225	22,340	0.02731	8,870	0.01955	70,770	1,586.50	158,600	391.19	0.00234	0.01839
RUN 12		14.119	0.00850	30.2	99	0.07178	0.00428	0.07606	45.0	0.00169	22,130	0.00344	9,300	0.00242	59,080	1,324.44	141,640	349.36	0.00033	0.00230
RUN 13		4.600	0.00850	29.9	99	0.02315	0.00424	0.02739	44.0	0.00062	19,240	0.00142	8,770	0.00098	66,750	1,496.38	138,830	342.42	0.00012	0.00092
RUN 17		8.274	0.00850	27.2	99	0.03789	0.00385	0.04174	72.0	0.00058	30,950	0.00135	13,900	0.00093	104,850	2,350.49	228,760	564.24	0.00011	0.00087
AVG.					**94**					**0.00357**		0.00820		**0.00558**					0.00068	0.00525
STD. DEV.					**7**					**0.00493**		0.01097		**0.00791**					0.00094	0.00744

* AVG. % SILT CONTENT OF SAND : **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE : **0.24665**

! Test Run 14 is not used to calculate the means or standard deviations because it is a statistical outlier (see Appendix A).

Table 4.2

CONTROLLED PM EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	PM per hour IN INLET (lb)	PM per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM ESCAPED INLET (lb)	PM OUT OUTLET (lb)	TOTAL PM RELEASED (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	PM per 1000 lb Solid Raw Material (lb)	PM per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING & CEMENT SILO FILLING																			
RUN 1	10.020	0.00850	56.8	71	3.88382	0.00805	3.89186	95.0	0.04097	48,620	0.08005	11,240	0.06502	135,290	3,032.89	281,640	694.67	0.00816	0.06120
RUN 3	19.456	0.00850	30.0	70	4.16914	0.00425	4.17339	50.0	0.08347	27,880	0.14969	0	0.14969	67,530	1,513.87	157,500	388.47	0.01650	0.14013
RUN 8	31.730	0.00850	27.8	72	5.71728	0.00394	5.72121	27.0	0.21190	14,170	0.40376	0	0.40376	36,030	807.71	86,430	213.18	0.04187	0.37662
AVG.				**71**					0.11211		0.21116		0.20615					0.02218	0.19265
STD. DEV.				**1**					0.08899		0.17039		0.17629					0.01756	0.16414
CEMENT SILO FILLING																			
RUN 7	18.004	0.00850	30.2	100	--	0.00428	0.00428			37,775	0.00011								
RUN 1 EST.							--			40,299	--								
RUN 3 EST.							--			34,268	--								
RUN 8 EST.							3.90929			31,722	0.12324								
AVG.											**0.06167**								
STD. DEV.											**0.07544**								
TRUCK MIX LOADING & NEWCEM SILO FILLING																			
RUN 5	72.339	0.00850	30.1	79	9.64673	0.00426	9.65099	51.0	0.18924	11,340	0.85106	0	0.85106	26,550	595.19	158,280	390.40	0.04920	0.78300
RUN 18	91.223	0.00850	29.9	65	24.47817	0.00424	24.48241	5.0	4.89648	1,800	13.60134	2,380	5.85704	7,260	162.75	16,570	40.87	0.87406	5.58497
AVG.				**72**					2.54286		7.22620		3.35405					0.46163	3.18399
STD. DEV.				**10**					3.32853		9.01581		3.53976					0.58327	3.39550
NEWCEM SILO FILLING																			
RUN 5 EST.							8.18083					30,096	0.27182						
RUN 18 EST.							23.95954					39,276	0.61004						
AVG.													**0.44093**						
STD. DEV.													**0.23915**						

* AVG. % SILT CONTENT OF SAND : **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE : **0.24665**

Table 4.3

CONTROLLED PM EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT
WALDORF, MD

	PM per hour IN INLET (lb)	PM per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM ESCAPED INLET (lb)	PM OUT OUTLET (lb)	TOTAL PM RELEASED (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	PM10 per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. ** (lb)	PM per 1000 lb Solid Raw Material (lb)	PM per 1000 lb ``FINES'' (lb)
GENERAL																			
SILO FILLING																			
RUN 7	18.004	0.00850	30.2	100	--	0.00428	0.00428			37,775		0	0.00011						
RUN 1 EST.							--			40,299		0	--						
RUN 3 EST.							--			34,268		0	--						
RUN 5 EST.							8.18083			0		30,096	0.27182						
RUN 8 EST.							3.90929			31,722		0	0.12324						
RUN 18 EST.							23.95954			0		39,276	0.61004						
AVG.													**0.25130**						
STD. DEV.													**0.26370**						

Table 5.1

METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT
WALDORF, MD

	METAL per hour IN INLET (lb)	TIME (min)	METAL IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. ** (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
RUNS 2, 4, 9, 14, 15 & 16 TRUCK MIX LOADING																	
ARSENIC	1.71E-005	172.4	4.91E-005	68	7.23E-005	306.5	**2.36E-007**	157,740	4.58E-007	25,570	**3.94E-007**	430,330	9,646.99	970,400	2393.49	4.56E-008	3.70E-007
BERYLLIUM	1.56E-006	172.4	4.48E-006	68	6.59E-006	306.5	**2.15E-008**	157,740	4.18E-008	25,570	**3.60E-008**	430,330	9,646.99	970,400	2393.49	4.16E-009	3.37E-008
CADMIUM	8.62E-007	172.4	2.48E-006	68	3.64E-006	306.5	**1.19E-008**	157,740	2.31E-008	25,570	**1.99E-008**	430,330	9,646.99	970,400	2393.49	2.30E-009	1.86E-008
CHROMIUM	3.05E-004	172.4	8.76E-004	68	1.29E-003	306.5	**4.20E-006**	157,740	8.17E-006	25,570	**7.03E-006**	430,330	9,646.99	970,400	2393.49	8.14E-007	6.60E-006
LEAD	2.39E-005	172.4	6.87E-005	68	1.01E-004	306.5	**3.29E-007**	157,740	6.40E-007	25,570	**5.51E-007**	430,330	9,646.99	970,400	2393.49	6.38E-008	5.17E-007
MANGANESE	2.00E-003	172.4	5.75E-003	68	8.45E-003	306.5	**2.76E-005**	157,740	5.36E-005	25,570	**4.61E-005**	430,330	9,646.99	970,400	2393.49	5.34E-006	4.33E-005
MERCURY	--	172.4	--	68	--	306.5	--	157,740	--	25,570	--	430,330	9,646.99	970,400	2393.49		--
NICKEL	2.38E-004	172.4	6.84E-004	68	1.01E-003	306.5	**3.28E-006**	157,740	6.38E-006	25,570	**5.49E-006**	430,330	9,646.99	970,400	2393.49	6.35E-007	5.15E-006
PHOSPHORUS	8.35E-004	172.4	2.40E-003	68	3.53E-003	306.5	**1.15E-005**	157,740	2.24E-005	25,570	**1.92E-005**	430,330	9,646.99	970,400	2393.49	2.23E-006	1.81E-005
SELENIUM	--	172.4	--	68	--	306.5	--	157,740	--	25,570	--	430,330	9,646.99	970,400	2393.49		--
RUNS 10, 11, 12, 13 & 17 CENTRAL MIX LOADING																	
ARSENIC	7.37E-006	147.6	1.81E-005	94	1.93E-005	255.8	**7.54E-008**	110,940	1.74E-007	54,740	**1.16E-007**	369,580	8,285.12	811,300	2001.07	1.43E-008	1.10E-007
BERYLLIUM	--	147.6	--	94	--	255.8	--	110,940	--	54,740	--	369,580	8,285.12	811,300	2001.07		--
CADMIUM	3.75E-007	147.6	9.23E-007	94	9.81E-007	255.8	**3.84E-009**	110,940	8.85E-009	54,740	**5.92E-009**	369,580	8,285.12	811,300	2001.07	7.29E-010	5.58E-009
CHROMIUM	4.50E-005	147.6	1.11E-004	94	1.18E-004	255.8	**4.60E-007**	110,940	1.06E-006	54,740	**7.11E-007**	369,580	8,285.12	811,300	2001.07	8.75E-008	6.69E-007
LEAD	1.21E-005	147.6	2.98E-005	94	3.17E-005	255.8	**1.24E-007**	110,940	2.85E-007	54,740	**1.91E-007**	369,580	8,285.12	811,300	2001.07	2.35E-008	1.80E-007
MANGANESE	1.94E-003	147.6	4.77E-003	94	5.08E-003	255.8	**1.98E-005**	110,940	4.58E-005	54,740	**3.06E-005**	369,580	8,285.12	811,300	2001.07	3.77E-006	2.89E-005
MERCURY	--	147.6	--	94	--	255.8	--	110,940	--	54,740	--	369,580	8,285.12	811,300	2001.07		--
NICKEL	1.04E-004	147.6	2.56E-004	94	2.72E-004	255.8	**1.06E-006**	110,940	2.45E-006	54,740	**1.64E-006**	369,580	8,285.12	811,300	2001.07	2.02E-007	1.55E-006
PHOSPHORUS	6.37E-004	147.6	1.57E-003	94	1.67E-003	255.8	**6.52E-006**	110,940	1.50E-005	54,740	**1.01E-005**	369,580	8,285.12	811,300	2001.07	1.24E-006	9.47E-006
SELENIUM	--	147.6	--	94	--	255.8	--	110,940	--	54,740	--	369,580	8,285.12	811,300	2001.07		--

* AVG. % SILT CONTENT OF SAND : **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE : **0.24665**

Table 5.2

METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT
WALDORF, MD

	METAL per hour IN INLET (lb)	TIME (min)	METAL IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. (lb)	METAL per 1000 lb Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
RUN 7 CEMENT SILO FILLING																	
ARSENIC	6.29E-005	30.2	3.17E-005	100	3.17E-005			37,775	**8.38E-007**								
BERYLLIUM	6.73E-007	30.2	3.39E-007	100	3.39E-007			37,775	**8.97E-009**								
CADMIUM	8.75E-006	30.2	4.40E-006	100	4.40E-006			37,775	**1.17E-007**								
CHROMIUM	9.42E-006	30.2	4.74E-006	100	4.74E-006			37,775	**1.26E-007**								
LEAD	2.76E-005	30.2	1.39E-005	100	1.39E-005			37,775	**3.68E-007**								
MANGANESE	7.61E-003	30.2	3.83E-003	100	3.83E-003			37,775	**1.01E-004**								
MERCURY	--	30.2	--	100	--			37,775	--								
NICKEL	6.63E-004	30.2	3.34E-004	100	3.34E-004			37,775	**8.83E-006**								
PHOSPHORUS	4.41E-003	30.2	2.22E-003	100	2.22E-003			37,775	**5.88E-005**								
SELENIUM	--	30.2	--	100	--			37,775	--								

Table 5.3

METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT
WALDORF, MD

	METAL per hour IN INLET (lb)	TIME (min)	METAL IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
RUN 5 TRUCK MIX LOADING & NEWCEM SILO FILLING																	
ARSENIC	1.46E-005	30.1	7.32E-006	79	9.27E-006	51.0	1.82E-007	11,340	**8.18E-007**	0	**8.18E-007**	26,550	595.19	158,280	390.40	4.73E-008	**7.52E-007**
BERYLLIUM	--	30.1	--	79	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40		--
CADMIUM	--	30.1	--	79	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40		--
CHROMIUM	3.91E-005	30.1	1.96E-005	79	2.48E-005	51.0	4.87E-007	11,340	**2.19E-006**	0	**2.19E-006**	26,550	595.19	158,280	390.40	1.27E-007	**2.01E-006**
LEAD	--	30.1	--	79	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40		--
MANGANESE	7.67E-002	30.1	3.85E-002	79	4.87E-002	51.0	9.55E-004	11,340	**4.30E-003**	0	**4.30E-003**	26,550	595.19	158,280	390.40	2.48E-004	**3.95E-003**
MERCURY	--	30.1	--	79	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40		--
NICKEL	1.30E-004	30.1	6.52E-005	79	8.26E-005	51.0	1.62E-006	11,340	**7.28E-006**	0	**7.28E-006**	26,550	595.19	158,280	390.40	4.21E-007	**6.70E-006**
PHOSPHORUS	--	30.1	--	79	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40		--
SELENIUM	--	30.1	--	79	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40		--

RUN 5 ESTIMATED NEWCEM SILO FILLING			
ARSENIC	4.71E-006	30,096	**1.57E-007**
BERYLLIUM	--	30,096	--
CADMIUM	--	30,096	--
CHROMIUM	--	30,096	--
LEAD	--	30,096	--
MANGANESE	4.82E-002	30,096	**1.60E-003**
MERCURY	--	30,096	--
NICKEL	1.91E-005	30,096	**6.35E-007**
PHOSPHORUS	--	30,096	--
SELENIUM	--	30,096	--

* AVG. % SILT CONTENT OF SAND : 2.24177

** AVG. % SILT CONTENT OF AGGREGATE 0.24665

Table 5.4

METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT
WALDORF, MD

	METAL per hour IN INLET (lb)	TIME (min)	METAL IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
RUN 18 TRUCK MIX LOADING & NEWCEM SILO FILLING																	
ARSENIC	8.31E-006	29.9	4.14E-006	65	6.37E-006	5.0	**1.27E-006**	1,800	**3.54E-006**	2,380	**1.52E-006**	7,260	162.75	16,570	40.87	2.27E-007	**1.45E-006**
BERYLLIUM	1.33E-006	29.9	6.63E-007	65	1.02E-006	5.0	**2.04E-007**	1,800	**5.66E-007**	2,380	**2.44E-007**	7,260	162.75	16,570	40.87	3.64E-008	**2.33E-007**
CADMIUM	--	29.9	--	65	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87		--
CHROMIUM	--	29.9	--	65	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87		--
LEAD	--	29.9	--	65	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87		--
MANGANESE	3.48E-002	29.9	1.73E-002	65	2.67E-002	5.0	**5.34E-003**	1,800	**1.48E-002**	2,380	**6.38E-003**	7,260	162.75	16,570	40.87	9.53E-004	**6.09E-003**
MERCURY	--	29.9	--	65	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87		--
NICKEL	1.14E-004	29.9	5.68E-005	65	8.74E-005	5.0	**1.75E-005**	1,800	**4.86E-005**	2,380	**2.09E-005**	7,260	162.75	16,570	40.87	3.12E-006	**1.99E-005**
PHOSPHORUS	--	29.9	--	65	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87		--
SELENIUM	--	29.9	--	65	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87		--

RUN 18 ESTIMATED NEWCEM SILO FILLING					
ARSENIC	4.75E-006	39,276	**1.21E-007**		
BERYLLIUM	8.72E-007	39,276	**2.22E-008**		
CADMIUM	--	39,276	--		
CHROMIUM	--	39,276	--		
LEAD	--	39,276	--		
MANGANESE	2.65E-002	39,276	**6.74E-004**		
MERCURY	--	39,276	--		
NICKEL	6.48E-005	39,276	**1.65E-006**		
PHOSPHORUS	--	39,276	--		
SELENIUM	--	39,276	--		

* AVG. % SILT CONTENT OF SAND : 2.24177

** AVG. % SILT CONTENT OF AGGREGATE 0.24665

Table 5.5 METAL EMISSION FACTORS FOR CONCRETE BATCHING
CHANEY ENTERPRISES CEMENT PLANT, WALDORF, MD

	AVG. METAL per 1000 lb CEMENT & NEWCEM (lb)	STD. DEVIATION (lb)
AVG. RUN 5 & 18		
ESTIMATED NEWCEM SILO FILLING		
ARSENIC	**1.39E-07**	2.52E-08
BERYLLIUM	**2.22E-08**	--
CADMIUM	--	--
CHROMIUM	--	--
LEAD	--	--
MANGANESE	**1.14E-03**	6.55E-04
MERCURY	--	--
NICKEL	**1.14E-06**	7.18E-07
PHOSPHORUS	--	--
SELENIUM	--	--
AVG. RUN 5, 7, 18		
ESTIMATED GENERAL SILO FILLING		
ARSENIC	**3.72E-07**	4.04E-07
BERYLLIUM	**1.56E-08**	9.35E-09
CADMIUM	**1.17E-07**	--
CHROMIUM	**1.26E-07**	--
LEAD	**3.68E-07**	--
MANGANESE	**7.92E-04**	7.57E-04
MERCURY	--	--
NICKEL	**3.71E-06**	4.47E-06
PHOSPHORUS	**5.88E-05**	--
SELENIUM	--	--

Table 6.1

CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	METAL per hour IN INLET (lb)	METAL per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	METAL ESCAPED INLET (lb)	METAL OUT OUTLET (lb)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per yard ^{3} CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES'' (lb)
RUNS 2, 4, 9, 14 15 & 16 TRUCK MIX LOADING																			
ARSENIC	1.71E-005	1.59E-007	172.4	68	2.31E-005	4.57E-007	2.36E-005	306.5	**7.69E-008**	157,740	1.49E-007	25,570	**1.29E-007**	430,330	9,646.99	970,400	2,393.49	1.49E-008	1.21E-007
BERYLLIUM	1.56E-006	--	172.4	68	2.11E-006	--	2.11E-006	306.5	**6.88E-009**	157,740	1.34E-008	25,570	**1.15E-008**	430,330	9,646.99	970,400	2,393.49	1.33E-009	1.08E-008
CADMIUM	8.62E-007	--	172.4	68	1.17E-006	--	1.17E-006	306.5	**3.80E-009**	157,740	7.39E-009	25,570	**6.36E-009**	430,330	9,646.99	970,400	2,393.49	7.36E-010	5.97E-009
CHROMIUM	3.05E-004	1.40E-006	172.4	68	4.12E-004	4.02E-006	4.16E-004	306.5	**1.36E-006**	157,740	2.64E-006	25,570	**2.27E-006**	430,330	9,646.99	970,400	2,393.49	2.63E-007	2.13E-006
LEAD	2.39E-005	4.62E-007	172.4	68	3.23E-005	1.33E-006	3.36E-005	306.5	**1.10E-007**	157,740	2.13E-007	25,570	**1.84E-007**	430,330	9,646.99	970,400	2,393.49	2.12E-008	1.72E-007
MANGANESE	2.00E-003	3.72E-006	172.4	68	2.70E-003	1.07E-005	2.72E-003	306.5	**8.86E-006**	157,740	1.72E-005	25,570	**1.48E-005**	430,330	9,646.99	970,400	2,393.49	1.71E-006	1.39E-005
MERCURY	--	--	172.4	68	--	--	--	306.5	--	157,740	--	25,570	--	430,330	9,646.99	970,400	2,393.49	--	--
NICKEL	2.38E-004	1.69E-006	172.4	68	3.22E-004	4.85E-006	3.27E-004	306.5	**1.07E-006**	157,740	2.07E-006	25,570	**1.78E-006**	430,330	9,646.99	970,400	2,393.49	2.06E-007	1.67E-006
PHOSPHORUS	8.35E-004	--	172.4	68	1.13E-003	--	1.13E-003	306.5	**3.68E-006**	157,740	7.16E-006	25,570	**6.16E-006**	430,330	9,646.99	970,400	2,393.49	7.13E-007	5.78E-006
SELENIUM	--	--	172.4	68	--	--	--	306.5	--	157,740	--	25,570	--	430,330	9,646.99	970,400	2,393.49		--
RUNS 10, 11, 12 13 & 17 CENTRAL MIX LOADING																			
ARSENIC	7.37E-006	1.59E-007	147.6	94	1.16E-006	3.91E-007	1.55E-006	255.8	**6.05E-009**	110,940	1.40E-008	54,740	**9.35E-009**	369,580	8,285.12	811,300	2,001.07	1.15E-009	8.80E-009
BERYLLIUM	--	--	147.6	94	--	--	--	255.8	--	110,940	--	54,740	--	369,580	8,285.12	811,300	2,001.07	--	--
CADMIUM	3.75E-007	--	147.6	94	5.89E-008	--	5.89E-008	255.8	**2.30E-010**	110,940	5.31E-010	54,740	**3.55E-010**	369,580	8,285.12	811,300	2,001.07	4.37E-011	3.35E-010
CHROMIUM	4.50E-005	1.40E-006	147.6	94	7.07E-006	3.44E-006	1.05E-005	255.8	**4.11E-008**	110,940	9.47E-008	54,740	**6.34E-008**	369,580	8,285.12	811,300	2,001.07	7.81E-009	5.97E-008
LEAD	1.21E-005	4.62E-007	147.6	94	1.90E-006	1.14E-006	3.04E-006	255.8	**1.19E-008**	110,940	2.74E-008	54,740	**1.83E-008**	369,580	8,285.12	811,300	2,001.07	2.25E-009	1.73E-008
MANGANESE	1.94E-003	3.72E-006	147.6	94	3.05E-004	9.15E-006	3.14E-004	255.8	**1.23E-006**	110,940	2.83E-006	54,740	**1.89E-006**	369,580	8,285.12	811,300	2,001.07	2.33E-007	1.78E-006
MERCURY	--	--	147.6	94	--	--	--	255.8	--	110,940	--	54,740	--	369,580	8,285.12	811,300	2,001.07	--	--
NICKEL	1.04E-004	1.69E-006	147.6	94	1.63E-005	4.15E-006	2.05E-005	255.8	**8.01E-008**	110,940	1.85E-007	54,740	**1.24E-007**	369,580	8,285.12	811,300	2,001.07	1.52E-008	1.16E-007
PHOSPHORUS	6.37E-004	--	147.6	94	1.00E-004	--	1.00E-004	255.8	**3.91E-007**	110,940	9.02E-007	54,740	**6.04E-007**	369,580	8,285.12	811,300	2,001.07	7.43E-008	5.68E-007
SELENIUM	--	--	147.6	94	--	--	--	255.8	--	110,940	--	54,740	--	369,580	8,285.12	811,300	2,001.07	--	--

* AVG. % SILT CONTENT OF SAND : **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE **0.24665**

Table 6.2

CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	METAL per hour IN INLET (lb)	METAL per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	METAL ESCAPED INLET (lb)	METAL OUT OUTLET (lb)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES'' (lb)
RUN 7 CEMENT SILO FILLING																			
ARSENIC	6.29E-005	1.59E-007	30.2	100	--	8.00E-008	8.00E-008			37,775	**2.12E-009**								
BERYLLIUM	6.73E-007	--	30.2	100	--	--	--			37,775	--								
CADMIUM	8.75E-006	--	30.2	100	--	--	--			37,775	--								
CHROMIUM	9.42E-006	1.40E-006	30.2	100	--	7.05E-007	7.05E-007			37,775	**1.87E-008**								
LEAD	2.76E-005	4.62E-007	30.2	100	--	2.33E-007	2.33E-007			37,775	**6.16E-009**								
MANGANESE	7.61E-003	3.72E-006	30.2	100	--	1.87E-006	1.87E-006			37,775	**4.96E-008**								
MERCURY	--	--	30.2	100	--	--	--			37,775	--								
NICKEL	6.63E-004	1.69E-006	30.2	100	--	8.50E-007	8.50E-007			37,775	**2.25E-008**								
PHOSPHORUS	4.41E-003	--	30.2	100	--	--	--			37,775	--								
SELENIUM	--	--	30.2	100	--	--	--			37,775	--								

Table 6.3

CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	METAL per hour IN INLET (lb)	METAL per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	METAL ESCAPED INLET (lb)	METAL OUT OUTLET (lb)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES'' (lb)
RUN 5 TRUCK MIX LOADING & NEWCEM SILO FILLING																			
ARSENIC	1.46E-005	1.59E-007	30.1	79	1.95E-006	7.98E-008	2.03E-006	51.0	**3.97E-008**	11,340	**1.79E-007**	0	**1.79E-007**	26,550	595.19	158,280	390.40	**1.03E-008**	**1.64E-007**
BERYLLIUM	--	--	30.1	79	--	--	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40	--	--
CADMIUM	--	--	30.1	79	--	--	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40	--	--
CHROMIUM	3.91E-005	1.40E-006	30.1	79	5.21E-006	7.02E-007	5.92E-006	51.0	**1.16E-007**	11,340	**5.22E-007**	0	**5.22E-007**	26,550	595.19	158,280	390.40	**3.02E-008**	**4.80E-007**
LEAD	--	4.62E-007	30.1	79	--	2.32E-007	2.32E-007	51.0	**4.54E-009**	11,340	**2.04E-008**	0	**2.04E-008**	26,550	595.19	158,280	390.40	**1.18E-009**	**1.88E-008**
MANGANESE	7.67E-002	3.72E-006	30.1	79	1.02E-002	1.87E-006	1.02E-002	51.0	**2.01E-004**	11,340	**9.02E-004**	0	**9.02E-004**	26,550	595.19	158,280	390.40	**5.21E-005**	**8.30E-004**
MERCURY	--	--	30.1	79	--	--	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40	--	--
NICKEL	1.30E-004	1.69E-006	30.1	79	1.73E-005	8.47E-007	1.82E-005	51.0	**3.57E-007**	11,340	**1.60E-006**	0	**1.60E-006**	26,550	595.19	158,280	390.40	**9.27E-008**	**1.48E-006**
PHOSPHORUS	--	--	30.1	79	--	--	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40	--	--
SELENIUM	--	--	30.1	79	--	--	--	51.0	--	11,340	--	0	--	26,550	595.19	158,280	390.40	--	--

RUN 5 ESTIMATED NEWCEM SILO FILLING			
ARSENIC	5.39E-007	30,096	**1.79E-008**
BERYLLIUM	--	30,096	--
CADMIUM	--	30,096	--
CHROMIUM	--	30,096	--
LEAD	--	30,096	--
MANGANESE	1.01E-002	30,096	**3.34E-004**
MERCURY	--	30,096	--
NICKEL	--	30,096	--
PHOSPHORUS	--	30,096	--
SELENIUM	--	30,096	--

* AVG. % SILT CONTENT OF SAND : **2.24177**

** AVG. % SILT CONTENT OF AGGREGATE 0.24665

Table 6.4

CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CHANEY ENTERPRISES CEMENT PLANT

WALDORF, MD

	METAL per hour IN INLET (lb)	METAL per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	METAL ESCAPED INLET (lb)	METAL OUT OUTLET (lb)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	NEWCEM LOADED (lb)	METAL per 1000 lb CEMENT & NEWCEM (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES'' (lb)
RUN 18 TRUCK MIX LOADING & NEWCEM SILO FILLING																			
ARSENIC	8.31E-006	1.59E-007	29.9	65	2.23E-006	7.92E-008	2.31E-006	5.0	4.62E-007	1,800	1.28E-006	2,380	5.52E-007	7,260	162.75	16,570	40.87	8.24E-008	5.27E-007
BERYLLIUM	1.33E-006	--	29.9	65	3.57E-007	--	3.57E-007	5.0	7.14E-008	1,800	1.98E-007	2,380	8.54E-008	7,260	162.75	16,570	40.87	1.27E-008	8.14E-008
CADMIUM	--	--	29.9	65	--	--	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87	--	--
CHROMIUM	--	1.40E-006	29.9	65	--	6.98E-007	6.98E-007	5.0	1.40E-007	1,800	3.88E-007	2,380	1.67E-007	7,260	162.75	16,570	40.87	2.49E-008	1.59E-007
LEAD	--	4.62E-007	29.9	65	--	2.30E-007	2.30E-007	5.0	4.60E-008	1,800	1.28E-007	2,380	5.51E-008	7,260	162.75	16,570	40.87	8.22E-009	5.25E-008
MANGANESE	3.48E-002	3.72E-006	29.9	65	9.34E-003	1.85E-006	9.34E-003	5.0	1.87E-003	1,800	5.19E-003	2,380	2.23E-003	7,260	162.75	16,570	40.87	3.33E-004	2.13E-003
MERCURY	--	--	29.9	65	--	--	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87	--	--
NICKEL	1.14E-004	1.69E-006	29.9	65	3.06E-005	8.41E-007	3.14E-005	5.0	6.29E-006	1,800	1.75E-005	2,380	7.52E-006	7,260	162.75	16,570	40.87	1.12E-006	7.17E-006
PHOSPHORUS	--	--	29.9	65	--	--	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87	--	--
SELENIUM	--	--	29.9	65	--	--	--	5.0	--	1,800	--	2,380	--	7,260	162.75	16,570	40.87	--	--

RUN 18 ESTIMATED NEWCEM SILO FILLING			
ARSENIC	1.78E-006	39,276	**4.53E-008**
BERYLLIUM	3.10E-007	39,276	**7.88E-009**
CADMIUM	--	39,276	--
CHROMIUM	--	39,276	--
LEAD	--	39,276	--
MANGANESE	9.28E-003	39,276	**2.36E-004**
MERCURY	--	39,276	--
NICKEL	2.41E-005	39,276	**6.14E-007**
PHOSPHORUS	--	39,276	--
SELENIUM	--	39,276	--

* AVG. % SILT CONTENT OF SAND : 2.24177

** AVG. % SILT CONTENT OF AGGREGATE 0.24665

Table 6.5 CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING
CHANEY ENTERPRISES CEMENT PLANT, WALDORF, MD

	AVG. METAL per 1000 lbs CEMENT & NEWCEM (lbs)	STD. DEVIATION (lbs)
AVG. RUN 5 & 18		
ESTIMATED NEWCEM SILO FILLING		
ARSENIC	**3.16E-08**	1.94E-08
BERYLLIUM	**7.88E-009**	--
CADMIUM	--	--
CHROMIUM	--	--
LEAD	--	--
MANGANESE	**2.85E-04**	6.93E-05
MERCURY	--	--
NICKEL	**6.14E-07**	0.00E+00
PHOSPHORUS	--	--
SELENIUM	--	--
AVG. RUN 5, 7, 18		
ESTIMATED GENERAL SILO FILLING		
ARSENIC	**2.18E-008**	
BERYLLIUM	**3.94E-009**	
CADMIUM	--	--
CHROMIUM	**1.87E-008**	--
LEAD	**6.16E-009**	--
MANGANESE	**1.90E-004**	
MERCURY	--	--
NICKEL	**2.12E-007**	
PHOSPHORUS	--	--
SELENIUM	--	--

4.2 Reference 2

This report (Reference 2) presents the results of emission testing on a typical concrete batching operation performed at Concrete Ready Mixed Corporation in Roanoke, VA. This test report includes measurements of the amounts of PM, PM_{10}, and ten select metals that were released during truck mix loadings and silo fillings. In addition, tests were conducted on process material samples and road surface samples.

Several kinds of test and test methods were used:

- EPA Reference Test Method 201A was used to collect emission released during the truck loadings and the silo fillings. In addition to recovering and weighing collected PM_{10}, larger particulate (greater than ten micrometers) collected in the probe and the cyclone was also recovered and weighed.
- Ambient air monitors were set up at upwind and downwind locations to measure background concentrations of suspended particulate matter resulting form both the traversal of paved and unpaved roads in and around the plant and the release of fugitive emissions from concrete batching operations.
- Sieve and moisture analyses were conducted on the process materials (aggregates) and the road materials.
- Laboratory tests were conducted on the emissions collected during the tests as well as the material collected for the sieve analyses to determine the amount of each of the ten metals that were contained in these materials.

Emissions resulting from the truck mix loadings were controlled with a hood system located above the truck delivery chute. This hood was connected to a central dust collector (Griffin Environmental Model JA-360DA). In order to develop both controlled and uncontrolled emission factors, tests were conducted at both the inlet and outlet of the dust collector. Also, visual estimates of the capture efficiency of the control device were made during each of the truck loadings. This information made it possible to estimate the amount of emissions that were not captured during the tests.

Emissions due to the pneumatic loading of silos were controlled with dust collectors located on the top of each of the silos. The dust collectors used fabric filters to clean air being displaced during the loading of cement or fly ash. Since emission tests were only conducted at the outlet of the dust collectors, no uncontrolled silo filling emission factors were developed.

Most of the emission data that were used to develop emission factors for truck mix loading warrants an A rating. However, the methodology used to estimate the capture efficiencies of the control device is qualitative rather than quantitative. This issue is significant since the uncontrolled and controlled emission factors from truck loading depend significantly on the capture efficiency estimates. Due to the subjective nature of the capture efficiency estimates, the emission data set for the truck loading emission factors is rated B.

The emission data set used to develop the controlled PM and controlled PM_{10} emission factors for cement and cement supplement silo filling is **rated A**, since it is sound and does not involve the subjective control efficiency estimations.

The emission data for the controlled metal emission factors for cement and cement supplement silo filling are generally of the same caliber as the controlled PM and controlled PM_{10} emission factors

for cement and cement supplement silo filling. However, only one emission rate was obtained for each of the ten metal types. Consequently, this emission data set is **rated B**.

The following tables present the data that were used to develop the emission factors for Reference 2. The layouts of the table make the method used to develop these emission factors largely self-evident (see the technical notes in Appendix B for more information).

Note that “fines” stands for cement, cement supplement, and the silt from sand and course aggregate.

Reference 2
Emission Factor Tables

Tables	Emission Factor Types
7	PM_{10} Emission Factors
8	Controlled PM_{10} Emission Factors
9	PM Emission Factors
10	Controlled PM Emission Factors
11	Controlled Cement Silo Filling Emission Factors
12	Controlled Fly Ash Silo Filling Emission Factors
13.1 - 13.3	Metal Emission Factors
14.1 - 14.3	Controlled Metal Emission Factors

Table 7

PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	PM-10 per hour IN INLET (lb)	TIME (min)	PM-10 IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM-10 RELEASED (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	PM-10 per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGRE-GATE (lb)	PM-10 per 1000 lb RAW MATERIAL (lb)	PM-10 per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING																	
RUN 1	0.878	120	1.756	83	2.11566	60.5	0.03497	28,786	0.07350	4,932	0.06275	87,240	1,764.87	97,920	89.11	0.00967	0.05948
RUN 2	1.440	120	2.880	85	3.38824	71.5	0.04739	32,424	0.10450	8,124	0.08356	97,457	1,971.56	99,930	90.94	0.01424	0.07952
RUN 3	1.146	119	2.273	84	2.70583	70.5	0.03838	29,574	0.09149	7,644	0.07270	95,720	1,936.42	113,100	102.92	0.01100	0.06893
RUN 4	0.628	120	1.256	83	1.51325	61.5	0.02461	27,598	0.05483	6,248	0.04471	77,418	1,566.17	69,412	63.16	0.00838	0.04266
RUN 5	0.604	120	1.208	84	1.43810	47.5	0.03028	17,742	0.08106	5,922	0.06077	61,680	1,247.79	75,270	68.50	0.00895	0.05757
RUN 6	1.275	120	2.550	54	4.72222	44.5	0.10612	13,572	0.34794	7,890	0.22003	52,440	1,060.86	45,990	41.85	0.03939	0.20927
RUN 7	1.002	120	2.004	72	2.78333	100.2	0.02778	53,790	0.05174	4,200	0.04800	143790	2,908.87	167,940	152.83	0.00753	0.04559
RUN 8	0.052	120	0.104	56	0.18571	84.5	0.00220	46,116	0.00403	6,474	0.00353	67800	1,371.59	145,680	132.57	0.00070	0.00343
RUN 9	0.050	122	0.102	61	0.16667	67.25	0.00248	30,618	0.00544	6,600	0.00448	90750	1,835.87	123,930	112.78	0.00066	0.00426
RUN 10	0.050	120	0.100	80	0.12500	50.0	0.00250	28,554	0.00438	4,554	0.00378	53,460	1,081.50	57,690	52.50	0.00087	0.00365
AVG.				**74**			**0.03167**		0.08189		**0.06043**					0.01014	0.05743
STD. DEV.				**13**			**0.03070**		0.10056		**0.06337**					0.01130	0.06025

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE : **0.0910**

Table 8

CONTROLLED PM-10 EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	PM-10 per hour IN INLET (lb)	PM-10 per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM-10 ESCAPED INLET (lb)	PM-10 OUT OUTLET (lb)	TOTAL PM-10 RELEASED (lb)	CONCRETE MADE (yd^3)	PM-10 per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	PM-10 per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	SILT FROM SAND * (lb)	COURSE AGGRE-GATE LOADED (lb)	SILT FROM AGGR. ** (lb)	PM-10 per 1000 lb Raw Material (lb)	PM-10 per 1000 lb ``FINES'' (lb)
TRUCK MIX LOADING																			
RUN 1	0.878	0.07947	120	83	0.360	0.15893	0.51859	60.5	0.00857	28,786	0.01802	4,932	0.01538	87,240	1,764.87	97,920	89.11	0.00237	0.01458
RUN 2	1.440	0.08302	120	85	0.508	0.16603	0.67427	71.5	0.00943	32,424	0.02080	8,124	0.01663	97,457	1,971.56	99,930	90.94	0.00283	0.01582
RUN 3	1.146	0.03952	119	84	0.433	0.07838	0.51131	70.5	0.00725	29,574	0.01729	7,644	0.01374	95,720	1,936.42	113,100	102.92	0.00208	0.01302
RUN 4	0.628	0.02351	120	83	0.257	0.04703	0.30428	61.5	0.00495	27,598	0.01103	6,248	0.00899	77,418	1,566.17	69,412	63.16	0.00168	0.00858
RUN 5	0.604	0.02289	120	84	0.230	0.04577	0.27587	47.5	0.00581	17,742	0.01555	5,922	0.01166	61,680	1,247.79	75,270	68.50	0.00172	0.01104
RUN 6	1.275	0.02331	120	54	2.172	0.04662	2.21884	44.5	0.04986	13,572	0.16349	7,890	0.10338	52,440	1,060.86	45,990	41.85	0.01851	0.09833
RUN 7	1.002	0.02902	120	72	0.779	0.05805	0.83738	100.2	0.00836	53,790	0.01557	4,200	0.01444	143790	2,908.87	167,940	152.83	0.00226	0.01372
RUN 8	0.052	0.03163	120	56	0.082	0.06327	0.14498	84.5	0.00172	46,116	0.00314	6,474	0.00276	67800	1,371.59	145,680	132.57	0.00054	0.00268
RUN 9	0.050	0.03175	122	61	0.065	0.06455	0.12955	67.25	0.00193	30,618	0.00423	6,600	0.00348	90750	1,835.87	123,930	112.78	0.00051	0.00331
RUN 10	0.050	0.03115	120	80	0.025	0.06231	0.08731	50.0	0.00175	28,554	0.00306	4,554	0.00264	53,460	1,081.50	57,690	52.50	0.00061	0.00255
AVG.				**74**					**0.00996**		0.02722		**0.01931**					0.00331	0.01836
STD. DEV.				**13**					**0.01432**		0.04833		**0.03003**					0.00540	0.02855

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE : **0.0910**

Table 9

PM EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	PM per hour IN INLET (lb)	TIME (min)	PM IN INLET (lb)	ESTIMATED CAPTURE EFFICIENCY (%)	TOTAL PM RELEASED (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	PM per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGRE-GATE (lb)	PM per 1000 lb Raw Material (lb)	PM per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING																	
RUN 1	3.500	120	7.000	83	8.43373	60.5	0.13940	28,786	0.29298	4,932	0.25013	87,240	1,764.87	97,920	89.11	0.03853	0.23709
RUN 2	7.079	120	14.158	85	16.65647	71.5	0.23296	32,424	0.51371	8,124	0.41078	97,457	1,971.56	99,930	90.94	0.07000	0.39090
RUN 3	5.124	119	10.163	84	12.09833	70.5	0.17161	29,574	0.40909	7,644	0.32507	95,720	1,936.42	113,100	102.92	0.04917	0.30818
RUN 4	3.322	120	6.644	83	8.00482	61.5	0.13016	27,598	0.29005	6,248	0.23651	77,418	1,566.17	69,412	63.16	0.04430	0.22564
RUN 5	2.468	120	4.936	84	5.87619	47.5	0.12371	17,742	0.33120	5,922	0.24832	61,680	1,247.79	75,270	68.50	0.03659	0.23523
RUN 6	6.163	120	12.326	54	22.82593	44.5	0.51294	13,572	1.68184	7,890	1.06355	52,440	1,060.86	45,990	41.85	0.19039	1.01158
RUN 7	1.029	120	2.058	72	2.85833	100.2	0.02853	53,790	0.05314	4,200	0.04929	143,790	2,908.87	167,940	152.83	0.00773	0.04682
RUN 8	0.063	120	0.126	56	0.22500	84.5	0.00266	46,116	0.00488	6,474	0.00428	67,800	1,371.59	145,680	132.57	0.00085	0.00416
RUN 9	0.101	122	0.205	61	0.33667	67.25	0.00501	30,618	0.01100	6,600	0.00905	90,750	1,835.87	123,930	112.78	0.00134	0.00860
RUN 10	0.099	120	0.198	80	0.24750	50.0	0.00495	28,554	0.00867	4,554	0.00748	53,460	1,081.50	57,690	52.50	0.00172	0.00723
AVG.				**74**			**0.13519**		0.35965		**0.26044**					0.04406	0.24754
STD. DEV.				**13**			**0.15514**		0.49989		**0.31798**					0.05677	0.30241

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE **0.0910**

Table 10

CONTROLLED PM EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	PM per hour IN INLET (lb)	PM per hour OUT OUTLET (lb)	TIME (min)	ESTIMATED CAPTURE EFFICIENCY (%)	PM ESCAPED INLET (lbs)	PM OUT OUTLET (lb)	TOTAL PM RELEASED (lb)	CONCRETE MADE (yd^3)	PM per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	PM per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	PM per 1000 lb Raw Material (lb)	PM per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING																			
RUN 1	3.500	0.11321	120	83	1.434	0.22642	1.66016	60.5	0.02744	28,786	0.05767	4,932	0.04924	87,240	1,764.87	97,920	89.11	0.00758	0.04667
RUN 2	7.079	0.11827	120	85	2.498	0.23654	2.73501	71.5	0.03825	32,424	0.08435	8,124	0.06745	97,457	1,971.56	99,930	90.94	0.01149	0.06419
RUN 3	5.124	0.05200	119	84	1.936	0.10313	2.03886	70.5	0.02892	29,574	0.06894	7,644	0.05478	95,720	1,936.42	113,100	102.92	0.00829	0.05194
RUN 4	3.322	0.03755	120	83	1.361	0.07511	1.43593	61.5	0.02335	27,598	0.05203	6,248	0.04243	77,418	1,566.17	69,412	63.16	0.00795	0.04048
RUN 5	2.468	0.03655	120	84	0.940	0.07310	1.01329	47.5	0.02133	17,742	0.05711	5,922	0.04282	61,680	1,247.79	75,270	68.50	0.00631	0.04056
RUN 6	6.163	0.03722	120	54	10.500	0.07445	10.57437	44.5	0.23763	13,572	0.77913	7,890	0.49270	52,440	1,060.86	45,990	41.85	0.08820	0.46862
RUN 7	1.029	0.04160	120	72	0.800	0.08320	0.88353	100.2	0.00882	53,790	0.01643	4,200	0.01524	143,790	2,908.87	167,940	152.83	0.00239	0.01447
RUN 8	0.063	0.04534	120	56	0.099	0.09068	0.18968	84.5	0.00224	46,116	0.00411	6,474	0.00361	67,800	1,371.59	145,680	132.57	0.00071	0.00351
RUN 9	0.101	0.04550	122	61	0.131	0.09252	0.22382	67.25	0.00333	30,618	0.00731	6,600	0.00601	90,750	1,835.87	123,930	112.78	0.00089	0.00571
RUN 10	0.099	0.04465	120	80	0.050	0.08930	0.13880	50.0	0.00278	28,554	0.00486	4,554	0.00419	53,460	1,081.50	57,690	52.50	0.00096	0.00405
AVG.				**74**					**0.03941**		0.11319		**0.07785**					0.01348	0.07402
STD. DEV.				**13**					**0.07078**		0.23581		**0.14760**					0.02652	0.14038

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE : **0.0910**

Table 11

CONTROLLED CEMENT SILO FILLING EMISSION FACTORS
CONCRETE READY MIXED CORPORATION
ROANOKE, VA

PM-10

	PM-10 per hour OUT OUTLET (lb)	TIME (min)	PM-10 OUT OUTLET (lb)	CEMENT LOADED (lb)	PM-10 per 1000 lb CEMENT (lb)
CEMENT SILO FILLING					
RUN 1	0.016	123	0.033	147,920	2.22E-004
RUN 2	0.016	125	0.033	97,660	3.41E-004
RUN 3	0.013	185	0.040	146,310	2.74E-004
AVG.					**2.79E-004**
STD. DEV.					**5.99E-005**

PM

	PM per hour OUT OUTLET (lb)	TIME (min)	PM OUT OUTLET (lb)	CEMENT LOADED (lb)	PM per 1000 lb CEMENT (lb)
CEMENT SILO FILLING					
RUN 1	0.023	123	0.047	147,920	3.19E-004
RUN 2	0.021	125	0.044	97,660	4.48E-004
RUN 3	0.016	185	0.049	146,310	3.37E-004
AVG.					**3.68E-004**
STD. DEV.					**6.99E-005**

METALS

	METAL per hour OUT OUTLET (lb)	TIME (min)	METAL OUT OUTLET (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)
RUNS 1, 2 & 3 CEMENT SILO FILLING					
ARSENIC	--	433	--	391,890	--
BERYLLIUM	1.32E-008	433	9.53E-008	391,890	**2.43E-010**
CADMIUM	--	433	--	391,890	--
CHROMIUM	5.53E-007	433	3.99E-006	391,890	**1.02E-008**
LEAD	2.58E-007	433	1.86E-006	391,890	**4.75E-009**
MANGANESE	3.68E-006	433	2.66E-005	391,890	**6.78E-008**
MERCURY	--	433	--	391,890	--
NICKEL	1.05E-006	433	7.58E-006	391,890	**1.93E-008**
PHOSPHORUS	--	433	--	391,890	--
SELENIUM	--	433	--	391,890	--

Table 12

CONTROLLED EMISSION FACTORS FOR FLY ASH SILO FILLING
CONCRETE READY MIXED CORPORATION
ROANOKE, VA

PM-10

	PM-10 per hour OUT OUTLET (lb)	TIME (min)	PM-10 OUT OUTLET (lb)	FLY ASH LOADED (lb)	PM-10 per 1000 lb FLY ASH (lb)
FLY ASH SILO FILLING					
RUN 1	0.204	62	0.211	50,820	4.15E-003
RUN 2	0.078	60	0.078	50,820	1.53E-003
RUN 3	0.081	61	0.082	50,820	1.62E-003
AVG.					**2.43E-003**
STD. DEV.					**1.48E-003**

PM

	PM per hour OUT OUTLET (lb)	TIME (min)	PM OUT OUTLET (lb)	FLY ASH LOADED (lb)	PM per 1000 lb FLY ASH (lb)
FLY ASH SILO FILLING					
RUN 1	0.221	62	0.228	50,820	4.49E-003
RUN 2	0.887	60	0.887	50,820	1.75E-002
RUN 3	0.091	61	0.093	50,820	1.82E-003
AVG.					**7.92E-003**
STD. DEV.					**8.36E-003**

METALS

	METAL per hour OUT OUTLET (lb)	TIME (min)	METAL OUT OUTLET (lb)	FLY ASH LOADED (lb)	METAL per 1000 lb FLY ASH (lb)
RUNS 1, 2 & 3 FLY ASH SILO FILLING					
ARSENIC	2.51E-005	183	7.66E-005	152,460	**5.02E-007**
BERYLLIUM	2.26E-006	183	6.89E-006	152,460	**4.52E-008**
CADMIUM	4.96E-007	183	1.51E-006	152,460	**9.92E-009**
CHROMIUM	3.05E-005	183	9.30E-005	152,460	**6.10E-007**
LEAD	1.30E-005	183	3.97E-005	152,460	**2.60E-007**
MANGANESE	6.40E-006	183	1.95E-005	152,460	**1.28E-007**
MERCURY	--	183	--	152,460	--
NICKEL	5.70E-005	183	1.74E-004	152,460	**1.14E-006**
PHOSPHORUS	8.85E-005	183	2.70E-004	152,460	**1.77E-006**
SELENIUM	1.81E-006	183	5.52E-006	152,460	**3.62E-008**

Table 13.1

METAL EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	METAL per hour IN INLET (lb)	TIME (min)	METAL IN INLET (lb)	EST. CAPTURE EFFI-CIENCY (%)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	METAL per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
PRELIMINARY RUN TRUCK MIX LOADING																	
ARSENIC	1.96E-005	120.1	3.92E-005	53	7.40E-005	24	**3.08E-006**	9,486	7.80E-006	2,694	**6.08E-006**	33,810	683.98	44,400	40.40	8.19E-007	5.74E-006
BERYLLIUM	2.12E-006	120.1	4.24E-006	53	8.01E-006	24	**3.34E-007**	9,486	8.44E-007	2,694	**6.57E-007**	33,810	683.98	44,400	40.40	8.86E-008	6.20E-007
CADMIUM	--	120.1	--	53	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40		--
CHROMIUM	3.92E-005	120.1	7.85E-005	53	1.48E-004	24	**6.17E-006**	9,486	1.56E-005	2,694	**1.22E-005**	33,810	683.98	44,400	40.40	1.64E-006	1.15E-005
LEAD	2.74E-005	120.1	5.48E-005	53	1.03E-004	24	**4.31E-006**	9,486	1.09E-005	2,694	**8.50E-006**	33,810	683.98	44,400	40.40	1.14E-006	8.02E-006
MANGANESE	1.16E-004	120.1	2.32E-004	53	4.38E-004	24	**1.83E-005**	9,486	4.62E-005	2,694	**3.60E-005**	33,810	683.98	44,400	40.40	4.85E-006	3.39E-005
MERCURY	--	120.1	--	53	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40		--
NICKEL	5.71E-005	120.1	1.14E-004	53	2.16E-004	24	**8.99E-006**	9,486	2.27E-005	2,694	**1.77E-005**	33,810	683.98	44,400	40.40	2.39E-006	1.67E-005
PHOSPHORUS	--	120.1	--	53	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40		--
SELENIUM	--	120.1	--	53	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40		--
RUNS 1, 2 & 3 TRUCK MIX LOADING																	
ARSENIC	2.70E-005	359	1.62E-004	84	1.92E-004	202.5	**9.50E-007**	90,784	2.12E-006	20,700	**1.73E-006**	280,417	5,672.84	310,950	282.96	2.74E-007	1.64E-006
BERYLLIUM	6.58E-007	359	3.94E-006	84	4.69E-006	202.5	**2.31E-008**	90,784	5.16E-008	20,700	**4.20E-008**	280,417	5,672.84	310,950	282.96	6.67E-009	3.99E-008
CADMIUM	4.93E-007	359	2.95E-006	84	3.51E-006	202.5	**1.73E-008**	90,784	3.87E-008	20,700	**3.15E-008**	280,417	5,672.84	310,950	282.96	5.00E-009	2.99E-008
CHROMIUM	3.45E-005	359	2.06E-004	84	2.46E-004	202.5	**1.21E-006**	90,784	2.71E-006	20,700	**2.20E-006**	280,417	5,672.84	310,950	282.96	3.50E-007	2.09E-006
LEAD	2.04E-005	359	1.22E-004	84	1.45E-004	202.5	**7.18E-007**	90,784	1.60E-006	20,700	**1.30E-006**	280,417	5,672.84	310,950	282.96	2.07E-007	1.24E-006
MANGANESE	2.13E-004	359	1.27E-003	84	1.52E-003	202.5	**7.49E-006**	90,784	1.67E-005	20,700	**1.36E-005**	280,417	5,672.84	310,950	282.96	2.16E-006	1.29E-005
MERCURY	--	359	--	84	--	202.5	--	90,784	--	20,700	--	280,417	5,672.84	310,950	282.96		--
NICKEL	5.48E-005	359	3.28E-004	84	3.90E-004	202.5	**1.93E-006**	90,784	4.30E-006	20,700	**3.50E-006**	280,417	5,672.84	310,950	282.96	5.55E-007	3.32E-006
PHOSPHORUS	--	359	--	84	--	202.5	--	90,784	--	20,700	--	280,417	5,672.84	310,950	282.96		--
SELENIUM	1.64E-006	359	9.81E-006	84	1.17E-005	202.5	**5.77E-008**	90,784	1.29E-007	20,700	**1.05E-007**	280,417	5,672.84	310,950	282.96	1.66E-008	9.95E-008

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE **0.0910**

Table 13.2

METAL EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	METAL per hour IN INLET (lb)	TIME (min)	METAL IN INLET (lb)	EST. CAPTURE EFFI-CIENCY (%)	TOTAL METAL (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	METAL per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES'' (lb)
RUNS 4, 5 & 6 TRUCK MIX LOADING																	
ARSENIC	2.53E-005	360	1.52E-004	74	2.06E-004	153.5	**1.34E-006**	58,912	3.50E-006	20,060	**2.61E-006**	191,538	3,874.81	190,672	173.51	4.47E-007	2.48E-006
BERYLLIUM	1.21E-006	360	7.26E-006	74	9.86E-006	153.5	**6.42E-008**	58,912	1.67E-007	20,060	**1.25E-007**	191,538	3,874.81	190,672	173.51	2.14E-008	1.19E-007
CADMIUM	1.05E-007	360	6.30E-007	74	8.55E-007	153.5	**5.57E-009**	58,912	1.45E-008	20,060	**1.08E-008**	191,538	3,874.81	190,672	173.51	1.85E-009	1.03E-008
CHROMIUM	2.37E-005	360	1.42E-004	74	1.93E-004	153.5	**1.26E-006**	58,912	3.28E-006	20,060	**2.44E-006**	191,538	3,874.81	190,672	173.51	4.19E-007	2.33E-006
LEAD	2.00E-005	360	1.20E-004	74	1.63E-004	153.5	**1.06E-006**	58,912	2.77E-006	20,060	**2.06E-006**	191,538	3,874.81	190,672	173.51	3.53E-007	1.96E-006
MANGANESE	6.79E-005	360	4.07E-004	74	5.53E-004	153.5	**3.60E-006**	58,912	9.39E-006	20,060	**7.00E-006**	191,538	3,874.81	190,672	173.51	1.20E-006	6.66E-006
MERCURY	--	360	--	74	--	153.5	--	58,912	--	20,060	--	191,538	3,874.81	190,672	173.51		--
NICKEL	4.05E-005	360	2.43E-004	74	3.30E-004	153.5	**2.15E-006**	58,912	5.60E-006	20,060	**4.18E-006**	191,538	3,874.81	190,672	173.51	7.15E-007	3.97E-006
PHOSPHORUS	--	360	--	74	--	153.5	--	58,912	--	20,060	--	191,538	3,874.81	190,672	173.51		--
SELENIUM	3.68E-005	360	2.21E-004	74	3.00E-004	153.5	**1.95E-006**	58,912	5.09E-006	20,060	**3.80E-006**	191,538	3,874.81	190,672	173.51	6.50E-007	3.61E-006
RUNS 7, 8, 9 & 10 TRUCK MIX LOADING																	
ARSENIC	1.17E-005	120	2.34E-005	67	3.48E-005	301.95	**1.15E-007**	159,078	2.19E-007	21,828	**1.92E-007**	355,800	7,197.83	495,240	450.67	3.37E-008	1.85E-007
BERYLLIUM	3.15E-007	120	6.30E-007	67	9.37E-007	301.95	**3.10E-009**	159,078	5.89E-009	21,828	**5.18E-009**	355,800	7,197.83	495,240	450.67	9.08E-010	4.97E-009
CADMIUM	3.94E-008	122	8.01E-008	67	1.19E-007	301.95	**3.95E-010**	159,078	7.49E-010	21,828	**6.59E-010**	355,800	7,197.83	495,240	450.67	1.15E-010	6.32E-010
CHROMIUM	4.49E-005	120	8.98E-005	67	1.34E-004	301.95	**4.42E-007**	159,078	8.39E-007	21,828	**7.38E-007**	355,800	7,197.83	495,240	450.67	1.29E-007	7.08E-007
LEAD	2.56E-005	120	5.12E-005	67	7.61E-005	301.95	**2.52E-007**	159,078	4.79E-007	21,828	**4.21E-007**	355,800	7,197.83	495,240	450.67	7.38E-008	4.04E-007
MANGANESE	1.97E-004	120	3.94E-004	67	5.86E-004	301.95	**1.94E-006**	159,078	3.68E-006	21,828	**3.24E-006**	355,800	7,197.83	495,240	450.67	5.68E-007	3.11E-006
MERCURY	--	120	--	67	--	301.95	--	159,078	--	21,828	--	355,800	7,197.83	495,240	450.67		--
NICKEL	3.31E-005	120	6.62E-005	67	9.84E-005	301.95	**3.26E-007**	159,078	6.19E-007	21,828	**5.44E-007**	355,800	7,197.83	495,240	450.67	9.54E-008	5.22E-007
PHOSPHORUS	--	120	--	67	--	301.95	--	159,078	--	21,828	--	355,800	7,197.83	495,240	450.67		--
SELENIUM	1.58E-006	120	3.16E-006	67	4.70E-006	301.95	**1.56E-008**	159,078	2.95E-008	21,828	**2.60E-008**	355,800	7,197.83	495,240	450.67	4.55E-009	2.49E-008

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE **0.0910**

Table 13.3

AVERAGE OF METAL EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	AVG. METAL per yard³ CONCRETE (lb)	STD. DEV. METAL per yard³ CONCRETE (lb)	AVG. METAL per 1000 lb CEMENT (lb)	STD. DEV. METAL per 1000 lb CEMENT (lb)	AVG. METAL per 1000 lb CEMENT & FLY ASH (lb)	STD. DEV. METAL per 1000 lb CEMENT & FLY ASH (lb)		AVG. METAL per 1000 lb Solid Raw Material (lb)	STD. DEV. METAL per 1000 lb Solid Raw Material (lb)	AVG. METAL per 1000 lb ``FINES'' (lb)	STD. DEV. METAL per 1000 lb ``FINES'' (lb)
TRUCK MIX LOADING											
ARSENIC	**1.37E-006**	**1.25E-006**	3.41E-006	3.22E-006	**2.65E-006**	2.49E-006		3.93E-007	3.30E-007	2.51E-006	2.35E-006
BERYLLIUM	**1.06E-007**	**1.54E-007**	2.67E-007	3.91E-007	**2.07E-007**	3.04E-007		2.94E-008	4.04E-008	1.96E-007	2.87E-007
CADMIUM	**7.77E-009**	**8.68E-009**	1.80E-008	1.92E-008	**1.43E-008**	1.57E-008		2.32E-009	2.47E-009	1.36E-008	1.49E-008
CHROMIUM	**2.27E-006**	**2.63E-006**	5.61E-006	6.75E-006	**4.39E-006**	5.23E-006		6.34E-007	6.81E-007	4.15E-006	4.93E-006
LEAD	**1.59E-006**	**1.85E-006**	3.94E-006	4.74E-006	**3.07E-006**	3.68E-006		4.45E-007	4.81E-007	2.91E-006	3.47E-006
MANGANESE	**7.82E-006**	**7.33E-006**	1.90E-005	1.89E-005	**1.50E-005**	1.47E-005		2.19E-006	1.89E-006	1.42E-005	1.38E-005
MERCURY	--	--	--	--	--	--		--	--	--	--
NICKEL	**3.35E-006**	**3.85E-006**	8.31E-006	9.84E-006	**6.48E-006**	7.65E-006		9.38E-007	1.00E-006	6.13E-006	7.21E-006
PHOSPHORUS	--	--	--	--	--	--		--	--	--	--
SELENIUM	**6.75E-007**	**1.11E-006**	1.75E-006	2.89E-006	**1.31E-006**	2.15E-006		2.24E-007	3.69E-007	1.24E-006	2.05E-006

Table 14.1

CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	METAL per hour IN INLET (lb)	METAL per hour OUT OUTLET (lb)	TIME (min)	EST. CAPTURE EFFI-CIENCY (%)	METAL ESCAPED INLET (lb)	METAL OUT OUTLET (lb)	TOTAL METAL RELEASED (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	METAL per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
PRELIMINARY RUN TRUCK MIX LOADING																			
ARSENIC	1.96E-005	6.62E-007	120.1	53	3.48E-005	1.32E-006	3.61E-005	24	**1.50E-006**	9,486	3.81E-006	2,694	**2.97E-006**	33,810	683.98	44,400	40.40	4.00E-007	2.80E-006
BERYLLIUM	2.12E-006	4.40E-008	120.1	53	3.76E-006	8.81E-008	3.85E-006	24	**1.60E-007**	9,486	4.06E-007	2,694	**3.16E-007**	33,810	683.98	44,400	40.40	4.26E-008	2.98E-007
CADMIUM	--	--	120.1	53	--	--	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40	--	--
CHROMIUM	3.92E-005	1.10E-006	120.1	53	6.96E-005	2.21E-006	7.18E-005	24	**2.99E-006**	9,486	7.57E-006	2,694	**5.89E-006**	33,810	683.98	44,400	40.40	7.94E-007	5.56E-006
LEAD	2.74E-005	1.71E-006	120.1	53	4.86E-005	3.42E-006	5.21E-005	24	**2.17E-006**	9,486	5.49E-006	2,694	**4.27E-006**	33,810	683.98	44,400	40.40	5.76E-007	4.03E-006
MANGANESE	1.16E-004	6.94E-006	120.1	53	2.06E-004	1.39E-005	2.20E-004	24	**9.16E-006**	9,486	2.32E-005	2,694	**1.80E-005**	33,810	683.98	44,400	40.40	2.43E-006	1.70E-005
MERCURY	--	--	120.1	53	--	--	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40	--	--
NICKEL	5.71E-005	4.40E-006	120.1	53	1.01E-004	8.81E-006	1.10E-004	24	**4.59E-006**	9,486	1.16E-005	2,694	**9.04E-006**	33,810	683.98	44,400	40.40	1.22E-006	8.54E-006
PHOSPHORUS	--	--	120.1	53	--	--	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40	--	--
SELENIUM	--	--	120.1	53	--	--	--	24	--	9,486	--	2,694	--	33,810	683.98	44,400	40.40	--	--
RUNS 1, 2 & 3 TRUCK MIX LOADING																			
ARSENIC	2.81E-005	6.62E-007	359	84	3.20E-005	3.96E-006	3.60E-005	202.5	**1.78E-007**	90,784	3.96E-007	20,700	**3.23E-007**	280,417	5,672.84	310,950	282.96	5.12E-008	3.06E-007
BERYLLIUM	7.68E-007	4.40E-008	359	84	8.75E-007	2.63E-007	1.14E-006	202.5	**5.62E-009**	90,784	1.25E-008	20,700	**1.02E-008**	280,417	5,672.84	310,950	282.96	1.62E-009	9.69E-009
CADMIUM	4.93E-007	--	359	84	5.62E-007	--	5.62E-007	202.5	**2.77E-009**	90,784	6.19E-009	20,700	**5.04E-009**	280,417	5,672.84	310,950	282.96	7.99E-010	4.78E-009
CHROMIUM	3.45E-005	1.10E-006	359	84	3.93E-005	6.59E-006	4.59E-005	202.5	**2.27E-007**	90,784	5.06E-007	20,700	**4.12E-007**	280,417	5,672.84	310,950	282.96	6.53E-008	3.91E-007
LEAD	2.04E-005	1.71E-006	359	84	2.32E-005	1.02E-005	3.35E-005	202.5	**1.65E-007**	90,784	3.69E-007	20,700	**3.00E-007**	280,417	5,672.84	310,950	282.96	4.76E-008	2.85E-007
MANGANESE	2.13E-004	6.94E-006	359	84	2.43E-004	4.15E-005	2.84E-004	202.5	**1.40E-006**	90,784	3.13E-006	20,700	**2.55E-006**	280,417	5,672.84	310,950	282.96	4.04E-007	2.42E-006
MERCURY	--	--	359	84	--	--	--	202.5	--	90,784	--	20,700	--	280,417	5,672.84	310,950	282.96	--	--
NICKEL	6.58E-005	4.40E-006	359	84	7.50E-005	2.63E-005	1.01E-004	202.5	**5.00E-007**	90,784	1.12E-006	20,700	**9.09E-007**	280,417	5,672.84	310,950	282.96	1.44E-007	8.63E-007
PHOSPHORUS	--	--	359	84	--	--	--	202.5	--	90,784	--	20,700	--	280,417	5,672.84	310,950	282.96	--	--
SELENIUM	2.74E-006	--	359	84	3.12E-006	--	3.12E-006	202.5	**1.54E-008**	90,784	3.44E-008	20,700	**2.80E-008**	280,417	5,672.84	310,950	282.96	4.44E-009	2.66E-008

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE : **0.0910**

Table 14.2

CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	METAL per hour IN INLET (lb)	METAL per hour OUT OUTLET (lb)	TIME (min)	EST. CAPTURE EFFI-CIENCY (%)	METAL ESCAPED INLET (lb)	METAL OUT OUTLET (lb)	TOTAL METAL RELEASED (lb)	CONCRETE MADE (yd^3)	METAL per $yard^3$ CONCRETE (lb)	CEMENT LOADED (lb)	METAL per 1000 lb CEMENT (lb)	FLY ASH LOADED (lb)	METAL per 1000 lb CEMENT & FLY ASH (lb)	SAND LOADED (lb)	* SILT FROM SAND (lb)	COURSE AGGRE-GATE LOADED (lb)	** SILT FROM AGGR. (lb)	METAL per 1000 lb Solid Raw Material (lb)	METAL per 1000 lb ``FINES" (lb)
RUNS 4, 5 & 6 TRUCK MIX LOADING																			
ARSENIC	2.63E-005	6.62E-007	360	74	5.64E-005	3.97E-006	6.04E-005	153.5	**3.93E-007**	58,912	1.02E-006	20,060	**7.65E-007**	191,538	3,874.81	190,672	173.51	1.31E-007	7.27E-007
BERYLLIUM	1.32E-006	4.40E-008	360	74	2.83E-006	2.64E-007	3.10E-006	153.5	**2.02E-008**	58,912	5.25E-008	20,060	**3.92E-008**	191,538	3,874.81	190,672	173.51	6.71E-009	3.73E-008
CADMIUM	1.05E-007	--	360	74	2.25E-007	--	2.25E-007	153.5	**1.47E-009**	58,912	3.82E-009	20,060	**2.85E-009**	191,538	3,874.81	190,672	173.51	4.88E-010	2.71E-009
CHROMIUM	2.37E-005	1.10E-006	360	74	5.08E-005	6.61E-006	5.74E-005	153.5	**3.74E-007**	58,912	9.75E-007	20,060	**7.27E-007**	191,538	3,874.81	190,672	173.51	1.25E-007	6.92E-007
LEAD	2.00E-005	1.71E-006	360	74	4.29E-005	1.02E-005	5.31E-005	153.5	**3.46E-007**	58,912	9.02E-007	20,060	**6.73E-007**	191,538	3,874.81	190,672	173.51	1.15E-007	6.40E-007
MANGANESE	6.79E-005	6.94E-006	360	74	1.46E-004	4.16E-005	1.87E-004	153.5	**1.22E-006**	58,912	3.18E-006	20,060	**2.37E-006**	191,538	3,874.81	190,672	173.51	4.06E-007	2.26E-006
MERCURY	--	--	360	74	--	--	--	153.5	--	58,912	--	20,060	--	191,538	3,874.81	190,672	173.51	--	--
NICKEL	5.10E-005	4.40E-006	360	74	1.09E-004	2.64E-005	1.36E-004	153.5	**8.85E-007**	58,912	2.30E-006	20,060	**1.72E-006**	191,538	3,874.81	190,672	173.51	2.94E-007	1.64E-006
PHOSPHORUS	--	--	360	74	--	--	--	153.5	--	58,912	--	20,060	--	191,538	3,874.81	190,672	173.51	--	--
SELENIUM	4.73E-006	--	360	74	1.01E-005	--	1.01E-005	153.5	**6.61E-008**	58,912	1.72E-007	20,060	**1.28E-007**	191,538	3,874.81	190,672	173.51	2.20E-008	1.22E-007
RUNS 7, 8, 9 & 10 TRUCK MIX LOADING																			
ARSENIC	1.25E-005	6.62E-007	120	67	1.22E-005	1.32E-006	1.35E-005	301.95	**4.47E-008**	159,078	8.49E-008	21,828	**7.46E-008**	355,800	7,197.83	495,240	450.67	1.31E-008	7.16E-008
BERYLLIUM	3.94E-007	4.40E-008	120	67	3.84E-007	8.80E-008	4.72E-007	301.95	**1.56E-009**	159,078	2.97E-009	21,828	**2.61E-009**	355,800	7,197.83	495,240	450.67	4.57E-010	2.50E-009
CADMIUM	3.94E-008	--	122	67	3.90E-008	--	3.90E-008	301.95	**1.29E-010**	159,078	2.45E-010	21,828	**2.16E-010**	355,800	7,197.83	495,240	450.67	3.78E-011	2.07E-010
CHROMIUM	4.49E-005	1.10E-006	120	67	4.37E-005	2.20E-006	4.59E-005	301.95	**1.52E-007**	159,078	2.89E-007	21,828	**2.54E-007**	355,800	7,197.83	495,240	450.67	4.45E-008	2.44E-007
LEAD	2.56E-005	1.71E-006	120	67	2.49E-005	3.41E-006	2.83E-005	301.95	**9.39E-008**	159,078	1.78E-007	21,828	**1.57E-007**	355,800	7,197.83	495,240	450.67	2.75E-008	1.50E-007
MANGANESE	1.97E-004	6.94E-006	120	67	1.92E-004	1.39E-005	2.06E-004	301.95	**6.81E-007**	159,078	1.29E-006	21,828	**1.14E-006**	355,800	7,197.83	495,240	450.67	1.99E-007	1.09E-006
MERCURY	--	--	120	67	--	--	--	301.95	--	159,078	--	21,828	--	355,800	7,197.83	495,240	450.67	--	--
NICKEL	4.10E-005	4.40E-006	120	67	3.99E-005	8.80E-006	4.87E-005	301.95	**1.61E-007**	159,078	3.06E-007	21,828	**2.69E-007**	355,800	7,197.83	495,240	450.67	4.72E-008	2.58E-007
PHOSPHORUS	--	--	120	67	--	--	--	301.95	--	159,078	--	21,828	--	355,800	7,197.83	495,240	450.67	--	--
SELENIUM	2.37E-006	--	120	67	2.31E-006	--	2.31E-006	301.95	**7.64E-009**	159,078	1.45E-008	21,828	**1.28E-008**	355,800	7,197.83	495,240	450.67	2.24E-009	1.22E-008

* AVG. % SILT CONTENT OF SAND : **2.0230**

** AVG. % SILT CONTENT OF AGGREGATE : **0.0910**

Table 14.3

AVERAGE OF CONTROLLED METAL EMISSION FACTORS FOR CONCRETE BATCHING

CONCRETE READY MIXED CORPORATION

ROANOKE, VA

	AVG. METAL per yard³ CONCRETE (lb)	STD. DEV. METAL per yard³ CONCRETE (lb)	AVG. METAL per 1000 lb CEMENT (lb)	STD. DEV. METAL per 1000 lb CEMENT (lb)	AVG. METAL per 1000 lb CEMENT & FLY ASH (lb)	STD. DEV. METAL per 1000 lb CEMENT & FLY ASH (lb)	AVG. METAL per 1000 lb Solid Raw Material (lb)	STD. DEV. METAL per 1000 lb Solid Raw Material (lb)	AVG. METAL per 1000 lb ``FINES" (lb)	STD. DEV. METAL per 1000 lb ``FINES" (lb)
TRUCK MIX LOADING										
ARSENIC	**5.30E-007**	**6.65E-007**	1.33E-006	1.70E-006	**1.03E-006**	**1.32E-006**	1.49E-007	1.74E-007	9.76E-007	1.25E-006
BERYLLIUM	**4.70E-008**	**7.61E-008**	1.19E-007	1.93E-007	**9.21E-008**	**1.50E-007**	1.28E-008	2.00E-008	8.70E-008	1.42E-007
CADMIUM	**1.46E-009**	**1.32E-009**	3.42E-009	2.99E-009	**2.70E-009**	**2.42E-009**	3.31E-010	3.83E-010	2.57E-009	2.29E-009
CHROMIUM	**9.36E-007**	**1.37E-006**	2.33E-006	3.50E-006	**1.82E-006**	**2.72E-006**	2.57E-007	3.60E-007	1.72E-006	2.57E-006
LEAD	**6.94E-007**	**9.89E-007**	1.73E-006	2.52E-006	**1.35E-006**	**1.96E-006**	1.92E-007	2.59E-007	1.28E-006	1.85E-006
MANGANESE	**3.12E-006**	**4.04E-006**	7.69E-006	1.04E-005	**6.03E-006**	**8.04E-006**	8.60E-007	1.05E-006	5.70E-006	7.58E-006
MERCURY	**--**	**--**	--	--	--	--			--	--
NICKEL	**1.53E-006**	**2.06E-006**	3.84E-006	5.25E-006	**2.99E-006**	**4.08E-006**	4.26E-007	5.38E-007	2.82E-006	3.85E-006
PHOSPHORUS	**--**	**--**	--	--	--	--			--	--
SELENIUM	**2.97E-008**	**3.17E-008**	7.37E-008	8.59E-008	**5.64E-008**	**6.29E-008**	7.17E-009	1.01E-008	5.37E-008	5.98E-008

4.3 Reference 3

This test report (Reference 3) presents the results of emission testing on the pneumatic transfer of cement to a silo at Allied Concrete Supply, Chicago Illinois on October 17, 1972. The emissions resulting from the silo filling were controlled with two baghouses (Tiberi Engineering Company dust collectors) located on the top of the silo. Because of the low flow rates from the dust collectors, a temporary six inch diameter stack of four feet length was added to one of the collectors. As a result, the emission testing quantified only particulate emissions from one of the two dust collectors. Consequently, the actual amount of total controlled emissions was assumed to be twice the measured amount.

The test method used to collect the emissions appears to be similar to EPA's Test Method Number 5. Explicit isokinetic calculations are not present in the test report. However based upon the 3/8 inch nozzle diameter and 13.67 cubic foot sample volume present in the report, a 99% isokinetic sampling rate can be calculated. Also, while two test runs were performed, meter volumes, nozzle diameters, and filter weights for only one test run are available. The test contains no QA data on meter volumes, nozzle geometry, and size or pitot geometries. Lastly, no details are included in the test report on whether changes were made in the arrangement of the S type pitot and the nozzle because of the small duct diameter. As a consequence of the deficiencies, the test data set from this report is **rated C**.

The following presents results from the report and demonstrates how these results were used to develop a controlled particulate matter (PM) emission factor for cement silo filling.

- **Results from the emission testing:**

Exhaust Loading	0.0139 grains per ft3
Exhaust Rate	115.4 ft3 per min
Test Duration	30 minutes
Cement Loaded	44,340 lb

- Calculations for the PM emission factor for cement silo filling:

$$\text{Lb of PM in inlet per dust collector} = \left(0.0139 \frac{\text{grains}}{\text{ft}^3}\right)\left(115.4 \frac{\text{ft}^3}{\text{min}}\right)(30\text{min})\left(\frac{1\,\text{lb}}{7{,}000\,\text{grains}}\right)$$

= 0.00687 lb of PM

Total for both collectors = 2 x 0.00687 lb of PM
= 0.0137 lb of PM

$$\text{Lb of PM per 1,000 lb of cement loaded} = \left(\frac{0.0137\,\text{lb PM}}{44.34 \quad 1{,}000\ \text{lb cement loaded}}\right)$$

$$3.10 \times 10^{-4} \frac{\text{lb PM}}{1{,}000\,\text{lb cement loaded}}$$

4.4 Reference 4

The bulk of this test report (Reference 4) is classified as confidential and was not available for review. Apparently, this test report presents the results of emission testing on the uncontrolled and controlled pneumatic transfer of cement and Pozmix™ (a cement supplement) to a silo for an unknown company in Oklahoma City, Oklahoma in February of 1976. The emissions resulting from the silo filling were controlled with a baghouse (type unknown).

Only one page of information is available. This page includes process weights, permissible emissions, measured emissions, calculated baghouse control efficiencies and isokinetic variations for each of the twelve runs. This limited information is insufficient for determining whether the test method was in accordance with EPA standards. Consequently, the test data set from this report is **rated D**.

The following presents results from the report and demonstrates how these results were used to develop a controlled particulate matter (PM) emission factor for both cement silo filling and cement supplement silo filling.

- Results from the cement emission testing

Test 1 Cement Emission Rate	=	0.085 lb/hr	Baghouse efficiency	=	97.6%
Test 2 Cement Emission Rate	=	0.044 lb/hr	Baghouse efficiency	=	99.2%
Test 3 Cement Emission Rate	=	0.039 lb/hr	Baghouse efficiency	=	99.3%
Average	**=**	**0.056 lb/hr**			

- **Calculations for the PM emission factor for cement silo filling:**

Since the rate for all three transfers was 47,000 $\frac{\text{lb cement loaded}}{\text{hour}}$, the average emission factor was:

$$\text{Average Emission Factor} = \frac{0.056 \frac{\text{lb PM}}{\text{hour}}}{47 \frac{1000 \text{ lb cement loaded}}{\text{hour}}}$$

$$= 1.2 \text{ x } 10^{-3} \frac{\text{lb PM}}{1000 \text{ lb cement loaded}}$$

- **Results from the Pozmix™ emission testing:**

Test 1 Pozmix™ Emission Rate	=	0.1328 lb/hr	Baghouse efficiency	=	99.2%
Test 2 Pozmix™ Emission Rate	=	0.0940 lb/hr	Baghouse efficiency	=	98.5%
Test 3 Pozmix™Emission Rate	=	0.0541 lb/hr	Baghouse efficiency	=	99.0%
Average	**=**	**0.0936 lb/hr**			

- **Calculations for the PM emission factor for Pozmix™ silo filling:**

Since the rate for all three transfers was 92,500 $\frac{\text{lb cement loaded}}{\text{hour}}$, the average emission factor was:

$$\text{Average Emission Factor} = \frac{0.0936 \frac{\text{lb PM}}{\text{hour}}}{92.5 \frac{1000 \text{ lb cement loaded}}{\text{hour}}}$$

$$= 1.01 \text{x} 10^{-3} \frac{\text{lb PM}}{1000 \text{ lb cement loaded}}$$

4.5 Reference 5

This report (Reference 5) documents particulate emissions testing conducted by the State of Tennessee, Division of Air Pollution Control of a silo filling operation at Specialty Alloys Corporation in Gallaway, Tennessee. The silo filling operation was controlled by a water impingement scrubber made from a 55 gallon drum with a burlap cover. Emission testing was accomplished with a high volume air sampler held at a single point approximately two feet above the rim of the barrel. Two sets of emissions tests were conducted. The first series were three runs during a lowered loading rate while one layer of burlap covered the drum. Opacities averaged 30% and ranged from 5% to 80% during these test runs. The second series were two runs during a normal loading rate while two layers of burlap covered the drum. Opacities averaged less than 20% and ranged from 5% to 15% during the second run. The test report presents average emissions rates of 0.11 lb/hr during the first test series and 0.04 lb/hr during the second test series. Approximately 26.5 tons of cement was unloaded during each test series. The data documented in this reference are not suitable for developing emission factors. The control device is unique and atypical of those typically used for controlling silo filling emissions. The emission testing methodology used is unlikely to provide a reasonable quantification of the emissions which are fugitive in nature. The test report is not rated.

4.6. Information Useful for Estimating Emission Factors for Traversing Paved and Unpaved Roads and for Loading Aggregate and Sand to Elevated Bins (data are from Reference 1 and Reference 2)

Tables 15.1 and 16.1 present information presented in references 1 and 2 that are parameters needed to estimate emissions using methodologies contained in other AP-42 sections. Table 16.2 presents summary statistical information of the batch formulations that were produced during the emissions testing documents in references 1 and 2. Table 16.3 presents the application of the methodology presented in AP-42 Section 13.2.4, *Aggregate Handling and Storage Piles***,** and used to develop the final emissions factors for loading aggregate and sand to storage piles, and to elevated bins.

Table	Table Name
15.1	Percent Silt and Silt Loading of Road Surfaces
16.1	Silt & Moisture Content of Aggregate and Sand
16.2	Batch Formulation Summary Statistics
16.3	Emission Factors for Aggregates & Sand Transfer to Elevated Bins

Table 15.1

PERCENT SILT & SILT LOADING OF ROAD SURFACES

		Sample Number	Avg. % Silt Content (%)
Unpaved	Chaney Enterprises	2	6.131
		3	9.172
	Average	--	**7.652**

			Sample Number	Avg. % Silt Content (%)	Sample Mass (g)	Silt Mass (g)	Sample Area (m^2)	Silt Loading (g/m^2)
Paved (uncontrolled)		Chaney Enterprises	1	16.908	5,614	949.2	37.16	25.54
			4	11.375	6,124	696.6	10.41	66.94
			Average	**14.1415**	**5,869**	**822.9**	**23.7838**	**46.2437**
	*	AP-42	**Average**	--	--	--	--	**12.00**
		Average of Averages	--	--	--	--	--	**29.1218**
Paved (controlled)		Concrete Ready Mixed	1	10.727	8,732	936.7	31.39	29.85
			2	12.540	2,722	341.3	48.45	7.04
			Average	**11.63355**	**5,727**	**639.0**	**39.9179**	**18.4452**

* The value from AP-42 is taken from Table 13.2.1-3 in Chapter 13.2.1 (10/97).

Table 16.1

SILT & MOISTURE CONTENT OF AGGREGATE & SAND

		Sample Description	Avg. % Silt Content (%)	Avg. % Moisture (%)
Aggregate	Chaney Enterprises	Course Chaney Stone	0.1398	3.28
		Course Black Aggregate	0.3535	0.61
		Average	**0.2467**	**1.95**
	Concrete Ready Mixed	Aggregate Gravel	**0.0910**	**1.59**
	Average of Facilities	--	**0.1688**	**1.77**
Sand	Chaney Enterprises	Sand 1	1.8216	4.88
		Sand 2	2.4295	4.87
		Sand 3	2.4742	5.26
		Average	**2.2418**	**5.00**
	Concrete Ready Mixed	Sand from West Pit (Right)	2.0230	3.29
		Sand from West Pit (Left)		3.39
		Average	**2.0230**	**3.34**
	Average of Facilities	--	**2.1324**	**4.17**

Table 16.2

BATCH FORMULATION SUMMARY STATISTICS

	Concrete Ready Mixed Corp., Roanoke, VA												
	Course Aggregate		Sand		Cement		Fly Ash		Cement + Fly Ash		Water		Total weight
	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(gal/yard)	(weight %)	(lbs/yard)
Average	1864.8	45.1%	1454.2	35.4%	467.6	11.4%	97.1	2.5%	565	13.9%	27.3	5.7%	4111
Standard Deviation	593.5	10.8%	484.9	8.6%	167.6	3.8%	67.2	2.1%	150	3.8%	5.8	1.9%	746
Median	1839.9	46.4%	1440.0	34.9%	470.4	11.3%	116.8	2.7%	563	12.7%	27.1	5.7%	3976
5th Percentile	853.2	37.4%	1183.0	28.5%	284.6	7.2%	0.0	0.0%	414	10.5%	22.5	4.1%	3277
10th Percentile	1677.5	42.6%	1221.8	29.6%	289.8	7.3%	0.0	0.0%	422	10.7%	25.6	4.1%	3846
25th Percentile	1788.8	45.1%	1249.7	31.3%	371.2	9.3%	72.0	1.8%	478	11.7%	26.2	5.5%	3953
50th Percentile	1839.9	46.4%	1440.0	34.9%	470.4	11.3%	116.8	2.7%	563	12.7%	27.1	5.7%	3976
75th Percentile	1868.8	47.0%	1508.0	37.1%	535.1	13.5%	128.0	3.2%	624	15.8%	28.8	6.0%	4148
90th Percentile	2830.3	55.1%	1674.4	39.1%	612.0	15.5%	143.4	3.6%	687	17.4%	31.0	6.4%	5249
95th Percentile	2906.0	55.4%	1770.3	42.6%	615.8	15.6%	152.7	4.4%	692	18.6%	33.0	7.6%	5329
Count	154												

	Chaney Enterprises, Waldorf, MD												
	Course Aggregate			Sand		Cement		New Cem		Cement + New Cem		Water		Total weight
	(lbs/yard)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(gal/yard)	(weight %)	(lbs/yard)
Average	3141	1865	47.0%	1413	35.5%	504	12.7%	59	1.4%	563	14.1%	16	3.4%	3975
Standard Deviation	388	230	6.4%	218	5.4%	114	3.1%	161	3.7%	275	3.1%	4	1.1%	266
Median	3160	1876	47.8%	1386	35.1%	527	13.7%	0	0.0%	527	14.3%	16	3.4%	3931
5th Percentile	3041	1805	42.5%	1221	31.2%	260	6.1%	0	0.0%	260	7.3%	8	1.7%	3762
10th Percentile	3080	1829	44.1%	1252	32.6%	278	6.9%	0	0.0%	278	11.5%	10	2.1%	3814
25th Percentile	3128	1857	47.0%	1307	33.8%	469	11.9%	0	0.0%	469	12.7%	14	2.8%	3862
50th Percentile	3160	1876	47.8%	1386	35.1%	527	13.7%	0	0.0%	527	14.3%	16	3.4%	3931
75th Percentile	3253	1932	48.7%	1453	36.0%	565	14.5%	15	0.4%	580	15.5%	19	3.9%	4046
90th Percentile	3304	1962	49.5%	1620	38.4%	610	15.7%	467	10.6%	1077	17.5%	20	4.3%	4281
95th Percentile	3331	1978	50.3%	1640	41.6%	623	16.2%	515	11.6%	1138	18.6%	21	4.5%	4416
Count	266													

Values in first column of course aggregate are as reported on weigh sheets. Since the average value is significantly greater than the average for Concrete Ready Mix, typical formulations and results in a yard of concrete weight significantly higher than typical, all course aggregate weights were adjusted by a common ratio to achieve the average presented.

	Combined Summary Statistics for Two Plants												
		Course Aggregate		Sand		Cement		Fly Ash / New Cem		Cement + Pozolan		Water		Total weight
		(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(lbs/yard)	(weight %)	(gal/yard)	(weight %)	(lbs/yard)
Average		1864.9	46.3%	1428.4	35.5%	490.7	12.3%	73.0	1.8%	563.8	14.0%	20.1	4.2%	4024.6
Standard Deviation		403.4	8.4%	341.6	6.8%	137.4	3.4%	135.5	3.3%	140.4	3.4%	7.4	1.8%	503.3
Median		1864.4	47.3%	1394.5	35.0%	514.2	12.7%	3.4	0.1%	562.2	14.0%	18.9	3.9%	3956.4
5th Percentile		1699.0	41.8%	1210.0	29.3%	260.0	6.6%	0.0	0.0%	280.3	9.3%	8.8	1.9%	3710.3
10th Percentile		1788.8	43.0%	1233.3	30.9%	289.5	7.3%	0.0	0.0%	418.2	10.8%	10.8	2.3%	3812.8
25th Percentile		1833.1	45.6%	1300.8	33.0%	440.3	9.6%	0.0	0.0%	493.0	12.1%	15.2	3.2%	3892.0
50th Percentile		1864.4	47.3%	1394.5	35.0%	514.2	12.7%	3.4	0.1%	561.1	14.0%	18.9	3.9%	3956.9
75th Percentile		1907.6	48.5%	1477.6	36.4%	564.2	14.4%	116.7	2.7%	616.8	15.6%	26.8	5.6%	4071.5
90th Percentile		1971.3	50.2%	1624.6	38.9%	611.3	15.5%	144.0	3.7%	690.0	17.5%	28.8	6.1%	4406.8
95th Percentile		2750.0	52.7%	1703.2	41.7%	620.0	16.2%	470.0	11.6%	776.2	18.6%	30.6	6.4%	5240.9
Count		420												

Table 16.3

EMISSION FACTORS FOR AGGREGATE & SAND TRANSFER TO ELEVATED BINS

Aggregate Transfer Emission Factors	
PM-10	PM

1.68E-003	kg/Mg	**3.54E-003**	kg/Mg
3.27E-003	lb/ton	**6.92E-003**	lb/ton

Sand Transfer Emission Factors	
PM-10	PM

5.05E-004	kg/Mg	**1.07E-003**	kg/Mg
9.86E-004	lb/ton	**2.08E-003**	lb/ton

The emission factors were developed from the following formulas from AP-42 Section 13.2.4:

This formula was used to compute the emission factors for the metric units.

E = k (.0016) [(U/2.2)^1.3 / (M/2)^1.4]

This formula was used to compute the emission factors for the english units.

E = k (.0032) [(U/5)^1.3 / (M/2)^1.4]

E	=	emission factors (kg / Mg & lb / ton)								
k	=	particle size multiplier for PM-10		k	=	0.35				
k	=	particle size multiplier for PM		k	=	0.74				
U	=	mean wind speed (m/s & mph)		U	=	4.48	m/s	U	=	10 mph
M	=	material moisture content for aggregate (%)		M	=	1.77	%			
M	=	material moisture content for sand (%)		M	=	4.17	%			

4.7 Reference 6

Reference 6 concerned a series of emission test programs sponsored by The Ready Mixed Concrete Research Foundation (RMC Research Foundation) at six ready mixed concrete facilities located in North Carolina, Virginia, and South Carolina. The purpose of this project is to prepare an updated and expanded set of AP-42, Chapter 11.12 emission factors for total particulate matter, PM_{10}, $PM_{10-2.5}$, $PM_{2.5}$, and arsenic from truck mix and central mix process operations at ready mixed concrete plants.

Three truck mix operations and three central mix operations are included in the scope of this test program. Reference 6 presents the results of December 2003, February 2004 and May 2004 emission factor testing at the (1) Ready Mixed Concrete Company, Inc. (RMCC) truck mix and central mix operations at the Wake Forest, North Carolina plant, (2) the S.T. Wooten central mix plant in Raleigh, N.C., (3) the Chandler Concrete truck mix plant in Troutville, Virginia, (4) the Concrete Supply truck mix plant in Rock Hill, South Carolina, and (5) the RMC Carolina Materials central mix plant in Raleigh, North Carolina.

The test program was designed to provide emission factor data at the following locations at ready mixed concrete plants.

- Outlet of the fabric filter collector serving the mixing operation
- Inlet to the fabric filter collector serving the mixing operation
- Fugitive emissions from the mixing operations and trucks

The inlets of the fabric filters were tested using EPA reference methods in conventional ducts. During the tests at RMCC Wake Forest, EPA reference method tests were also conducted in the fabric filter outlet ducts. During the subsequent tests at S.T. Wooten Raleigh, Chandler Concrete Troutville, Concrete Supply Rock Hill, and RMC Carolina Materials, the fabric filter outlet PM_{10} emissions were measured using a continuous particulate matter monitor that was sensitive to the low mass loadings present in the effluent gas streams from the fabric filters.

Fugitive emissions from the mixing operations were measured simultaneously with the tests at the inlet and outlet to the fabric filter. The fugitive emissions were captured in a set of sampling arrays that were located immediately adjacent to the fugitive emission points.

U.S. EPA Conditional Test Method 040 was conducted at the inlets of the mixing operation fabric filter particulate matter control devices to simultaneously measure the concentrations of (1) total particulate matter, (2) PM_{10} particulate matter, (3) $PM_{10-2.5}$ particulate matter, and (4) $PM_{2.5}$ particulate matter. The PM_{10}, $PM_{10-2.5}$, and $PM_{2.5}$ emission concentrations were measured directly in this sampling train by partitioning the captured particulate matter into several size ranges. PM_{10} was measured as the sum of the $PM_{10-2.5}$ and $PM_{2.5}$ particulate matter. Total particulate matter was measured as the sum of PM_{10} particulate matter and all of the solids having a size greater than 10 micrometers that were captured in the cyclone and sampling train. There is a possible bias to higher-than-true total particulate matter concentration results due to the geometry of the PM_{10} cyclone, the short length of the sampling nozzle, and the inertia of particles larger than 10 micrometers in the sampling gas stream. Despite this possible bias, it was decided to measure the total particulate matter using the Preliminary Method 4 sampling train due to the ability to collect data in all size ranges simultaneously.

During the tests at RMCC Wake Forest, EPA Preliminary Method 4 was also used at the fabric filter outlet; however, the total particulate matter catch weights in the sampling trains ranged from only 1.0 to 2.3 milligrams. These small catch weights were distributed in several different particle size

fractions. Air Control Techniques, P.C. determined that tests sponsored by EPA[1] in 1993 also experienced low catch weights. To minimize data precision problems at these low catch weights, Air Control Techniques, P.C. proposed to the RMC Research Foundation to modify the fabric filter outlet tests procedures to use a tapered element oscillating microbalance (TEOM) continuous particulate matter monitor. This instrument is sensitive down to particulate matter concentrations of less than 10 micrograms per cubic meter and is therefore very appropriate for testing low concentration particulate matter gas streams. During the tests at S.T. Wooten (central mix), Chandler Concrete (truck mix), Concrete Supply (truck mix) and RMC Carolina Materials (central mix), a PM_{10} TEOM was used at the fabric filter outlet, and EPA Preliminary Method 4 was used only at the fabric filter inlet.

The presently available hood capture efficiency data were obtained during 1993 tests sponsored by EPA at two plants: one in Maryland and one in Virginia. In both test programs, EPA used qualitative visible emission evaluations to estimate capture efficiency. Air Control Techniques, P.C. use of a TEOM based downwind emissions profiling sampling method provides a quantitative methodology to determine the emissions which escape capture of the batch loading system, thereby eliminating the subjective nature of determining capture efficiency using visible observation methods in the source tests documented in references 1 and 2. Based on the TEOM instrument system, Air Control Techniques, P.C. designed and used a downwind sampling array to quantify the capture efficiency of the ready mixed concrete plant hood systems. This sampling array design was based on the sampling principles adopted by EPA in Method 5D (40 CFR Part 60, Appendix A, Method 5D) used for sampling open top fabric filter systems. This sampling array is also similar to the traversing hood system designed and used by Air Control Techniques, P.C. to measure fugitive particulate matter emissions[2] from sloped vibrating screens at stone crushing plants.

Air Control Techniques, P.C. used a set of downwind sampling arrays mounted vertically on the side walls of the truck loading area and at the inlet of central mixing operations to measure the fugitive dust mass flux through a defined 200 square foot area[3]. Due to space constraints, the downwind sampling arrays were limited to a 140 square foot area for all of the following tests at both truck and central mix facilities. The sampling arrays were mounted directly adjacent to the transfer operations, and portions of the arrays were close to parts of the truck receiving concrete. There were sixty sampling points in the set of two arrays; this number of points exceeds the requirements of EPA Method 5D. The area monitored by the sampling arrays included all of the downwind area subject to dispersion of the fugitive particulate matter. The gas transport velocities through all sampling tubes and ductwork were maintained at a minimum of 3,500 feet per minute to prevent settling of dust in the tubes and ductwork. Method 22 visual observations were conducted during the run. These observations also provided qualitative supporting information concerning the fugitive particulate matter concentrations.

Each of the sampling arrays was ducted together to yield a single sample gas stream. This gas stream was directed past an enlarged duct with the intake for an ambient TEOM monitor meeting the requirements of Method IO-1.3 (the *Compendium of Methods for the Determination of PM_{10} In Inorganic Compounds in Ambient Air Using A Continuous Rupprecht And Patashnick [R&P] Teom® Particle Monitor*). The gas flow rate through this enclosure was maintained at less than 5 mph. The TEOM had a PM_{10} sampling head and operated at a flow rate of 16.67 liters per minute. The TEOM was operated in accordance with Method IO-1.3. The instrument was calibrated in accordance with Section 12.1 of Method IO-1.3.

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[1] EPA References 9 and 10 in AP-42 Section 11.12.

[2] The emission factors measured using the screening operation traversing hood system have been published in AP-42 Section 11.19.2 (Fifth Edition, 1995).

[3] The array area for the inlet to the central mixer was limited to 140 square feet due to space constraints.

The TEOM instrument was mounted on a secure base. The instrument was protected from severe vibration. The TEOM was equilibrated prior to the start of the first test run on each test day. The fugitive PM_{10} emissions (PM_{10} escaping the plant hood system) were measured by multiplying the measured ambient PM_{10} concentration by the ambient air flow rate through the sampling array. A Davis Instruments, Inc. meteorological monitoring station was located within 20 feet of the sampling arrays and at the same elevation as the sampling arrays to measure the wind direction and wind speed through the arrays. During the initial set of tests at the RMCC Plant in December 2003, Air Control Techniques, P.C. determined that the meteorological monitoring equipment was subject to swirling and suppressed winds caused by the deflection of ambient wind by the plant equipment and trucks in the immediate vicinity of the monitoring equipment. Accordingly, Air Control Techniques, P.C. obtained confirming wind speed data from a local meteorological monitoring station located within ten miles of the plant site. During the tests at S.T. Wooten, Chandler Concrete, Concrete Supply, and RMC Carolina Materials, Air Control Techniques, P.C. used multiple wind speed and direction monitoring stations on the plant site located in areas immediately adjacent to the sampling array to provide confirmation data. Wind pennants were also mounted on the arrays to provide a direct indication of wind direction through the array.

All of the particulate matter measured by the TEOM during the time that the equipment being tested was operating was assumed to originate as fugitive emissions from the mixing operation being tested. This approach introduced a bias to lower-than-true capture efficiency due to the presence of ambient PM_{10} in the ambient air upwind of the plant and due to other fugitive PM_{10} sources in the plant area (i.e. roadways and truck exhaust). There was no practical means to identify and correct for these other sources of PM_{10} on a continuous basis.

During the initial set of tests at the RMCC plant sources, Air Control Techniques, P.C. determined that the particulate matter catch weights were extremely low due to the high efficiency of the fabric filter. Air Control Techniques, P.C revised the testing procedures prior to the tests at S.T. Wooten, Chandler Concrete, Concrete Supply, and RMC Carolina Materials to address this issue. A second TEOM monitor was used to provide a more sensitive and precise measurement of particulate matter emissions from the fabric filter. The entire fabric filter outlet gas stream was captured and directed through a duct with an installed TEOM monitor. The TEOM was used to provide a continuous indication of the PM_{10} concentration in the fabric filter effluent gas stream. Total particulate matter emissions were calculated based on (1) the measured PM_{10} emissions from the fabric filter and (2) the total PM/ PM_{10} ratio at the inlet to the fabric filter. The total PM/ PM_{10} ratio was checked based on scanning electron microscopy sizing of filter samples obtained at the fabric filter outlet.

The results of the controlled[4] emission factor tests are summarized in Table 17.1 for the truck mix sources and Table 17.2 for the central mix sources. Uncontrolled emission factor data for truck mix sources and central mix sources are provided in Tables 17.3 and 17.4 respectively.

The RMC Research Foundation measured emission factors for filterable particulate matter and PM_{10} particulate matter are compared with previously published AP-42 emission factors (controlled conditions). No emission factors were previously available for $PM_{10-2.5}$ (termed “coarse particulate matter”) and $PM_{2.5}$ (termed “fine particulate matter”). The run-by-run data used in compiling Tables 17.1 and 17.2 are provided in Tables 17.5 through 17.10.

[4] Controlled emissions are the total of emissions from the fabric filter used to control the mixing operation plus the fugitive emissions not captured by the hood.

Table 17.1 Reference 6 Truck Mix Emission Factor Test Results

Emission Factors	RMCC Raleigh Truck Mix (Controlled)	Chandler Concrete Truck Mix (Controlled)	Concrete Supply Truck Mix (Controlled)	Reference 6 Truck Mix Average
Emission Factors	Lbs./ton	Lbs./ton	Lbs./ton	Lbs./ton
Total Particulate Matter	0.0094	0.0512	0.0197	0.0268
PM_{10}	0.0039	0.0225	0.0035	0.0100
$PM_{10-2.5}$	0.0033	0.0195	0.0032	0.0086
$PM_{2.5}$	0.0007	0.0031	0.0003	0.0013
Truck Hood, %	99.5	93.1	99.3	97.3

1. All emission factors expressed as pounds of mass per ton of cement and cement supplement processed.
2. Ratio calculated based on penetration; 100%-97.3% for RMC Research Foundation tests, 100% - 71% for previous tests.

Table 17.2. Reference 6 Central Mix Emission Factor Test Results

Emission Factors	RMCC Raleigh Central Mix (Controlled)	S.T. Wooten Raleigh Central Mix (Controlled)	RMC Carolina Materials Raleigh Central Mix (Controlled)	Reference Central Mix Average
Emission Factors	Lbs./ton	Lbs./ton	Lbs./ton	Lbs./ton
Total Particulate Matter	0.0042	0.0402	0.0191	0.0212
PM_{10}	0.0028	0.0095	0.0049	0.0057
$PM_{10-2.5}$	0.0014	0.0087	0.0043	0.0048
$PM_{2.5}$	0.0014	0.0007	0.0006	0.0009
Central Mix Hood, %	99.3	97.5	97.2	98.0

1. All emission factors expressed as pounds of mass per ton of cement and cement supplement processed
2. Ratio calculated based on penetration; 100%-98% for RMC Research Foundation tests, 100% - 94% for previous tests.

Table 17.3 Reference 6 Truck Mix Uncontrolled Emission Factor Test Results

Emission Factors	RMCC Raleigh Truck Mix (Uncontrolled)	Chandler Concrete Truck Mix (Uncontrolled)	Concrete Supply Truck Mix (Uncontrolled)	Reference 6 Truck Mix Average
Emission Factors	Lbs./ton	Lbs./ton	Lbs./ton	Lbs./ton
Total Particulate Matter	2.128	0.544	1.693	1.455
PM_{10}	0.726	0.232	0.291	0.416
$PM_{10-2.5}$	0.624	0.200	0.265	0.363
$PM_{2.5}$	0.102	0.032	0.026	0.053

1. All emission factors expressed as pounds of mass per ton of cement and cement supplement processed.

Table 17.4 Reference 6 Central Mix Uncontrolled Emission Factor Test Results

Emission Factors	RMCC Raleigh Central Mix (Uncontrolled)	S.T. Wooten Raleigh Central Mix (Uncontrolled)	RMC Carolina Materials Raleigh Central Mix (Uncontrolled)	Reference Central Mix Average
Emission Factors	Lbs./ton	Lbs./ton	Lbs./ton	Lbs./ton
Total Particulate Matter	0.155	1.254	0.654	0.688
PM_{10}	0.056	0.331	0.160	0.183
$PM_{10-2.5}$	0.047	0.306	0.141	0.165
$PM_{2.5}$	0.009	0.025	0.020	0.018

1. All emission factors expressed as pounds of mass per ton of cement and cement supplement processed.

Table 17.5 Wake Forest RMCC Truck Mix Emissions Data

Test Results	Run # 1 12/8/03	Run # 2 12/8/03	Run # 3 12/9/03	Averages
Method 5 D-Sampling Array Results				
Average Array PM_{10} Particulate Concentration, ug/m^3	36.1	130.5	64.6	77.1
Measured PM_{10} Emissions Thru Array, lbs./hour	0.0026	0.0120	0.0043	0.0063
Calculated Total Emissions Thru Array, lbs./hour	0.0084	0.0465	0.0116	0.0222
Calculated $PM_{2.5}$ Emissions Thru Array, lbs./hour	0.0003	0.0012	0.0006	0.0007
Calculated $PM_{10\text{-}2.5}$ Emissions Thru Array, lbs./hour	0.0023	0.0109	0.0036	0.0056
Fabric Filter Results				
Fabric Filter Inlet, Total Particulate Concentration, lbs./hr	3.2497	3.9991	32.1562	13.1350
Fabric Filter Outlet, Total Particulate Concentration, lbs./hr	0.0214	0.0139	0.0211	0.0188
Fabric Filter Inlet, PM_{10} Particulate Concentration, lbs./hr	1.0090	1.0351	11.8126	4.6189
Fabric Filter Outlet, PM_{10} Particulate Concentration, lbs./hr	0.0214	0.0042	0.0211	0.0156
Fabric Filter Inlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.1247	0.0989	1.7750	0.6662
Fabric Filter Outlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.00005	0.0014	0.00703	0.0028
Fabric Filter Inlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	0.8843	0.9362	10.0376	3.9527
Fabric Filter Outlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	0.0214	0.0028	0.0141	0.0128
Particulate Size Ratios based on Fabric Filter Inlet Data				
Total / PM_{10} for TEOM Total Calculation	3.22	3.86	2.72	3.27
$PM_{2.5}$ / PM_{10} for TEOM $PM_{2.5}$ Calculation	0.12	0.10	0.15	0.12
$PM_{10\text{-}2.5}/PM_{10}$ Ratio for TEOM $PM_{10\text{-}2.5}$ Calculation	0.88	0.90	0.85	0.88
Emission Factor Results				
Average Plant Production Levels During Tests, Tons/Hour	8.58	3.00	6.91	6.16
Total Particulate Emission Factor, lbs./ton	0.00347	0.02011	0.00468	0.00942
Total PM_{10} Emission Factor, lbs./ton	0.00280	0.00538	0.00362	0.00393
Total $PM_{10\text{-}2.5}$ Emission Factor, lbs./ton	0.00276	0.00452	0.00253	0.00327
Total $PM_{2.5}$ Emission Factor, lbs./ton	0.00003	0.00086	0.00109	0.00066
Collection Efficiencies				
Fabric Filter Total Efficiency	99.3%	99.7%	99.9%	99.6%
Truck Hood PM_{10} Efficiency	99.7%	98.8%	99.9%	99.5%
System Collection Efficiency	97.6%	98.4%	99.8%	98.6%

Table 17.6. Wake Forest RMCC Central Mix Emissions Data

Test Results	Run # 1 12/10/03	Run # 2 12/11/03	Run # 3 12/11/03	Averages
Method 5 D-Sampling Array Results				
Average Array PM_{10} Particulate Concentration, ug/m^3	18.8	16.4	57.9	31.0
Measured PM_{10} Emissions Thru Array, lbs./hour	0.0009	0.0020	0.0067	0.0032
Calculated Total Emissions Thru Array, lbs./hour	0.0029	0.0053	0.0178	0.0087
Calculated $PM_{2.5}$ Emissions Thru Array, lbs./hour	0.0003	0.0003	0.0010	0.0005
Calculated $PM_{10-2.5}$ Emissions Thru Array, lbs./hour	0.0006	0.0018	0.0057	0.0027
Fabric Filter Results				
Fabric Filter Inlet, Total Particulate Concentration, lbs./hr	0.6950	1.5389	1.3322	1.1887
Fabric Filter Outlet, Total Particulate Concentration, lbs./hr	0.0270	0.0198	0.0262	0.0243
Fabric Filter Inlet, PM_{10} Particulate Concentration, lbs./hr	0.2094	0.5922	0.4987	0.4334
Fabric Filter Outlet, PM_{10} Particulate Concentration, lbs./hr	0.0270	0.0128	0.0148	0.0182
Fabric Filter Inlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.0617	0.0799	0.0729	0.0715
Fabric Filter Outlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.0170	0.0000	0.0103	0.0091
Fabric Filter Inlet, $PM_{10-2.5}$ Particulate Concentration, lbs./hr	0.1477	0.5123	0.4258	0.3619
Fabric Filter Outlet, $PM_{10-2.5}$ Particulate Concentration, lbs./hr	0.0099	0.0128	0.0046	0.0091
Particulate Size Ratios based on Fabric Filter Inlet Data				
Total / PM_{10} for TEOM Total Calculation	3.32	2.60	2.67	2.86
$PM_{2.5}$ / PM_{10} for TEOM $PM_{2.5}$ Calculation	0.29	0.13	0.15	0.19
$PM_{10-2.5}/PM_{10}$ Ratio for TEOM $PM_{10-2.5}$ Calculation	0.71	0.87	0.85	0.81
Emission Factor Results				
Average Plant Production Levels During Tests, Tons/Hour	6.82	8.88	7.18	7.63
Total Particulate Emission Factor, lbs./ton	0.00431	0.00232	0.00612	0.00425
Total PM_{10} Emission Factor, lbs./ton	0.00401	0.00134	0.00299	0.00278
Total $PM_{10-2.5}$ Emission Factor, lbs./ton	0.00153	0.00130	0.00142	0.00142
Total $PM_{2.5}$ Emission Factor, lbs./ton	0.00249	0.00003	0.00157	0.00136
Collection Efficiencies				
Fabric Filter Total Efficiency	96.1%	98.7%	98.0%	97.6%
Truck Hood PM_{10} Efficiency	99.6%	99.7%	98.7%	99.3%
System Collection Efficiency	86.7%	97.5%	95.7%	93.3%

Table 17.7. S.T. Wooten Central Mix Emissions Data

Test Results	Run # 1 3/2/04	Run # 2 3/2/04	Run # 3 3/2/04	Averages
Method 5 D-Sampling Array Results				
Average Array PM_{10} Particulate Concentration, ug/m^3	80.86	426.70	402.62	303.4
Measured PM_{10} Emissions Thru Array, lbs./hour	0.0261	0.1616	0.0501	0.0792
Calculated Total Emissions Thru Array, lbs./hour	0.1088	0.9414	0.1119	0.3874
Calculated $PM_{2.5}$ Emissions Thru Array, lbs./hour	0.0023	0.0136	0.0029	0.0063
Calculated $PM_{10\text{-}2.5}$ Emissions Thru Array, lbs./hour	0.0238	0.1480	0.0471	0.0730
Fabric Filter Results				
Fabric Filter Inlet, Total Particulate Concentration, lbs./hr	13.46	14.82	12.74	13.67
Fabric Filter Outlet, Total Particulate Concentration, lbs./hr	0.047	0.049	0.274	0.123
Fabric Filter Inlet, PM_{10} Particulate Concentration, lbs./hr	3.22	2.54	5.7	3.82
Fabric Filter Outlet, PM_{10} Particulate Concentration, lbs./hr	0.011	0.008	0.122	0.047
Fabric Filter Inlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.28	0.21	0.33	0.28
Fabric Filter Outlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.00098	0.00070	0.0071	0.00294
Fabric Filter Inlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	2.94	2.33	5.36	3.55
Fabric Filter Outlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	0.0103	0.0076	0.1152	0.0444
Particulate Size Ratios based on Fabric Filter Inlet Data				
Total / PM_{10} for TEOM Total Calculation	4.17	5.83	2.24	4.08
$PM_{2.5}$ / PM_{10} for TEOM $PM_{2.5}$ Calculation	0.09	0.08	0.06	0.08
$PM_{10\text{-}2.5}/PM_{10}$ Ratio for TEOM $PM_{10\text{-}2.5}$ Calculation	0.91	0.92	0.94	0.92
Emission Factor Results				
Average Plant Production Levels During Tests, Tons/Hour	7.90	13.10	15.27	12.09
Total Particulate Emission Factor, lbs./ton	0.01972	0.07560	0.02526	0.04020
Total PM_{10} Emission Factor, lbs./ton	0.00470	0.01240	0.01127	0.00945
Total $PM_{10\text{-}2.5}$ Emission Factor, lbs./ton	0.00428	0.01131	0.01061	0.00873
Total $PM_{2.5}$ Emission Factor, lbs./ton	0.00042	0.00109	0.00065	0.00072
Collection Efficiencies				
Fabric Filter Total Efficiency	99.6%	99.7%	97.9%	99.0%
Truck Hood PM_{10} Efficiency	99.2%	94.0%	99.1%	97.5%
System Collection Efficiency	98.8%	93.3%	97.0%	96.4%

Table 17.8. Chandler Concrete, Troutville Truck Mix Emissions Data

Test Results	Run # 1 12/8/03	Run # 2 12/8/03	Run # 3 12/9/03	Averages
Method 5 D-Sampling Array Results				
Average Array PM_{10} Particulate Concentration, ug/m^3	983.4	495.3	1511.2	996.6
Measured PM_{10} Emissions Thru Array, lbs./hour	0.0786	0.0991	0.0886	0.0887
Calculated Total Emissions Thru Array, lbs./hour	0.1623	0.2099	0.2410	0.2044
Calculated $PM_{2.5}$ Emissions Thru Array, lbs./hour	0.0163	0.0098	0.0108	0.0123
Calculated $PM_{10\text{-}2.5}$ Emissions Thru Array, lbs./hour	0.0622	0.0893	0.0777	0.0764
Fabric Filter Results				
Fabric Filter Inlet, Total Particulate Concentration, lbs./hr	2.52	1.80	5.62	3.32
Fabric Filter Outlet, Total Particulate Concentration, lbs./hr	0.065	0.064	0.150	0.093
Fabric Filter Inlet, PM_{10} Particulate Concentration, lbs./hr	1.221	0.851	2.066	1.380
Fabric Filter Outlet, PM_{10} Particulate Concentration, lbs./hr	0.031	0.030	0.055	0.039
Fabric Filter Inlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.254	0.084	0.252	0.197
Fabric Filter Outlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.007	0.003	0.007	0.005
Fabric Filter Inlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	0.967	0.767	1.814	1.183
Fabric Filter Outlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	0.025	0.027	0.048	0.033
Particulate Size Ratios based on Fabric Filter Inlet Data				
Total / PM_{10} for TEOM Total Calculation	2.07	2.12	2.72	2.30
$PM_{2.5}$ / PM_{10} for TEOM $PM_{2.5}$ Calculation	0.21	0.10	0.12	0.14
$PM_{10\text{-}2.5}/PM_{10}$ Ratio for TEOM $PM_{10\text{-}2.5}$ Calculation	0.79	0.90	0.88	0.86
Emission Factor Results				
Average Plant Production Levels During Tests, Tons/Hour	6.19	4.12	7.75	6.02
Total Particulate Emission Factor, lbs./ton	0.03673	0.06647	0.05045	0.05122
Total PM_{10} Emission Factor, lbs./ton	0.01771	0.03133	0.01853	0.02252
Total $PM_{10\text{-}2.5}$ Emission Factor, lbs./ton	0.01395	0.02823	0.01623	0.01947
Total $PM_{2.5}$ Emission Factor, lbs./ton	0.00377	0.00311	0.00230	0.00306
Collection Efficiencies				
Fabric Filter Total Efficiency	97.4%	96.5%	97.3%	97%
Truck Hood PM_{10} Efficiency	94.0%	89.6%	95.9%	93.1%
System Collection Efficiency	91.0%	84.8%	93.0%	89.6%

Table 17.9. Concrete Supply, Rock Hill Truck Mix Emissions Data

Test Results	Run # 1 5/12/04	Run # 2 5/12/04	Run # 3 5/13/04	Averages
Method 5 D-Sampling Array Results				
Average Array PM_{10} Particulate Concentration, ug/m^3	351.0	854.6	527.0	577.5
Measured PM_{10} Emissions Thru Array, lbs./hour	0.0170	0.0585	0.0378	0.0378
Calculated Total Emissions Thru Array, lbs./hour	0.0885	0.2154	0.2897	0.1979
Calculated $PM_{2.5}$ Emissions Thru Array, lbs./hour	0.0025	0.0049	0.0026	0.0034
Calculated $PM_{10-2.5}$ Emissions Thru Array, lbs./hour	0.0145	0.0536	0.0351	0.0344
Fabric Filter Results				
Fabric Filter Inlet, Total Particulate Concentration, lbs./hr	15.992	24.505	43.483	27.99
Fabric Filter Outlet, Total Particulate Concentration, lbs./hr	0.070	0.132	0.192	0.131
Fabric Filter Inlet, PM_{10} Particulate Concentration, lbs./hr	3.071	6.654	5.668	5.131
Fabric Filter Outlet, PM_{10} Particulate Concentration, lbs./hr	0.013	0.036	0.025	0.025
Fabric Filter Inlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.456	0.561	0.393	0.470
Fabric Filter Outlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.002	0.003	0.002	0.002
Fabric Filter Inlet, $PM_{10-2.5}$ Particulate Concentration, lbs./hr	2.615	6.093	5.275	4.6609
Fabric Filter Outlet, $PM_{10-2.5}$ Particulate Concentration, lbs./hr	0.011	0.033	0.023	0.023
Particulate Size Ratios based on Fabric Filter Inlet Data				
Total / PM_{10} for TEOM Total Calculation	5.21	3.68	7.67	5.52
$PM_{2.5}$ / PM_{10} for TEOM $PM_{2.5}$ Calculation	0.15	0.08	0.07	0.10
$PM_{10-2.5}/PM_{10}$ Ratio for TEOM $PM_{10-2.5}$ Calculation	0.85	0.92	0.93	0.90
Emission Factor Results				
Average Plant Production Levels During Tests, Tons/Hour	20.24	21.73	13.91	18.63
Total Particulate Emission Factor, lbs./ton	0.00783	0.01599	0.03538	0.01973
Total PM_{10} Emission Factor, lbs./ton	0.00148	0.00435	0.00461	0.00348
Total $PM_{10-2.5}$ Emission Factor, lbs./ton	0.00126	0.00399	0.00427	0.00317
Total $PM_{2.5}$ Emission Factor, lbs./ton	0.00022	0.00036	0.00034	0.00031
Collection Efficiencies				
Fabric Filter Total Efficiency	99.6%	99.5%	99.6%	99.5%
Truck Hood PM_{10} Efficiency	99.4%	99.1%	99.3%	99.3%
System Collection Efficiency	99.0%	98.6%	98.9%	98.8%

Table 17.10. RMC Carolina Materials Central Mix Emissions Data

Test Results	Run # 1 5/19/04	Run # 2 5/19/04	Run # 3 5/20/04	Averages
Method 5 D-Sampling Array Results				
Average Array PM_{10} Particulate Concentration, ug/m^3	309.2	223.7	193.3	242.1
Measured PM_{10} Emissions Thru Array, lbs./hour	0.1013	0.0456	0.0132	0.0534
Calculated Total Emissions Thru Array, lbs./hour	0.3972	0.1761	0.0601	0.2111
Calculated $PM_{2.5}$ Emissions Thru Array, lbs./hour	0.0072	0.0083	0.0013	0.0056
Calculated $PM_{10\text{-}2.5}$ Emissions Thru Array, lbs./hour	0.0942	0.0373	0.0119	0.0478
Fabric Filter Results				
Fabric Filter Inlet, Total Particulate Concentration, lbs./hr	7.580	5.823	10.254	7.886
Fabric Filter Outlet, Total Particulate Concentration, lbs./hr	0.0056	0.0064	0.0058	0.0060
Fabric Filter Inlet, PM_{10} Particulate Concentration, lbs./hr	1.934	1.508	2.245	1.896
Fabric Filter Outlet, PM_{10} Particulate Concentration, lbs./hr	0.0014	0.0017	0.0013	0.0015
Fabric Filter Inlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.137	0.274	0.219	0.2098
Fabric Filter Outlet, $PM_{2.5}$ Particulate Concentration, lbs./hr	0.0001	0.0003	0.0001	0.0002
Fabric Filter Inlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	1.797	1.235	2.027	1.6860
Fabric Filter Outlet, $PM_{10\text{-}2.5}$ Particulate Concentration, lbs./hr	0.001	0.001	0.001	0.001
Particulate Size Ratios based on Fabric Filter Inlet Data				
Total / PM_{10} for TEOM Total Calculation	3.92	3.86	4.57	4.12
$PM_{2.5}$ / PM_{10} for TEOM $PM_{2.5}$ Calculation	0.07	0.18	0.10	0.12
$PM_{10\text{-}2.5}/PM_{10}$ Ratio for TEOM $PM_{10\text{-}2.5}$ Calculation	0.93	0.82	0.90	0.88
Emission Factor Results				
Average Plant Production Levels During Tests, Tons/Hour	13.01	8.15	16.82	12.66
Total Particulate Emission Factor, lbs./ton	0.03097	0.02240	0.00392	0.01909
Total PM_{10} Emission Factor, lbs./ton	0.00790	0.00581	0.00086	0.00485
Total $PM_{10\text{-}2.5}$ Emission Factor, lbs./ton	0.00733	0.00475	0.00078	0.00429
Total $PM_{2.5}$ Emission Factor, lbs./ton	0.000561	0.0010555	0.0000835	0.00057
Collection Efficiencies				
Fabric Filter Total Efficiency	99.9%	99.9%	99.9%	99.9%
Truck Hood PM_{10} Efficiency	95.0%	97.1%	99.4%	97.2%
System Collection Efficiency	94.7%	96.9%	99.4%	97.0%

The total amount of concrete processed by the concrete mixing trucks during each test run was recorded in units of yards. The five plants tested recorded the amount of each raw material used for each order. The mix composition information and processing rate information are summarized for each test run in Tables 17.11 through 17.16. All of the processes operated in a normal manner during the test program.

Table 17.11. Wake Forest, RMCC Truck Mix Production Data

Parameters	Truck Mix Run # 1	Truck Mix Run # 2	Truck Mix Run # 3	Averages
Test Date	12/8/03	12/8/03	12/9/03	N/A
Run Start Time	9:01	12:14	7:53	N/A
Run Stop Time	11:12	14:14	10:03	N/A
Number of Truck Loads	11	6	7	8
Sand, lbs.	104,440	30,280	80,360	71,693
Stone 67 Size, lbs.	118,840	25,480	72,440	72,253
Stone 78 Size, lbs.	14,480	9,960	20,680	15,040
Cement, lbs.	28,170	9,540	21,480	19,730
Flyash, lbs.	9,350	2,460	7,180	6,330
Liquid Air, lbs.	26.06	4.56	19.50	16.71
Water Reducer, lbs.	11.81	16.94	37.25	22.00
Retarder, lbs.	0	0	0	0
High Range Water Reducer, lbs.	0	3.44	0	1.15
Calcium Accelerator, lbs.	175	0	71.88	82.29
Non-Chloride Accelerator, lbs.	210	0	0	70
Water, lbs.	9,552	1,872	5,552	5,658.7
Total Process Weight, lbs.	285,255	79,617	207,821	190,897.7
Total Process Weight, tons	142.6	39.8	103.9	95.4
Total Process Weight, yards	75	23	54	50.7
Tons / Yard	1.91	1.77	1.92	1.87

Table 17.12. Wake Forest, RMCC Central Mix Production Data

Parameters	Run # 1	Run # 2	Run # 3	Averages
Test Date	12/10/03	12/11/03	12/11/03	N/A
Run Start Time	8:22	7:31	12:21	N/A
Run Stop Time	13:24	9:37	15:35	N/A
Number of Truck Loads	5	7	7	6.3
Sand, lbs.	66,560	96,560	88,640	83,920
Stone 67 Size, lbs.	88,240	124,120	113,240	108,533
Stone 78 Size, lbs.	0	0	0	0
Cement, lbs.	22,230	29,680	26,320	26,076.7
Flyash, lbs.	4,770	7,430	6,970	6,390
Liquid Air, lbs.	14.44	21.88	21.5	19.27
Water Reducer, lbs.	34.81	11.88	45.31	30.67
Retarder, lbs.	0	0	0	0
High Range Water Reducer, lbs.	0	0	0	0
Calcium Accelerator, lb	65.63	66.25	17.50	49.79
Non-Chloride Accelerator, lbs.	0	280	0	93.3
Water, lbs.	3,160	6,564	3,888	4,537.3
Total Process Weight, lbs	185,075	264,734	239,142	296,317
Total Process Weight, tons	92.5	132.4	119.6	114.8
Total Process Weight, yards	49	69	64	60.7
Tons / Yard	1.89	1.92	1.87	1.89

Table 17.13. S.T. Wooten Concrete Central Mix Production Data

Parameters	Run # 1	Run # 2	Run # 3	Averages
Test Date	3/2/04	3/2/04	3/2/04	N/A
Run Start Time	9:10	11:12	13:04	N/A
Run Stop Time	10:10	12:12	14:05	N/A
Number of Truck Loads	5	5	6	5.3
Sand, lbs.	41,380	68,780	79,100	63,090
Stone 57 Size, lbs.	53,620	88,800	101,880	81,433
Cement, lbs.	12,540	19,310	23,800	18,550
Flyash, lbs.	3,460	6,580	7,190	5,743
Liquid Air, lbs.	5.43	6.18	9.06	6.90
Polyheed, lbs.	52.5	157.25	153.5	121.1
Water, lbs.	2,804	6,192	6,885	5,294
Total Process Weight, lbs	113,862	189,815	219,018	174,238
Total Process Weight, tons	56.94	94.91	109.51	87.12
Total Process Weight, yards	29.500	50.000	57.50	45.67
Tons / Yard	1.98	1.90	1.90	1.93

Table 17.14. Chandler Concrete Truck Mix Production Data

Parameters	Run # 1	Run # 2	Run # 3	Averages
Test Date	3/17/04	3/17/04	3/18/04	N/A
Run Start Time	7:17	9:17	12:40	N/A
Run Stop Time	8:34	13:21	14:50	N/A
Number of Truck Loads	4	4	4	4
Stone 57, lbs.	43,180	28,700	56,960	42,946.7
Limestone, lbs.	33,040	17,220	28,260	26,173.3
Type 1-2 Cement, lbs.	12,245	6,690	11,915	10,283.3
Castle	5,100	6,620	19,120	10,280.0
Flyash, lbs.	1,220	1,495	4,105	2,273.3
Liquid Air, lbs.	1.75	2.25	3.00	2.33
Water Reducer, lbs.	12.81	14.50	38.38	21.90
Polarset, lbs.	69	0	0	23.0
Water, lbs.	5315.95	2,995.96	6,993.36	5,101.8
Total Process Weight, lbs.	100,185	63,738	127,395	97,105.7
Total Process Weight, tons	50.092	31.869	63.697	48.6
Total Process Weight, yards	24.5	14.50	32.0	23.7
Tons / Yard	2.03	2.16	1.99	2.1

Table 17.15. Concrete Supply Truck Mix Production Data

Parameters	Run # 1	Run # 2	Run # 3	Averages
Test Date	5/12/04	5/12/04	5/13/04	N/A
Run Start Time	7:50	10:07	9:06	N/A
Run Stop Time	8:50	11:06	10:10	N/A
Number of Truck Loads	8	9	5	7.3
Sand, lbs.	95,731	80,700	51,080	75,837
Stone, lbs.	130,660	107,130	66,750	101,513
Type 1-2 Cement, lbs.	38,490	33,525	21,380	31,131
Flyash, lbs.	1,785	9,160	5,910	5,618
Water, lbs.	11,082.16	9,897.17	6,225.37	9,068.23
Water Reducer, lbs.	58.5	55.31	6.5	40.1
Liquid Air, lbs.	3.81	13.88	10.06	9.25
M.S. Sand, lbs.	5,970	26,150	17,740	16,620
Retarder, lbs.	42.81	29.13	46.56	39.29
Adva, lbs.	53.13	0	0	17.71
Delvo, lbs	75.06	0	0	25.02
Total Process Weight, lbs.	283,951	266,660	169,148	239,919
Total Process Weight, tons	141.976	133.330	84.574	119.96
Total Process Weight, yards	71.250	67.20	43.00	60.48
Tons / Yard	1.99	1.99	1.97	1.98

Table 17.16. RMC Carolina Materials Central Mix Production Data

Parameters	Run # 1	Run # 2	Run # 3	Averages
Test Date	5/19/04	5/19/04	5/20/04	N/A
Run Start Time	8:10	10:08	8:52	N/A
Run Stop Time	9:09	11:11	9:52	N/A
Number of Truck Loads	5	4	8	5.7
Sand, lbs.	65,120	39,700	81,320	62,046
Stone, lbs.	78,860	51,840	100,700	77,133
Type 1-2 Cement, lbs.	20,860	13,100	27,280	20,413
Flyash, lbs.	4,990	3,190	6,580	4,920
Water, lbs.	66,092.4	40,256.28	61,763.04	56,037.24
Water Reducer, lbs.	64.69	34.94	67.31	55.65
Liquid Air, lbs.	0	3.06	18.25	7.10
Retarder, lbs.	0	0	6.5	2.2
Total Process Weight, lbs.	235,987	148,124	277,735	220,614
Total Process Weight, tons	117.994	74.052	138.868	110.307
Total Process Weight, yards	45.0	29.0	58.0	44
Tons / Yard	2.62	2.55	2.42	2.51

The raw materials for both the truck and central mix processes come from the same sources and, therefore, were sampled only once at the Wake Forest, RMCC plant. The raw material size distribution, moisture levels, and silt contents are summarized in Table 17.17.

Table 17.17. Raw Material Particle Size Distribution, Moisture Levels and Silt Contents

Raw Material	Date of Test	Time Sample Taken	% Greater than 75 mm	% Greater than 19 mm	% Greater than #20 Mesh	% Greater than 100 Mesh	% Greater than 200 Mesh	Pan % Less than # 200 Mesh (Silt)	% Moisture
RMCC, Wake Forest Plants (Truck Mix and Central Mix)									
Sand	12/8/03	13:00	0.0	0.0	41.06	56.61	1.56	0.77	12.87[5]
Stone	12/8/03	13:00	0.0	33.59	64.93	0.77	0.34	0.38	1.44
Cement	12/8/03	14:00	0.0	0.0	0.0	79.96	10.01	10.03	0.27
Flyash	12/9/03	08:07	0.0	0.0	0.0	4.14	11.13	84.73	0.21
S.T. Wooten, Raleigh Plant									
Cement	3/2/04	11:52	0.0	0.0	0.0	37.7	12.5	49.8	0.30
Flyash	3/2/04	13:06	0.0	0.0	0.31	1.78	10.3	87.6	0.09
Sand	3/2/04	9:11	0.0	0.0	19.3	79.1	0.7	0.8	6.3
Stone	3/2/04	11:18	0.0	18.8	78.9	1.1	0.4	0.8	1.1
Chandler Concrete, Troutville Plant									
Cement	3/16/04	13:15	0.0	0.0	0.0	73.5	21.94	4.56	0.39
Flyash	3/16/04	13:22	0.0	0.0	37.2	3.18	9.63	86.81	0.16
Sand	3/16/04	10:57	0.0	0.0	5.80	92.57	1.43	0.2	8.01
Stone	3/16/04	12:24	0.0	9.92	89.05	0.35	0.18	0.50	2.07
Concrete Supply, Rock Hill Plant									
Cement	5/11/04	13:15	0.0	0.0	0.09	80.68	18.12	1.11	0.31
Flyash	5/11/04	14:38	0.0	0.0	0.189	3.89	12.28	83.64	0.07
Sand	5/11/04	15:21	0.0	0.0	24.96	72.59	1.96	0.48	3.43
Stone	5/11/04	16:33	0.0	18.87	80.41	0.17	0.11	0.44	0.46
RMC Carolina Materials, Raleigh Plant									
Cement	5/18/04	15:13	0.0	0.0	0.70	91.74	5.26	2.30	1.07
Flyash	5/18/04	16:13	0.0	0.0	0.24	4.07	26.87	68.82	0.19
Sand	5/18/04	12:45	0.0	0.0	23.89	73.25	2.25	0.62	7.70
Stone	5/18/04	17:08	0.0	22.05	76.94	0.39	0.19	0.42	0.86

Wind Speed and Direction

Meteorological data were monitored on a continuous basis on the downwind side of the process being tested. During the first test run at the RMCC plant, it was determined that the wind speed and direction were erratic due to constant truck traffic moving from the loading areas to the wash-off area and the topography of the surrounding plant area. Earth berms and trees surround the plant and form a bowl shaped depression around the plant. The topography causes

[5] The sand moisture content of 12.87% is higher than levels in some parts of the U.S. This sand moisture value has been confirmed for this facility.

swirling wind conditions, especially during truck movement in and out of the loading areas. For this reason, the data were erratic and could not be used to evaluate wind direction. Air Control Techniques, P.C. visually observed wind direction to confirm that fugitive emissions were passing through the array. The rapid response of the TEOM monitor to the fugitive emissions during each truck and central mixer loading operation also provided direct confirmation that the wind direction was in the appropriate direction during the test program. Table 17.18 summarizes the average wind speeds during both the truck and central mix tests for the five plants tested.

Table 17.18. Wind Speed Averages

Test Run	Average Wind Speed, MPH
RMCC Wake Forest	
Truck Mix Run # 1	1.1
Truck Mix Run # 2	1.4
Truck Mix Run # 3	1[1]
Average	1.2
RMCC Wake Forest	
Central Mix Run # 1	1[1]
Central Mix Run # 2	2.7
Central Mix Run # 3	2.5
Average	2.1
S.T. Wooten, Raleigh	
Central Mix Run # 1	7.0
Central Mix Run # 2	8.2
Central Mix Run # 3	2.7
Average	6.0
Chandler Concrete[2]	
Truck Mix Run # 1	1.7
Truck Mix Run # 2	4.3
Truck Mix Run # 3	1.3
Average	2.4
Concrete Supply	
Truck Mix Run # 1	1.1
Truck Mix Run # 2	1.5
Truck Mix Run # 3	1.6
Average	1.4
RMC Carolina Materials	
Central Mix Run # 1	7.1
Central Mix Run # 2	4.4
Central Mix Run # 3	1.5
Average	4.3

1. One mph was used as a default value during tests in which the meteorological monitoring station was blocked by trucks being loaded.
2. Wind speed potentially biased low due to wind blocking effect of truck on meteorological monitoring station.

REFERENCES FOR SECTION 4

1. *Final Test Report for USEAP* [sic] Test *Program Conducted at Chaney Enterprises Cement Plant*, ETS, Inc. Roanoke, VA, April 1994.

2. *Final Test Report for USEPA* [sic] *Test Program Conducted at Concrete Ready Mixed Corporation*, ETS, Inc. Roanoke, VA, April 1994.

3. *Emission Test for Tiberi Engineering Compan*y, Alar Engineering Corporation, Burbank, IL, October 1972.

4. *Stack Test "Confidential*" (Test obtained from State of Tennessee,), Environmental Consultants, Oklahoma City, OK, February 1976.

5. Source Sampling Report, Particulate Emissions from Cement Silo Loading, Specialty Alloys Corporation, Gallaway, Tennessee, Reference Number 24-00051-02, State of Tennessee, Department of Health and Environmental, Division of Air Pollution Control, June 12, 1984.

6. Richards, J. and T. Brozell. "*Ready Mixed Concrete Emission Factors, Final Report*" Report to the Ready Mixed Concrete Research Foundation, Silver Spring, Maryland. August 2004.

5. FINAL EMISSION FACTORS

5.1 Truck Mix and Central Mix Loading Particulate Matter Emission Factors

Emission factor data (run-by-run) applicable to controlled truck mix and central mix loading operations are summarized in Tables 18.1 and 18.2. The emission factor data for uncontrolled conditions are summarized in Tables 18.3 and 18.4.

The emission factor data for the six plants summarized in reference 6 are rated A because the fugitive emission rates were measured directly using EPA reference methods. The emission factor data for the plant summarized in reference 1 and the two plants summarized in reference 2 are rated B because the fugitive emission rates from the loading operations were estimated based on qualitative visible emission observations.

Table 18.1. Central Mix Loading Operation (Controlled) Emission Factor Data.

Reference	Plant	Run	Cement Moisture %	Cement Supplement Moisture, %	Minimum Moisture of Cement and Supplement, %	Tons per Hour of Cement and Cement Supplement	Wind Speed, mph	Total PM, lbs/ton	PM_{10}, lbs/ton	$PM_{2.5}$, lbs/ton	Report Format
6	RMCC	1	0.27	0.21	0.21	6.82	1	0.0043	0.0041	0.00259	A
6	RMCC	2	0.27	0.21	0.21	8.88	2.7	0.0023	0.0013	0.00003	A
6	RMCC	3	0.27	0.21	0.21	7.18	2.5	0.0030	0.0030	0.00157	A
Test Average			**0.27**	**0.21**	**0.21**	**7.63**	**2.1**	**0.0032**	**0.0028**	**0.00140**	
6	S.T.Wooten	1	0.30	0.09	0.09	7.90	1.0	0.0197	0.0047	0.00042	A
6	S.T.Wooten	2	0.30	0.09	0.09	13.10	8.2	0.0756	0.0124	0.00109	A
6	S.T.Wooten	3	0.30	0.09	0.09	15.27	2.7	0.0253	0.0114	0.00066	A
Test Average			**0.3**	**0.09**	**0.09**	**12.09**	**4.0**	**0.0402**	**0.0095**	**0.00072**	
6	Carolina Mat'l	1	1.07	0.19	0.19	13.01	7.1	0.0310	0.0079	0.00056	A
6	Carolina Mat'l	2	1.07	0.19	0.19	8.15	4.4	0.0224	0.0058	0.00106	A
6	Carolina Mat'l	3	1.07	0.19	0.19	16.80	1.5	0.0039	0.0039	0.00008	A
Test Average			**1.07**	**0.19**	**0.19**	**12.65**	**4.3**	**0.0191**	**0.0059**	**0.00057**	
1	Cheney Enterprises	10	0.13	0.06	0.13	15.09	ND	0.0081	0.0057	ND	B
1	Cheney Enterprises	11	0.13	0.06	0.13	15.61	ND	0.0391	0.0101	ND	B
1	Cheney Enterprises	12	0.13	0.06	0.13	15.72	ND	0.0048	0.0002	ND	B
1	Cheney Enterprises	13	0.13	0.06	0.13	14.01	ND	0.0020	0.0014	ND	B
1	Cheney Enterprises	17	0.13	0.06	0.13	22.43	ND	0.0019	0.0015	ND	B
Test Average			**0.13**	**0.06**	**0.13**	**16.572**		**0.0111**	**0.0038**		
Average, Central Mix Controlled								**0.0184**	**0.0055**	**0.0009**	

Table 18.2. Truck Mix Loading Operation (Controlled) Emission Factor Data.

Reference	Plant	Run	Cement Moisture %	Cement Supplement Moisture, %	Minimum Moisture, %	Tons per Hour of Cement and Cement Supplement	Wind Speed, mph	Total PM, lbs/ton	PM_{10}, lbs/ton	$PM_{2.5}$, lbs/ton	Report Rating
6	RMCC	1	0.27	0.21	0.21	8.58	1.0	0.0035	0.0028	3.50E-05	A
6	RMCC	2	0.27	0.21	0.21	3.00	1.4	0.0201	0.0054	8.63E-04	A
6	RMCC	3	0.27	0.21	0.21	6.91	1.0	0.0047	0.0036	1.09E-03	A
Test Average			**0.27**	**0.21**	**0.21**	**6.16**	**1.13**	**0.0094**	**0.0039**	**6.63E-04**	
6	Chandler	1	0.39	0.16	0.16	6.19	1.7	0.0367	0.0177	3.77E-03	A
6	Chandler	2	0.39	0.16	0.16	4.12	4.3	0.0665	0.0313	3.11E-03	A
6	Chandler	3	0.39	0.16	0.16	7.75	1.3	0.0504	0.0185	2.30E-03	A
Test Average			**0.39**	**0.16**	**0.16**	**6.02**	**2.43**	**0.0512**	**0.0225**	**3.06E-03**	
6	Concrete Supply	1	0.31	0.07	0.07	20.24	1.1	0.0078	0.0015	2.22E-04	A
6	Concrete Supply	2	0.31	0.07	0.07	21.73	1.5	0.0160	0.0044	3.64E-04	A
6	Concrete Supply	3	0.31	0.07	0.07	13.61	1.6	0.0354	0.0046	3.38E-04	A
Test Average			**0.31**	**0.07**	**0.07**	**18.53**	**1.40**	**0.0197**	**0.0035**	**3.08E-04**	
2	CRMC	1	0.03	NA	0.03	16.86	ND	0.0985	0.0308	ND	B
2	CRMC	2	0.03	NA	0.03	20.27	ND	0.1349	0.0333	ND	B
2	CRMC	3	0.03	NA	0.03	18.61	ND	0.1096	0.0275	ND	B
2	CRMC	4	0.03	NA	0.03	16.92	ND	0.0849	0.0180	ND	B
2	CRMC	5	0.03	NA	0.03	11.83	ND	0.0856	0.0233	ND	B
2	CRMC	6	0.03	NA	0.03	ND	ND	0.9854	0.2067	ND	B
2	CRMC	7	0.03	NA	0.03	29.00	ND	0.0305	0.0289	ND	B
2	CRMC	8	0.03	NA	0.03	26.30	ND	0.0072	0.0055	ND	B
2	CRMC	9	0.03	NA	0.03	18.61	ND	0.0120	0.0070	ND	B
2	CRMC	10	0.03	NA	0.03	16.55	ND	0.0084	0.0053	ND	B
Test Average			**0.03**		**0.03**	**19.44**		**0.1557**	**0.0386**		
1	Chaney	2	0.13	0.06	0.06	14.60	ND	0.0721	0.0540	ND	B
1	Chaney	4	0.13	NA	0.13	13.92	ND	0.0396	0.0285	ND	B
1	Chaney	9	0.13	NA	0.13	19.56	ND	0.0261	0.0116	ND	B
1	Chaney	14	0.13	0.06	0.06	14.70	ND		0.0980	ND	B
1	Chaney	15	0.13	0.06	0.06	17.88	ND	0.6304	0.0706	ND	B
1	Chaney	16	0.13	NA	0.13	11.01	ND	0.5054	0.1144	ND	B
Test Average			**0.13**	**0.06**	**0.095**	**15.28**		**0.2547**	**0.0629**		
Average, Truck Mix Controlled								**0.098**	**0.0263**	**0.00134**	

Table 18.3. Central Mix Loading Operation (Uncontrolled) Emission Factor Data.

Reference	Plant	Run	Cement Moisture %	Cement Supplement Moisture, %	Minimum Moisture of Cement and Supplement, %	Tons per Hour of Cement and Cement Supplement	Wind Speed, mph	Total PM, lbs/ton	PM_{10}, lbs/ton	$PM_{2.5}$, lbs/ton	Report Format
6	RMCC	1	0.27	0.21	0.21	6.82	1	0.102	0.031	0.009	A
6	RMCC	2	0.27	0.21	0.21	8.88	2.7	0.174	0.067	0.009	A
6	RMCC	3	0.27	0.21	0.21	7.18	2.5	0.188	0.070	0.009	A
Test Average			**0.27**	**0.21**	**0.21**	**7.63**	**2.1**	**0.155**	**0.056**	**0.009**	
6	S.T.Wooten	1	0.30	0.09	0.09	7.90	1.0	1.718	0.411	0.0357	A
6	S.T.Wooten	2	0.30	0.09	0.09	13.10	8.2	1.203	0.206	0.017	A
6	S.T.Wooten	3	0.30	0.09	0.09	15.27	2.7	0.841	0.376	0.022	A
Test Average			**0.3**	**0.09**	**0.09**	**12.09**	**4.0**	**1.254**	**0.331**	**0.0249**	
6	Carolina Mat'l	1	1.07	0.19	0.19	13.01	7.1	0.613	0.156	0.011	A
6	Carolina Mat'l	2	1.07	0.19	0.19	8.15	4.4	0.736	0.191	0.035	A
6	Carolina Mat'l	3	1.07	0.19	0.19	16.80	1.5	0.613	0.134	0.0131	A
Test Average			**1.07**	**0.19**	**0.19**	**12.65**	**4.3**	**0.654**	**0.160**	**0.0197**	
1	Cheney Enterprises	10	0.13	0.06	0.13	15.09	ND	0.0794	0.0564	ND	B
1	Cheney Enterprises	11	0.13	0.06	0.13	15.61	ND	0.242	0.0622	ND	B
1	Cheney Enterprises	12	0.13	0.06	0.13	15.72	ND	0.4568	0.01	ND	B
1	Cheney Enterprises	13	0.13	0.06	0.13	14.01	ND	0.166	0.123	ND	B
1	Cheney Enterprises	17	0.13	0.06	0.13	22.43	ND	0.17	0.137	ND	B
Test Average			**0.13**	**0.06**	**0.13**	**16.572**		**0.223**	**0.078**		
Average, Central Mix Uncontrolled								**0.572**	**0.156**	**0.018**	

Table 18.4. Truck Mix Loading Operation (Uncontrolled) Emission Factor Data.

Reference	Plant	Run	Cement Moisture %	Cement Supplement Moisture, %	Minimum Moisture, %	Tons per Hour of Cement and Cement Supplement	Wind Speed, mph	Total PM, lbs/ton	PM_{10}, lbs/ton	$PM_{2.5}$, lbs/ton	Report Rating
6	RMCC	1	0.27	0.21	0.21	8.58	1.0	0.380	0.118	1.46E-02	A
6	RMCC	2	0.27	0.21	0.21	3.00	1.4	1.349	0.349	3.34E-02	A
6	RMCC	3	0.27	0.21	0.21	6.91	1.0	4.655	1.710	2.57E-01	A
Test Average			**0.27**	**0.21**	**0.21**	**6.16**	**1.13**	**2.128**	**0.726**	**1.02E-01**	
6	Chandler	1	0.39	0.16	0.16	6.19	1.7	0.388	0.188	3.91E-02	A
6	Chandler	2	0.39	0.16	0.16	4.12	4.3	0.488	0.231	2.28E-02	A
6	Chandler	3	0.39	0.16	0.16	7.75	1.3	0.756	0.278	3.39E-02	A
Test Average			**0.39**	**0.16**	**0.16**	**6.02**	**2.43**	**0.544**	**0.232**	**3.19E-02**	
6	Concrete Supply	1	0.31	0.07	0.07	20.24	1.1	0.795	0.153	2.27E-02	A
6	Concrete Supply	2	0.31	0.07	0.07	21.73	1.5	1.1378	0.309	2.60E-02	A
6	Concrete Supply	3	0.31	0.07	0.07	13.61	1.6	3.1470	0.410	2.84E-02	A
Test Average			**0.31**	**0.07**	**0.07**	**18.53**	**1.40**	**1.693**	**0.291**	**2.57E-02**	
2	CRMC	1	0.03	NA	0.03	16.86	ND	0.500	0.1256	ND	B
2	CRMC	2	0.03	NA	0.03	20.27	ND	0.822	0.1680	ND	B
2	CRMC	3	0.03	NA	0.03	18.61	ND	0.650	0.1460	ND	B
2	CRMC	4	0.03	NA	0.03	16.92	ND	0.474	0.0894	ND	B
2	CRMC	5	0.03	NA	0.03	11.83	ND	0.496	0.1215	ND	B
2	CRMC	6	0.03	NA	0.03	ND	ND	2.128	0.4406	ND	B
2	CRMC	7	0.03	NA	0.03	29.00	ND	0.098	0.0960	ND	B
2	CRMC	8	0.03	NA	0.03	26.30	ND	0.009	0.0070	ND	B
2	CRMC	9	0.03	NA	0.03	18.61	ND	0.018	0.0090	ND	B
2	CRMC	10	0.03	NA	0.03	16.55	ND	0.015	0.0076	ND	B
Test Average			**0.03**		**0.03**	**19.44**		**0.5210**	**0.1211**		
1	Chaney	2	0.13	0.06	0.06	14.60	ND	0.2564	0.1922	ND	B
1	Chaney	4	0.13	NA	0.13	13.92	ND	0.1872	0.135	ND	B
1	Chaney	9	0.13	NA	0.13	19.56	ND	0.1178	0.0522	ND	B
1	Chaney	14	0.13	0.06	0.06	14.70	ND		0.2224	ND	B
1	Chaney	15	0.13	0.06	0.06	17.88	ND	1.7494	0.1956	ND	B
1	Chaney	16	0.13	NA	0.13	11.01	ND	1.2026	0.2718	ND	B
Test Average			**0.13**	**0.06**	**0.095**	**15.28**		**0.703**	**0.178**		
Average, Truck Mix Uncontrolled								**1.118**	**0.310**	**0.053**	

The emission factors for the truck mix and central mix loading operations have been compiled in two different formats: (1) a general factor that is based strictly on cement and cement supplement loading rates, and (2) predictive equations that take into account site specific information. The latter approach is preferred whenever the site specific information is available.

5.1.1 General Emission Factors

The general emission factors have been compiled based on the test average values summarized in Tables 18.1 through 18.4.

Previously, EPA has determined that Run 14 conducted at the truck mix loading operation at Chaney Enterprises (Reference 1) was an outlier. This was confirmed during this update to the data tables. Several additional high and low outliers were identified in references 1 and 2 for the truck mix operations. However, the removal of these outliers had essentially no impact on the final emission factor test results. Accordingly, all of the test average values shown in Tables 18.1 through 18.2 have been used without any adjustments to correct for outliers with the exception or Reference 1, Run 14. The general emission factors for total particulate matter, PM_{10}, and $PM_{2.5}$ are summarized in Tables 18.5 and 18.6.

The results of the controlled truck mix loading data analyses (Table 18.5) yield an arithmetic emission factor value of 0.026 pounds PM_{10} per ton of cement and cement supplement loaded. The 90% confidence interval for this data set of is 0.010 pounds PM_{10}/ton of cement and cement supplement (minimum) and 0.043 pounds PM_{10}/ton of cement and cement supplement (maximum). The standard deviation for the data set of five test averages is 0.022 pounds PM_{10}/ton of cement and cement supplement loaded.

The results of the controlled central mix loading data analyses (Table 18.5) yield an arithmetic emission factor value of 0.006 pounds PM_{10} per ton of cement and cement supplement loaded. The 90% confidence interval for this data set is 0.003 pounds PM_{10}/ton of cement and cement supplement loaded and 0.008 pounds PM_{10}/ton of cement and cement supplement loaded. The standard deviation for the data set of five test averages is 0.003 pounds PM_{10}/ton of cement and cement supplement loaded.

Table 18.5. General Emission Factors, Loading Operations, Controlled.

Type of Loading Operation	Analyte	Emissions, pounds per ton of cement and cement supplement loaded			
		Average	Standard Deviation	Minimum of 90% Confidence Interval	Maximum of 90% Confidence Interval
Truck Mix	PM	0.098	0.094	0.029	0.167
	PM_{10}	0.026	0.022	0.010	0.043
	$PM_{2.5}$	0.001	0.001	0.000	0.003
Central Mix	PM	0.018	0.016	0.005	0.031
	PM_{10}	0.006	0.003	0.003	0.008
	$PM_{2.5}$	0.001	0.000	0.000	0.001

Similar analyses were conducted for the uncontrolled emission factor data. With respect to the Reference 6 data, the uncontrolled emissions were calculated as the total of the fugitive emissions plus the inlet mass flow rate to the fabric filter. The results of the analyses of the uncontrolled emission factor data are provided in Table 18.6.

The results of the uncontrolled truck mix loading data analyses (Table 18.6) yield an arithmetic emission factor value of 0.031 pounds PM_{10} per ton of cement and cement supplement loaded. The 90% confidence interval for this data set of is 0.132 pounds PM_{10}/ton of cement and

cement supplement (minimum) and 0.487 pounds PM_{10}/ton of cement and cement supplement (maximum). The standard deviation for the data set of five test averages is 0.241 pounds PM_{10}/ton of cement and cement supplement loaded.

The results of the uncontrolled central mix loading data analyses (Table 18.6) yield an arithmetic emission factor value of 0.156 pounds PM_{10} per ton of cement and cement supplement loaded. The 90% confidence interval for this data set is 0.054 pounds PM_{10}/ton of cement and cement supplement loaded and 0.259 pounds PM_{10}/ton of cement and cement supplement loaded. The standard deviation for the data set of five test averages is 0.125 pounds PM_{10}/ton of cement and cement supplement loaded.

Table 18.6. General Emission Factors, Loading Operations, Uncontrolled.

Type of Loading Operation	Analyte	Emissions, pounds per ton of cement and cement supplement loaded			
		Average	Standard Deviation	Minimum of 90% Confidence Interval	Maximum of 90% Confidence Interval
Truck Mix	PM	1.118	0.743	0.571	1.664
	PM_{10}	0.310	0.241	0.132	0.487
	$PM_{2.5}$	0.053	0.042	0.013	0.093
Central Mix	PM	0.572	0.506	0.156	0.987
	PM_{10}	0.156	0.125	0.054	0.259
	$PM_{2.5}$	0.018	0.008	0.010	0.026

5.1.2 Site Specific Equations

In the previous edition of Section 11.12 and in Section 5.1.1 of this document, the truck mix and central mix loading emission factors for particulate matter have been expressed on the basis of pounds of emission per ton of cement and cement supplement loaded. In the planning for the emissions test program documented in reference 6, several previously unmeasured variables that may affect emissions were identified for improved monitoring. Several other AP-42 emissions factors have used material surface moisture levels and wind speed to increase the predictive precision of the resulting emissions factor equation over the traditional single value emissions factor. As with most particulate matter emissions factors, the within source and between source variability is significant. As presented in Tables 18.5 and 18.6, the Standard Deviation of the data is approximately equal in magnitude to the emissions factors. An examination of the test data supporting these emission factors indicated that the production rate (tons of cement and cement supplement) alone did not serve as an adequate parameter to explain the variability and improve the predictive capability of the emissions factor. For example, in Figure 5.1, the reference 1 and 2 PM_{10} controlled emissions data applicable to truck mix operations are illustrated along with the emission factor values that would be calculated based on the AP-42 factor of 0.051 pounds per ton of cement and cement supplement. Similar data are shown in Figure 5.2, for reference 1 PM_{10} controlled emissions data applicable to central mix loading operations. In the case of Figure 5.2, the data should fall on the emission factor line having a slope of 0.0038 pounds PM_{10} per ton of cement and cement supplement.

The lack of a strong relationship between the measured emission rate in pounds per hour and the production rate in tons of cement and supplement per hour is also apparent in the truck mix data provided in reference 6 (Figure 5.3). The emission factor data in references 1, 2, and 6 for truck mix and central mix loading operations indicates that there are variables in addition to production rate that affect particulate matter emissions.

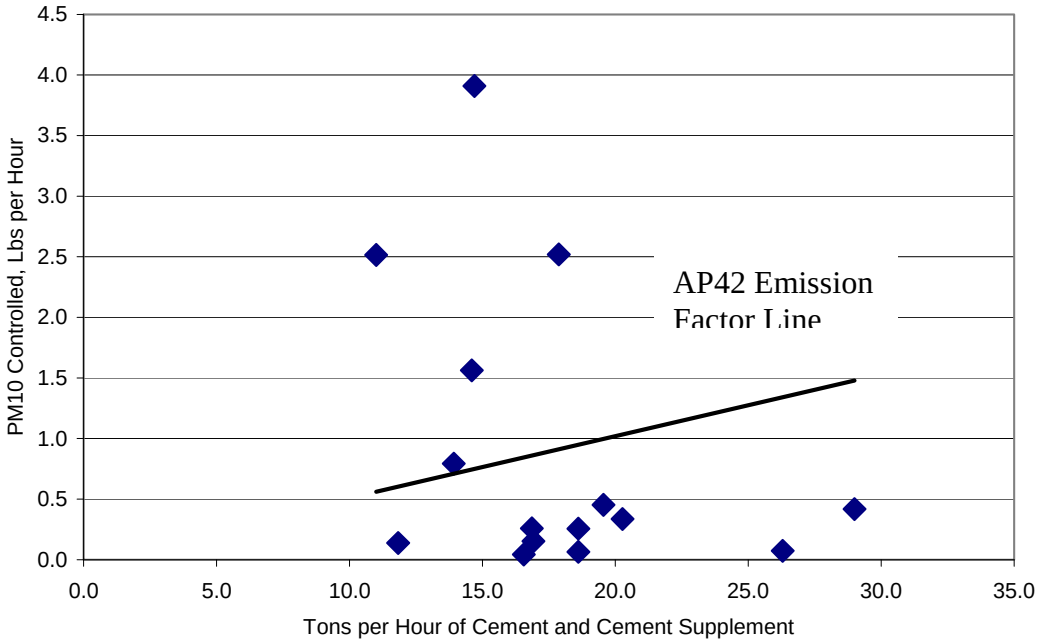


Figure 5.1. Truck Mix Emission Factor Data, EPA AP-42 Section 11.12 References 1 and 2 (Note: Data should be on a line with a slope of 0.051 lbs PM_{10}/ton of cement.)

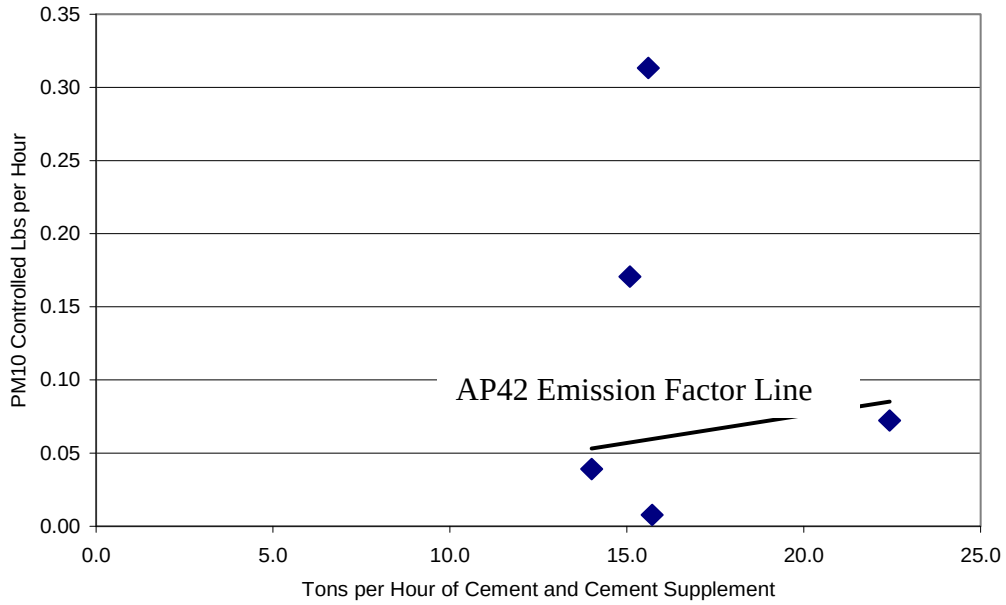


Figure 5.2. Central Mix Emission Factor Data, EPA AP-42 Section 11.12 Reference 1 (Note: Data should be a line with a slope of 0.0038 lbs PM_{10}/ton of cement.)

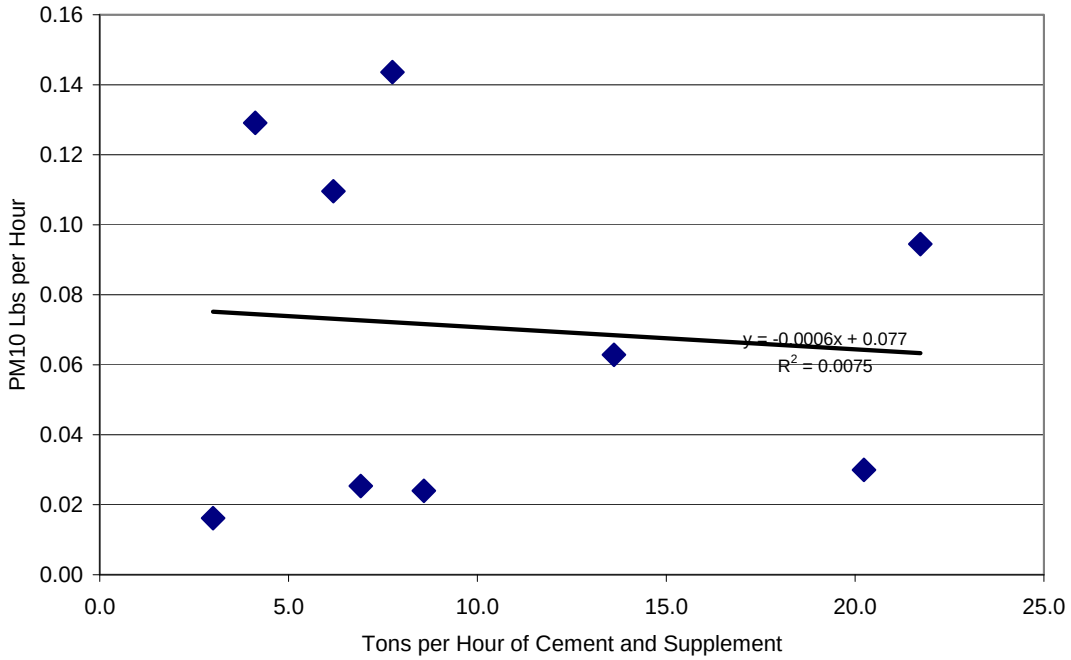


Figure 5.3. Truck Mix Emission Factor Data, Reference 6
(Note: Data should be on a line with a slope of 0.051 lbs PM_{10}/ton of cement.)

Since Reference 6 included documentation of the moisture content of the cement and cement supplement (fly ash) and the air velocity near the drop point, the effect of these variables on the emissions factors is possible. Performing a polynomial regression analysis mathematically evaluates the appropriate exponential relationship between the independent variables (moisture content, air velocity and production rate) and the dependent variable emissions per unit activity. Microsoft Excel® provides a multiple linear regression analysis capability in the analysis tools. Prior to using the regression analysis tool, the dependent (emissions) and independent (moisture and air velocity) data are log transformed. A regression analysis is performed on the log transformed data to generate the exponents for the independent variables and to determine the statistical significance that these variables provide to explain the variability of the data. Following determining the exponents and the strength of the relationship, those parameters exhibiting an R2 greater than approximately 0.5 are carried forward where a second regression analysis determines the slope multipliers to use with the polynomials and any constant to use with the equation. Tables 18.7 through 18.13 present the results of the regression analyses for Total PM, PM_{10} and $PM_{2.5}$ for truck mix operations and Tables 18.14 through 18.23 present similar results for central mix operations.

Table 18.7. Regression Output for Air Velocity and Moisture for Uncontrolled PM for Truck Mix Operations.

SUMMARY OUTPUT

Uncontrolled Total PM

Regression Statistics	
Multiple R	0.38
R Square	0.15
Adjusted R Square	-0.14
Standard Error	0.94
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and uncontrolled emissions as the dependent (Y) variable. The low (0.15) R Square indicates that wind and moisture have little influence on the variability of the uncontrolled emissions. In addition, the negative value for the air velocity exponent is counter to the engineering analysis

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.91	0.46	0.51	0.62
Residual	6	5.35	0.89		
Total	8	6.26			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.38	1.43	-0.27	0.80	-3.88	3.11	-3.88	3.11
X Variable 1	-0.33	0.67	-0.48	0.65	-1.97	1.32	-1.97	1.32
X Variable 2	-0.69	0.77	-0.89	0.41	-2.57	1.19	-2.57	1.19

Table 18.8. Regression Output for Air Velocity and Moisture for Uncontrolled PM_{10} Emissions from Truck Mix Operations.

SUMMARY OUTPUT
Uncontrolled PM10

Regression Statistics	
Multiple R	0.25
R Square	0.06
Adjusted R Square	-0.25
Standard Error	0.86
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and uncontrolled emissions as the dependent (Y) variable. The low (0.06) R Square indicates that wind and moisture have little influence on the variability of the uncontrolled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.31	0.15	0.21	0.82
Residual	6	4.46	0.74		
Total	8	4.77			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.57	1.30	-0.44	0.68	-3.76	2.62	-3.76	2.62
X Variable 1	0.25	0.62	0.41	0.69	-1.25	1.76	-1.25	1.76
X Variable 2	-0.34	0.70	-0.49	0.64	-2.06	1.37	-2.06	1.37

Table 18.9. Regression Output for Air Velocity and Moisture for Uncontrolled $PM_{2.5}$ from Truck Mix Operations.

SUMMARY OUTPUT
Uncontrolled PM2.5

Regression Statistics	
Multiple R	0.44
R Square	0.19
Adjusted R Square	-0.08
Standard Error	0.84
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and uncontrolled emissions as the dependent (Y) variable. The low (0.19) R Square indicates that wind and moisture has little influence on the variability of the uncontrolled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.00	0.50	0.71	0.53
Residual	6	4.25	0.71		
Total	8	5.26			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.10	1.27	-1.65	0.15	-5.22	1.01	-5.22	1.01
X Variable 1	0.52	0.60	0.86	0.42	-0.95	1.99	-0.95	1.99
X Variable 2	-0.56	0.68	-0.81	0.45	-2.23	1.12	-2.23	1.12

Table 18.10. Regression Output for Moisture and Air Velocity for Controlled PM from Truck Mix Operations.

SUMMARY OUTPUT

Controlled Total PM

Regression Statistics	
Multiple R	0.74
R Square	0.55
Adjusted R Square	0.40
Standard Error	0.81
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The moderate (0.55) R Square indicates that wind and moisture explain about 55% of the variability of the controlled emissions. The exponents of -0.29 for moisture and 1.75 for air velocity will be carried forward to determine the multiplier and intercept for the final emissions factor equation.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	4.80	2.40	3.64	0.09
Residual	6	3.96	0.66		
Total	8	8.77			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-5.33	1.23	-4.34	0.00	-8.34	-2.32	-8.34	-2.32
X Variable 1	-0.29	0.58	-0.49	0.64	-1.70	1.13	-1.70	1.13
X Variable 2	1.75	0.66	2.65	0.04	0.13	3.37	0.13	3.37

Table 18.11. Regression Output for Slope and Intercept Coefficients for Controlled PM for Truck Mix Operations.

SUMMARY OUTPUT

Controlled Total PM

Regression Statistics	
Multiple R	0.75
R Square	0.56
Adjusted R Square	0.50
Standard Error	0.02
Observations	9

This is the output from the MS Excel regression analysis from selecting the parameter value as the independent (X) variables and controlled emissions as the dependent (Y) variable. The moderate (0.56) R Square indicates that wind and moisture explain about 56% of the variability of the controlled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00212	0.00212	8.94373	0.02021
Residual	7	0.00166	0.00024		
Total	8	0.00378			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.0129	0.0068	1.8959	0.0998	-0.0032	0.0290	-0.0032	0.0290
X Variable 1	0.00258	0.00086	2.99061	0.02021	0.00054	0.00463	0.00054	0.00463

Table 18.12. Regression Output for Moisture and Air Velocity Exponents for Controlled PM_{10} Emissions From Truck Mix Operations.

SUMMARY OUTPUT
Controlled PM10

Regression Statistics	
Multiple R	0.82
R Square	0.67
Adjusted R Square	0.56
Standard Error	0.66
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The moderate (0.67) multiple R Square indicates that wind and moisture explain about 67% of the variability of the controlled emissions. However, the predicted exponent for moisture would indicate that emissions increase with increasing moisture. This is counter to good engineering analysis. As a result, the use of these parameters should not be used.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	5.30	2.65	6.09	0.04
Residual	6	2.61	0.43		
Total	8	7.90			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-4.35	1.00	-4.36	0.00	-6.79	-1.91	-6.79	-1.91
X Variable 1	0.70	0.47	1.49	0.19	-0.45	1.85	-0.45	1.85
X Variable 2	1.70	0.54	3.17	0.02	0.39	3.01	0.39	3.01

Table 18.13. Regression Output for Moisture and Air Velocity Exponents for Controlled $PM_{2.5}$ Emissions for Truck Mix Operations.

SUMMARY OUTPUT
Controlled PM2.5

Regression Statistics	
Multiple R	0.57
R Square	0.33
Adjusted R Square	0.10
Standard Error	1.37
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The moderate (0.33) multiple R Square indicates that wind and moisture may explain about 33% of the variability of the controlled emissions. However, the predicted exponent for moisture would indicate that emissions increase with increasing moisture. This is counter to good engineering analysis. As a result, the use of these parameters should not be used.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	5.49	2.75	1.47	0.30
Residual	6	11.23	1.87		
Total	8	16.72			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-6.53	2.07	-3.16	0.02	-11.59	-1.47	-11.59	-1.47
X Variable 1	0.74	0.98	0.75	0.48	-1.65	3.13	-1.65	3.13
X Variable 2	1.72	1.11	1.54	0.17	-1.01	4.44	-1.01	4.44

Table 18.14 Regression Output for Moisture and Air Velocity for Uncontrolled PM Emissions from Central Mix Operations.

SUMMARY OUTPUT

Uncontrolled Total PM

Regression Statistics	
Multiple R	0.86
R Square	0.74
Adjusted R Square	0.65
Standard Error	0.57
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The good (0.74) R Square indicates that wind and moisture explain about 74% of the variability of the uncontrolled emissions. The exponents of -1.27 for moisture and 0.59 for air velocity will be carried forward to determine the multiplier and intercept for the final emissions factor equation.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	5.44	2.72	8.40	0.018
Residual	6	1.94	0.32		
Total	8	7.38			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-3.81	0.98	-3.88	0.01	-6.21	-1.41	-6.21	-1.41
X Variable 1	-1.27	0.59	-2.14	0.08	-2.72	0.18	-2.72	0.18
X Variable 2	0.59	0.33	1.82	0.12	-0.20	1.39	-0.20	1.39

Table 18.15 Regression Output for Moisture and Air Velocity for Controlled PM Emissions from Central Mix Operations.

SUMMARY OUTPUT

Controlled Total PM

Regression Statistics	
Multiple R	0.87
R Square	0.75
Adjusted R Square	0.67
Standard Error	0.65
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The good (0.75) R Square indicates that wind and moisture explain about 75% of the variability of the uncontrolled emissions. The exponents of -1.04 for moisture and 0.95 for air velocity will be carried forward to determine the multiplier and intercept for the final emissions factor equation.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	7.74	3.87	9.19	0.015
Residual	6	2.53	0.42		
Total	8	10.27			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-7.47	1.12	-6.68	0.00	-10.21	-4.74	-10.21	-4.74
X Variable 1	-1.04	0.68	-1.54	0.17	-2.70	0.61	-2.70	0.61
X Variable 2	0.95	0.37	2.57	0.04	0.04	1.86	0.04	1.86

Table 18.16 Regression Output for Slope and Intercept Coefficients for Uncontrolled PM Emissions for Central Mix Operations.

SUMMARY OUTPUT
Uncontrolled Total PM

Regression Statistics	
Multiple R	0.90
R Square	0.80
Adjusted R Square	0.77
Standard Error	0.25
Observations	9

This is the output from the MS Excel regression analysis from selecting the parameter value as the independent (X) variables and uncontrolled emissions as the dependent (Y) variable. The good (0.80) R Square indicates that wind and moisture explain about 80% of the variability of the uncontrolled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.78	1.78	28.37	0.0011
Residual	7	0.44	0.063		
Total	8	2.22			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.12	0.13	0.92	0.39	-0.20	0.44	-0.20	0.44
X Variable 1	0.019	0.0035	5.33	0.0011	0.010	0.027	0.010	0.027

Table 18.17 Regression Output for Moisture and Air Velocity for Controlled PM Emissions from Central Mix Operations.

SUMMARY OUTPUT
Controlled Total PM

Regression Statistics	
Multiple R	0.82
R Square	0.67
Adjusted R Square	0.62
Standard Error	0.014
Observations	9

This is the output from the MS Excel regression analysis from selecting the parameter value as the independent (X) variables and controlled emissions as the dependent (Y) variable. The modest (0.67) R Square indicates that wind and moisture explain about 67% of the variability of the controlled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.0028	0.0028	14.22229	0.0070
Residual	7	0.0014	0.00020		
Total	8	0.0042			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.0012	0.0071	0.16	0.87	-0.016	0.018	-0.016	0.018
X Variable 1	0.00060	0.00016	3.77	0.0070	0.00023	0.00098	0.00023	0.0010

Table 18.18 Regression Output for Moisture and Air Velocity for Uncontrolled PM_{10} Emissions from Central Mix Operations.

SUMMARY OUTPUT

Uncontrolled PM10

Regression Statistics	
Multiple R	0.85
R Square	0.72
Adjusted R Square	0.62
Standard Error	0.52
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and uncontrolled emissions as the dependent (Y) variable. The good (0.72) R Square indicates that wind and moisture explain about 72% of the variability of the uncontrolled emissions. The exponents of -1.28 for moisture and 0.40 for air velocity will be carried forward to determine the multiplier and intercept for the final emissions factor equation.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	4.09	2.05	7.61	0.023
Residual	6	1.61	0.27		
Total	8	5.70			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-4.87	0.89	-5.44	0.00	-7.05	-2.68	-7.05	-2.68
X Variable 1	-1.28	0.54	-2.37	0.06	-2.60	0.04	-2.60	0.040
X Variable 2	0.40	0.30	1.36	0.22	-0.32	1.13	-0.32	1.13

Table 18.19 Regression Output for Moisture and Air Velocity for Controlled PM_{10} Emissions from Central Mix Operations.

SUMMARY OUTPUT

Contorlled PM10

Regression Statistics	
Multiple R	0.69
R Square	0.47
Adjusted R Square	0.29
Standard Error	0.74
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The modest (0.47) R Square indicates that wind and moisture explain about 47% of the variability of the controlled emissions. The exponents of -0.91 for moisture and 0.45 for air velocity will be carried forward to determine the multiplier and intercept for the final emissions factor equation.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.93	1.46	2.67	0.15
Residual	6	3.29	0.55		
Total	8	6.22			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-7.68	1.28	-6.01	0.00	-10.80	-4.55	-10.80	-4.55
X Variable 1	-0.91	0.77	-1.17	0.28	-2.80	0.98	-2.80	0.98
X Variable 2	0.45	0.42	1.06	0.33	-0.59	1.49	-0.59	1.49

Table 18.20 Regression Output for Slope and Intercept Coefficients for Uncontrolled PM_{10} Emissions for Central Mix Operations.

SUMMARY OUTPUT
Uncontrolled PM-10

Regression Statistics	
Multiple R	0.78
R Square	0.60
Adjusted R Square	0.55
Standard Error	0.090
Observations	9

This is the output from the MS Excel regression analysis from selecting the parameter value as the independent (X) variables and uncontrolled PM-10 emissions as the dependent (Y) variable. The moderately good (0.60) R Square indicates that wind and moisture explain about 60% of the variability of the uncontrolled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.086	0.086	10.72	0.014
Residual	7	0.056	0.0080		
Total	8	0.14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.043	0.052	0.83	0.43	-0.080	0.17	-0.080	0.17
X Variable 1	0.0061	0.0019	3.27	0.014	0.0017	0.011	0.002	0.011

Table 18.21 Regression Output for Slope and Intercept Coefficients for Controlled PM_{10} Emissions for Central Mix Operations.

SUMMARY OUTPUT
Controlled PM-10

Regression Statistics	
Multiple R	0.70
R Square	0.49
Adjusted R Square	0.41
Standard Error	0.0032
Observations	9

This is the output from the MS Excel regression analysis from selecting the parameter value as the independent (X) variables and controlled PM-10 emissions as the dependent (Y) variable. The modest (0.49) R Square indicates that wind and moisture explain about 49% of the variability of the controlled emissions.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.75E-05	6.75E-05	6.62	0.037
Residual	7	7.14E-05	1.02E-05		
Total	8	0.00014			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.0011	0.0021	0.54	0.61	-0.0038	0.0061	-0.0038	0.0061
X Variable 1	0.00042	0.00016	2.57	0.037	3.40E-05	0.00081	3.40E-05	0.00081

Table 18.22 Regression Output for Moisture and Air Velocity for Uncontrolled $PM_{2.5}$ Emissions from Central Mix Operations.

SUMMARY OUTPUT

Uncontrolled PM2.5

Regression Statistics	
Multiple R	0.66
R Square	0.43
Adjusted R Square	0.24
Standard Error	0.47
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and uncontrolled emissions as the dependent (Y) variable. The modest (0.43) R Square indicates that wind and moisture explain about 43% of the variability of the uncontrolled emissions. The relatively low R squared combined with difference between the moisture and air velocity exponents (-0.66 for moisture and 0.18 for air velocity) from PM and PM-10 preclude carrying these exponents forward.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.01	0.51	2.26	0.19
Residual	6	1.34	0.22		
Total	8	2.35			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-5.62	0.82	-6.89	0.00	-7.61	-3.62	-7.61	-3.62
X Variable 1	-0.66	0.49	-1.34	0.23	-1.87	0.55	-1.87	0.55
X Variable 2	0.18	0.27	0.68	0.52	-0.48	0.85	-0.48	0.85

Table 18.23 Regression Output for Moisture and Air Velocity for Controlled $PM_{2.5}$ Emissions from Central Mix Operations.

SUMMARY OUTPUT
Controlled PM2.5

Regression Statistics	
Multiple R	0.14
R Square	0.02
Adjusted R Square	-0.31
Standard Error	1.60
Observations	9

This is the output from the MS Excel regression analysis from selecting minimum moisture and wind speed as the independent (X) variables and controlled emissions as the dependent (Y) variable. The very low (0.02) R Square indicates that wind and moisture explain only 2% of the variability of the controlled emissions. The very low R squared precludes carrying these exponents forward.

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.32	0.16	0.062	0.94
Residual	6	15.40	2.57		
Total	8	15.72			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-8.55	2.76	-3.09	0.021	-15.31	-1.79	-15.31	-1.79
X Variable 1	-0.53	1.67	-0.32	0.76	-4.61	3.56	-4.61	3.56
X Variable 2	-0.033	0.92	-0.036	0.97	-2.27	2.21	-2.27	2.21

An examination of all of the emission factor data now available in reference 6 (six separate plants, A-rated tests) indicates that there is a strong relationship between the air velocity close to the drop point and the emissions factors. In addition, a weaker relationship exists between the fine material (cement or cement supplement) moisture content and the emissions factors. Except for uncontrolled truck mix operations, the use of equations based upon these relationships improves the predictive accuracy of the emissions factors by a factor of approximately two. For controlled truck mix operations, the dependency with air velocity is consistent for all particle sizes while the dependency with moisture content is neither as strong nor consistent. Rather than presenting three equations with different constants for exponents, slope and intercept, the equations for PM_{10} and $PM_{2.5}$ are based upon the average ratio of these particle sizes to total particulate and the equation developed for total particulate matter. For central mix operations, there are different air velocity dependencies for uncontrolled emissions than for controlled emissions and there are different air velocity dependencies for total particulate matter than for PM_{10} or $PM_{2.5}$. As a result, different constants for exponents, slope and intercept are presented. Because of the lack of a good relationship between $PM_{2.5}$ and the independent variables, the average ratio of $PM_{2.5}$ to PM_{10} will be applied to the equation developed for PM_{10}. Emissions factors of the general form presented by equation 5-1 provide for a more predicatively accurate estimate of emissions than a single value emissions factor based solely on production rate. Equation 5-1 includes parameters that take into account the moisture content of the cement and cement supplement (minimum value) and the air velocity at the point of material transfer. Both of these additional parameters are logically related to fugitive particulate matter emissions. Equation 5-1 is conceptually similar to a variety of emission factor equations presented in AP-42 Section 13.2, *Fugitive Dust Sources* due to the inclusion of material moisture content and wind speed. Tables 18.24 and 18.25 present the constants for the exponent for air velocity, the exponent for the moisture content, the slope of the curve (divided by 0.0032 to allow for particle size multipliers closer to unity) and the intercept.

$$E = xk \frac{U^a}{M^b} + c \qquad (5\text{-}1)$$

E	=	Emission factor in lbs/ton of cement and cement supplement
k	=	Particle size multiplier (dimensionless)
U	=	Air velocity at drop point, miles per hour (mph)
M	=	Minimum moisture (% by weight) of cement and cement supplement
a,b	=	Exponents
x	=	Slope constant (0.0032)
c	=	Intercept constant

These parameters provide the best fit of the measured emission factor data for controlled particulate matter emissions. The $PM_{10-2.5}$ emissions factors are calculated by subtracting the $PM_{2.5}$ values from the PM_{10} values.

Table 18.24 Equation Parameters for Controlled Truck Mix Operations.

Condition	Parameter Category	k	a	b	c
Controlled	Total PM	0.8	1.75	0.3	0.013
	PM_{10}	0.32	1.75	0.3	0.0052
	$PM_{2.5}$	0.048	1.75	0.3	0.00078

Table 18.25 Equation Parameters for Central Mix Operations.

Condition	Parameter Category	k	a	b	c
Controlled	Total PM	0.19	0.95	0.9	0.0010
	PM_{10}	0.13	0.45	0.9	0.0010
	$PM_{2.5}$	0.03	0.45	0.9	0.0002
Uncontrolled	Total PM	5.90	0.6	1.3	0.120
	PM_{10}	1.92	0.4	1.3	0.040
	$PM_{2.5}$	0.38	0.4	1.3	0.0

The relationship between the **PM_{10}** (controlled) emission factor calculated using Equation 5-1 and the measured **PM_{10}** (controlled) emission factors are shown in Figures 5.4 and 5.5. These figures present only the A-rated data from the six tests described in reference 6. Wind speed data were unavailable in the B-rated data from references 1 and 2.

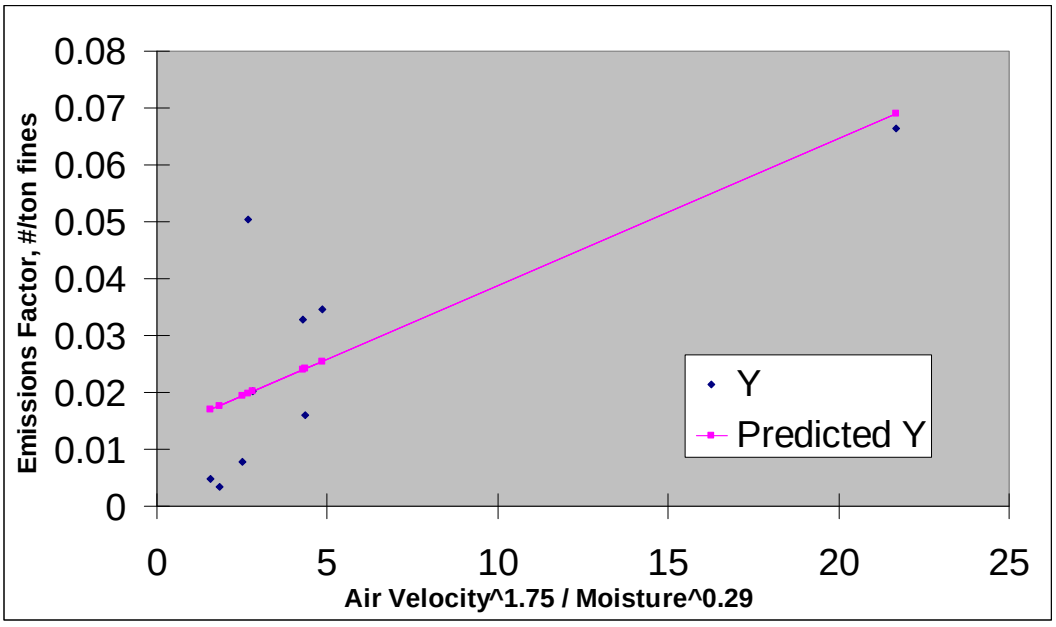


Figure 5.4 Controlled Particulate Matter Emissions from Truck Mix Operations.

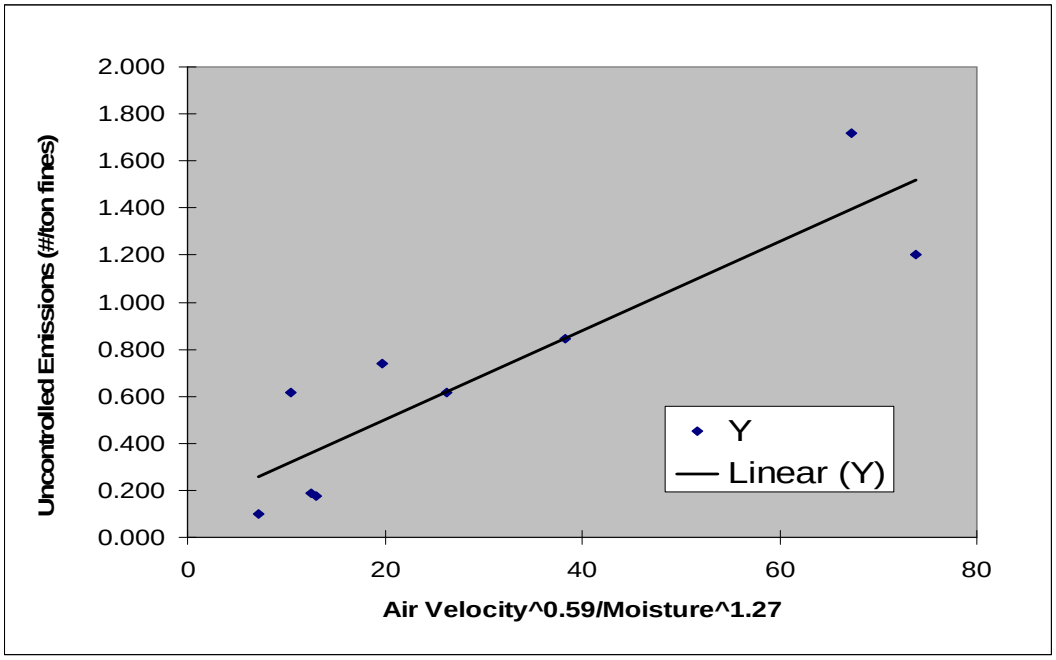


Figure 5.5 Uncontrolled Particulate Matter Emissions for Central Mix Operations.

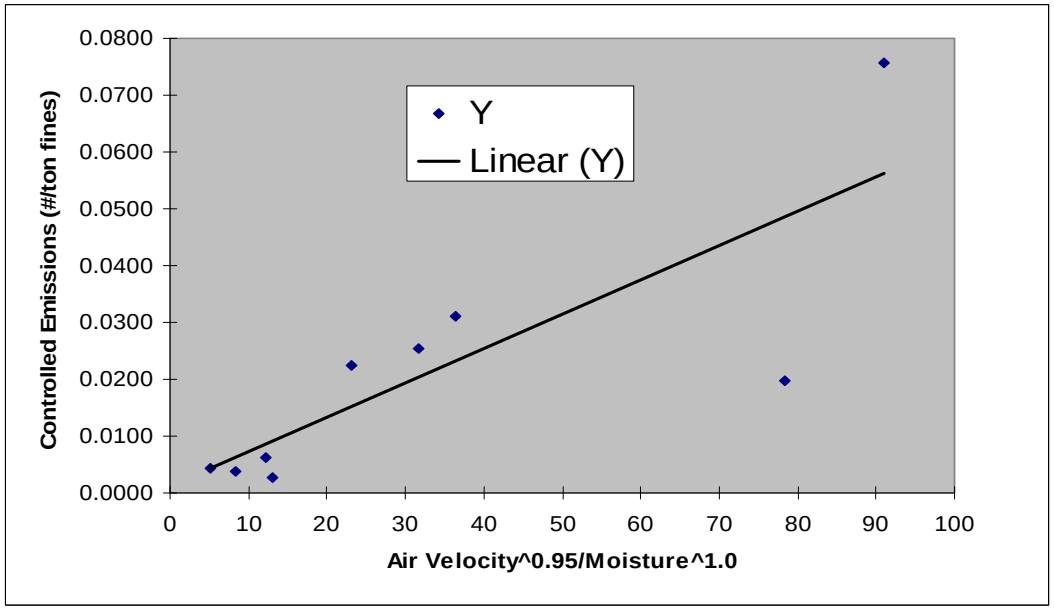


Figure 5.6 Controlled Particulate Matter Emissions for Central Mix Operations.

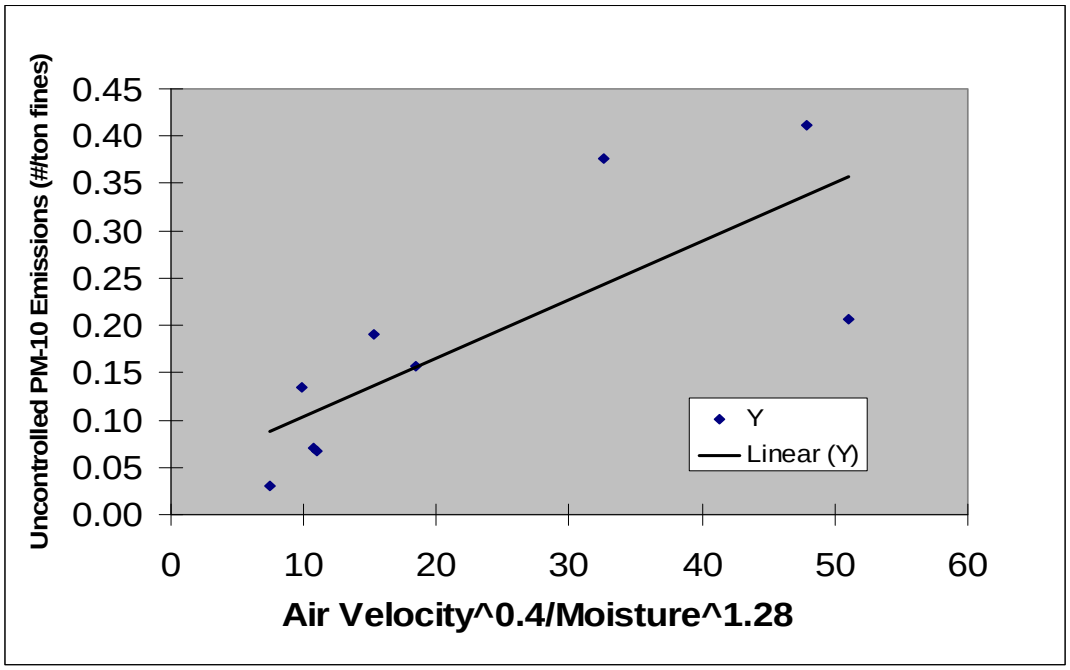


Figure 5.7 Uncontrolled PM_{10} Emissions from Central Mix Operations.

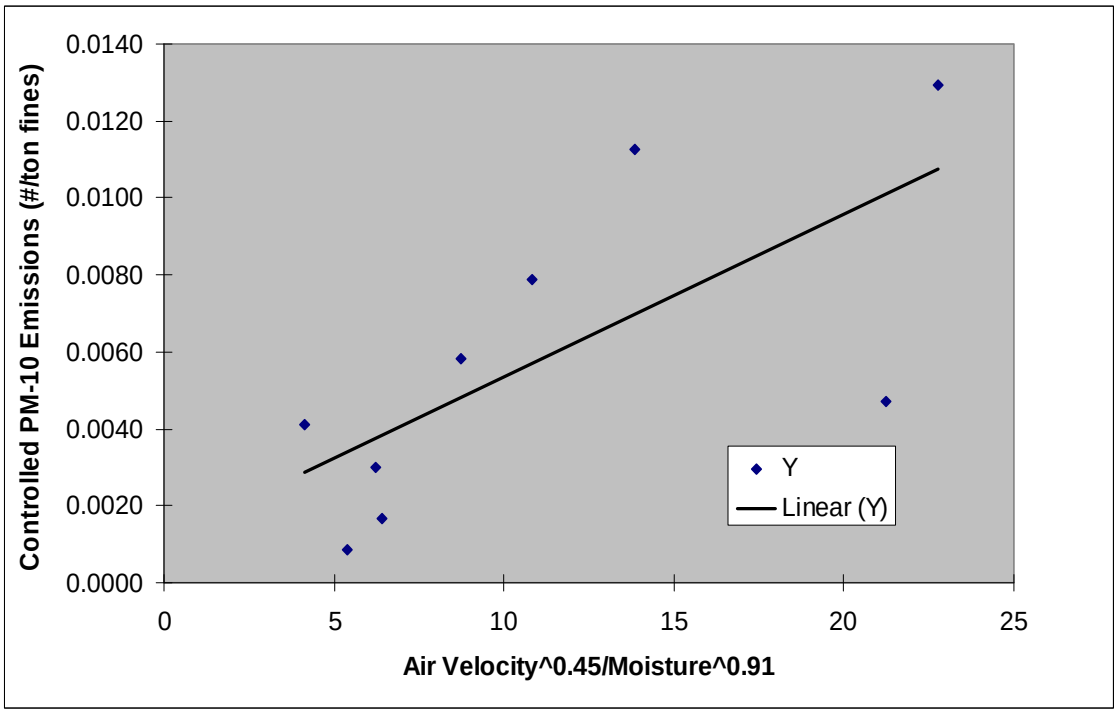


Figure 5.8 Controlled PM_{10} Emissions from Central Mix Operations.

Using Equation 5-1, it is possible to tailor emission factors to site specific conditions. It is also possible for plant operators to take steps to minimize particulate matter emissions by slightly increasing the moisture levels in the cement and cement supplement materials and by shielding the loading areas to reduce the wind speed in the areas immediately adjacent to the loading operations.

Equation 1 and the Table 18.7 equation parameters are based on the six plants tests described in reference 6. There was no wind speed data available for references 1 and 2. However, if a wind speed of approximately 3 mph is assumed for references 1 and 2, the emission factor data are generally comparable to those in Figures 5.3 and 5.4.

5.2 Truck Mix and Central Mix Loading Metals Emission Factors

Metals emissions from truck and central mix loading operations are summarized in Tables 18.26 and 18.27. These are based on data provided in reference 6 (six plants, A-rated metals data), reference 1 (two plants, C rated metals data), and reference 2 (one plant, B rated metals data).

There is considerable variability in the metals content of cement and cement supplement. These are the dominant sources of particulate matter and metals emissions from truck mix and central mix loading operations. As an alternative to the emission factors presented in Tables 18.5 and 18.6, sources can estimate metals emissions based on the total PM emission factor and site specific analyses of the metals contents of the cement and cement supplement. For example, the arsenic emissions can be expressed by Equation 5-2 as a function of the total particulate matter.

$$Metal_{EF} = PM_{EF}\left(\frac{aC + bS}{C + S}\right) \qquad \text{Equation 5-2}$$

Where:

$Metal_{EF}$	=	Metal Emissions, Lbs. As per Ton of Cement and Cement Supplement
PM_{EF}	=	Controlled Particulate Matter Emission Factor Lbs. per Ton of Cement and Cement Supplement
a	=	ppm of Metal in Cement
C	=	Quantity of Cement Used, Lbs. per hour
b	=	ppm of Metal in Cement Supplement
S	=	Quantity of Cement Supplement Used, Lbs. per hour

Table 18.26. Truck Mix Loading Metals Emission Factors

Metal Emission	Reference Number	Number of Test Runs	Data Rating	Emission Factors		
				Pounds per cubic yard of Concrete	Pounds per 1000 pounds of Cement and Cement Supplement	Final Emission Factor Rating
Uncontrolled						
Arsenic	1	1	C	2.37E-7	3.94E-7	
	2	4	B	1.37E-6	2.65E-6	
	6a	3	A	1.07E-5	2.09E-5	
	6b	3	A	5.82E-7	1.10E-6	
	6c	3	A	3.29E-6	5.42E-6	
			Average	3.24E-6	6.09E-6	D
Beryllium	1	1	C	2.15E-8	3.6E-8	
	2	4	B	1.06E-7	2.07E-7	
			Average	6.38E-8	1.22E-7	E
Cadmium	1	1	C	1.19E-8	1.99E-8	
	2	4	B	7.77E-9	1.43E-8	
			Average	9.84E-9	1.77E-8	E
Chromium	1	1	C	4.20E-6	7.03E-6	
	2	4	B	2.27E-6	4.39E-6	
			Average	3.24E-6	5.71E-6	E
Lead	1	1	C	3.29E-7	5.51E-7	
	2	4	B	1.59E-6	3.07E-6	
			Average	9.60E-7	1.81E-6	E
Manganese	1	1	C	2.76E-5	4.61E-5	
	2	4	B	7.82E-6	1.50E-5	
			Average	1.77E-5	3.06E-5	E
Mercury	1					
	1					
Nickel	1	1	C	3.28E-6	5.49E-6	
	2	4	B	3.35E-6	6.48E-6	
			Average	3.32E-6	5.99E-6	E
Phosphorus	1	1		1.15E-5	1.92E-5	
Selenium	2	3		6.75E-7	1.31E-6	E

Table 18.26. Truck Mix Loading Metals Emission Factors (Continued)

Metal Emission	Reference Number	Number of Test Runs	Data Rating	Emission Factors		Final Emission Factor Rating
				Pounds per cubic yard of Concrete	Pounds per 1000 pounds of Cement and Cement Supplement	
Controlled						
Arsenic	1	1	C	7.69E-8	1.29E-7	
	2	4	B	5.30E-7	1.03E-6	
	6a	3	A	8.58E-08	1.67E-7	
	6b	3	A	6.05E-08	1.14E-7	
	6c	3	A	3.95E-08	6.50E-8	
			Average	1.59E-7	3.01E-7	D
Beryllium	1	1	C	6.88E-9	1.15E-8	
	2	4	B	4.70E-8	9.21E-8	
			Average	2.69E-8	5.18E-8	E
Cadmium	1	1	C	3.80E-9	6.36E-9	
	2	4	B	1.46E-9	2.70E-9	
			Average	2.63E-9	4.53E-9	E
Chromium	1	1	C	1.36E-6	2.27E-6	
	2	4	B	9.36E-7	1.82E-6	
			Average	1.15E-6	2.05E-6	E
Lead	1	1	C	1.10E-7	1.84E-7	
	2	4	B	6.94E-7	1.35E-6	
			Average	4.02E-7	7.67E-7	E
Manganese	1	1	C	8.86E-6	1.48E-5	
	2	4	B	3.21E-6	6.03E-6	
			Average	5.99E-6	1.04E-5	E
Mercury	1					
	1					
Nickel	1	1	C	1.07E-6	1.778E-6	
	2	4	B	1.53E-6	2.99E-6	
			Average	1.30E-6	2.39E-6	E
Phosphorus	1	1		3.68E-6	6.16E-6	
Selenium	2	3		2.97E-8	5.64E-8	E

Table 18.27 Central Mix Loading Metals Emission Factors

Metal Emission	Reference Number	Number of Test Runs	Data Rating	Emission Factors		Final Emission Factor Rating
				Pounds per cubic yard of Concrete	Pounds per 1000 pounds of Cement and Cement Supplement	
Uncontrolled						
Arsenic	1	1	C	7.54E-8	1.16E-7	
	6d	3	A	6.16E-7	1.15E-6	
	6e	3	A	5.81E-6	1.10E-5	
	6f	3	A	2.60E-6	4.48E-6	
			Average	2.28E-6	4.19E-6	D
Beryllium	1	1				
Cadmium	1	1	C	3.84E-9	5.92-9	E
Chromium	1	1	C	4.60E-7	7.11E-7	E
Lead	1	1	C	1.24E-7	1.91E-7	E
Manganese	1	1	C	1.98E-5	3.06E-5	E
Mercury	1					
Nickel	1	1	C	1.06E-6	1.64E-6	E
Phosphorus	1	1	C	6.52E-6	1.01E-5	E
Selenium	2	3				
Controlled						
Arsenic	1	1	C	6.05E-9	9.35E-9	
	6d	3	A	1.91E-08	3.57E-8	
	6e	3	A	2.15E-07	4.07E-7	
	6f	3	A	8.06E-08	1.39E-7	
			Average	8.02E-08	1.48E-07	D
Beryllium	1	1				
Cadmium	1	1	C	2.30E-10	3.55E-10	E
Chromium	1	1	C	4.11E-8	6.34E-8	E
Lead	1	1	C	1.19E-8	1.83E-8	E
Manganese	1	1	C	1.23E-6	1.89E-6	E
Mercury	1	1				
Nickel	1	1	C	8.01E-8	1.24E-7	E
Phosphorus	1	1	C	3.91E-7	6.04E-7	E
Selenium	1	1				

Note: Reference 6, Plant d - RMCC Wake Forest; Plant e, S.T. Wooten Raleigh, and Plant f, RMC Carolina, Raleigh

5.3 Emission Factor Values

The emission factors for cement silo filling, cement supplement silo filling, transfer of aggregate and sand to elevated bins, and weight hoppers are summarized in Tables 19.1 through 19.4. The two main issues in rating the final emission factors were the number of facilities tested and the ratings of the test data sets. An emission factor as low as a C generally requires that a reasonable number of facilities be tested and that the test data ratings for each of these facilities be an A or B (see Section 3.1). The emission factor ratings for these sources are based on no more than four facilities, none are rated above D.

Unless noted otherwise, the following criteria were used to rate the final emission factors in Tables 19.1 through 19.4.

Rating D
1. At least two facilities were tested.
2. One of the test data sets is rated A or all of the test data sets are rated B.

Rating E
1. Fails to meet the above criteria for Rating D

b

19.1 CEMENT SILO FILLING EMISSION FACTORS

EMISSION TYPE	REFERENCE NUMBER	NUMBER OF TEST RUNS	DATA RATING	EMISSION FACTOR per 1000 lb CEMENT LOADED (lb)	FINAL EMISSION FACTORS RATING
PM-10	1	1	C	**0.23672**	**E**
CONTROLLED PM-10	1	1	C	6.00E-005	
	2	3	A	2.79E-004	
	AVERAGE			**1.70E-004**	**D**
PM	1	1	C	**0.36297**	**E**
CONTROLLED PM	1	1	C	1.10E-004	
	2	3	A	3.68E-004	
	3	1	C	3.10E-004	
	4	3	D	1.20E-003	
	AVERAGE			**4.97E-004**	**D**
METALS - UNCONTROLLED					
ARSENIC	1	1	C	**8.38E-007**	**E**
BERYLLIUM	1	1	C	**8.97E-009**	**E**
CADMIUM	1	1	C	**1.17E-007**	**E**
CHROMIUM	1	1	C	**1.26E-007**	**E**
LEAD	1	1	C	**3.68E-007**	**E**
MANGANESE	1	1	C	**1.01E-004**	**E**
MERCURY	1	--	--	--	--
NICKEL	1	1	C	**8.83E-006**	**E**
PHOSPHORUS	1	1	C	**5.88E-005**	**E**
SELENIUM	1	--	--	--	--
METALS - CONTROLLED					
ARSENIC	1	1	C	**2.12E-009**	**E**
	2	--	--	--	
BERYLLIUM	1	--	--	--	
	2	1	B	**2.43E-010**	**E**
CADMIUM	1	--	--	--	
	2	--	--	--	
CHROMIUM	1	1	C	1.87E-008	
	2	1	B	1.02E-008	
	AVERAGE			**1.45E-008**	**E**
LEAD	1	1	C	6.16E-009	
	2	1	B	4.75E-009	
	AVERAGE			**5.46E-009**	**E**
MANGANESE	1	1	C	4.96E-008	
	2	1	B	6.78E-008	
	AVERAGE			**5.87E-008**	**E**
MERCURY	1	--	--	--	
	2	--	--	--	
NICKEL	1	1	C	2.25E-008	
	2	1	B	1.93E-008	
	AVERAGE			**2.09E-008**	**E**
PHOSPHORUS	1	--	--	--	
	2	--	--	--	
SELENIUM	1	--	--	--	
	2	--	--	--	

19.2 CEMENT SUPPLEMENT SILO FILLING EMISSION FACTORS[c]

EMISSION TYPE	REFERENCE NUMBER	NUMBER OF TEST RUNS	DATA RATING	EMISSION FACTOR lb per 1000 lb CEMENT SUPPLEMENT LOADED	FINAL EMISSION FACTORS RATING
PM-10	1	2	C	**0.64611**	**E**
PM	1	2	C	**1.56773**	**E**
CONTROLLED PM-10	2	3	A	**2.43E-003**	**E**
CONTROLLED PM	2	3	A	7.92E-003	
	4	3	D	1.01E-003	
	AVERAGE			**4.47E-003**	**D**
CONTROLLED ARSENIC	2	1	C	**5.02E-007**	**E**
CONTROLLED BERYLLIUM	2	1	C	**4.52E-008**	**E**
CONTROLLED CADMIUM	2	1	C	**9.92E-009**	**E**
CONTROLLED CHROMIUM	2	1	C	**6.10E-007**	**E**
CONTROLLED LEAD	2	1	C	**2.60E-007**	**E**
CONTROLLED MANGANESE	2	1	C	**1.28E-007**	**E**
CONTROLLED MERCURY	2	--	--	--	--
CONTROLLED NICKEL	2	1	C	**1.14E-006**	**E**
CONTROLLED PHOSPHORUS	2	1	C	**1.77E-006**	**E**
CONTROLLED SELENIUM	2	1	C	**3.62E-008**	**E**

19.3 EMISSION FACTORS FOR AGGREGATE & SAND TRANSFER TO ELEVATED BINS[d]

	EMISSION TYPE	REFERENCE NUMBER	NUMBER OF SAMPLES	DATA RATING	EMISSION FACTORS per Mg transferred (kg)	EMISSION FACTORS per ton transferred (lb)	FINAL EMISSION FACTOR RATING
AGGREGATE	**PM-10**	1	2	A			
		2	1	A			
		1 & 2			**1.68E-003**	**3.27E-003**	**D**
	PM	1	2	A			
		2	1	A			
		1 & 2			**3.54E-003**	**6.92E-003**	**D**
SAND	**PM-10**	1	3	A			
		2	2	A			
		1 & 2			**5.05E-004**	**9.86E-004**	**D**
	PM	1	2	A			
		2	2	A			
		1 & 2			**1.07E-003**	**2.08E-003**	**D**

19.4 WEIGH HOPPER LOADING EMISSION FACTORS [d]

English Unit Emission Factors				FINAL
PM-10		PM		RATING
0.00375	lb/yd³	**0.00794**	lb/yd³	D
0.00228	lb/ton	**0.00482**	lb/ton	D

Metric Unit Emission Factors				FINAL
PM-10		PM		RATING
0.00117	kg/Mg	**0.00247**	kg/Mg	D

The emission factors were developed from the Aggregate and Sand Transfer to Elevated Bins Emission Factors as follows:

This formula was used to compute the lb of emissions per yd³ of concrete.
E = (AEF)(AYD3) + (SEF)(SYD3)

This formula was used to compute the lb of emissions per ton of aggregate and sand.
E = (AEF)(ATON) + (SEF)(STON)

This formula was used to compute the kg of emissions per Mg of aggregate and sand.
E = (AEF)(AMG) + (SEF)(SMG)

E	=	Emission Factors (lb / ton, lb / yd³, & kg / Mg)				
AEF	=	Aggregate Transfer Emission Factor for PM-10	AEF	=	3.27E-003	lb/ton
SEF	=	Sand Transfer Emission Factor for PM-10	SEF	=	9.86E-004	lb/ton
AEF	=	Aggregate Transfer Emission Factor for PM	AEF	=	6.92E-003	lb/ton
SEF	=	Sand Transfer Emission Factor for PM	SEF	=	2.08E-003	lb/ton
AEF	=	Aggregate Transfer Emission Factor for PM-10	AEF	=	1.68E-003	kg/Mg
SEF	=	Sand Transfer Emission Factor for PM-10	SEF	=	5.05E-004	kg/Mg
AEF	=	Aggregate Transfer Emission Factor for PM	AEF	=	3.54E-003	kg/Mg
SEF	=	Sand Transfer Emission Factor for PM	SEF	=	1.07E-003	kg/Mg
AYD3	=	Aggregate per Yd³ of Concrete (see Appendix C)	AYD3	=	1,865	lb
SYD3	=	Sand per Yd³ of Concrete (see Appendix C)	SYD3	=	1,428	lb
ATON	=	Aggregate per Ton of Aggregate and Sand	ATON	=	1,133	lb
STON	=	Sand per Ton of Aggregate and Sand	STON	=	867	lb
AMG	=	Aggregate per Mg of Aggregate and Sand	AMG	=	566	kg
SMG	=	Sand per Mg of Aggregate and Sand	SMG	=	434	kg

ATON + [ATON * (SYD3 / AYD3)] = Ton of Aggregate and Sand (TAS)
ATON = TAS / (1+ SYD3 / AYD3)
STON = [ATON * (SYD3 / AYD3)]

AMG and SMG are calculated in the same manner.

19.5 PLANT WIDE EMISSION FACTORS [e]

Truck Mix

	Uncontrolled		Controlled		
	PM (lb/yd³)	PM-10 (lb/yd³)	PM (lb/yd³)	PM-10 (lb/yd³)	FINAL RATING
Aggregate delivery to ground storage	0.0064	0.0031	0.0064	0.0031	
Sand delivery to ground storage	0.0015	0.0007	0.0015	0.0007	
Aggregate transfer to conveyor	0.0064	0.0031	0.0064	0.0031	
Sand transfer to conveyor	0.0015	0.0007	0.0015	0.0007	
Aggregate transfer to elevated storage	0.0064	0.0031	0.0064	0.0031	
Sand transfer to elevated storage	0.0015	0.0007	0.0015	0.0007	
Cement delivery to Silo (Controlled)	0.0002	0.0001	0.0002	0.0001	
Cement Supplement delivery to Silo (Controlled)	0.0003	0.0002	0.0003	0.0002	
Weigh Hopper Loading	0.0079	0.0038	0.0079	0.0038	
Truck Mix Loading	0.1725	0.0422	0.0579	0.0143	
Total	**0.2048**	**0.0576**	**0.0902**	**0.0297**	**E**

Central Mix

	Uncontrolled		Controlled		
	PM (lb/yd³)	PM-10 (lb/yd³)	PM (lb/yd³)	PM-10 (lb/yd³)	FINAL RATING
Aggregate delivery to ground storage	0.0064	0.0031	0.0064	0.0031	
Sand delivery to ground storage	0.0015	0.0007	0.0015	0.0007	
Aggregate transfer to conveyor	0.0064	0.0031	0.0064	0.0031	
Sand transfer to conveyor	0.0015	0.0007	0.0015	0.0007	
Aggregate transfer to elevated storage	0.0064	0.0031	0.0064	0.0031	
Sand transfer to elevated storage	0.0015	0.0007	0.0015	0.0007	
Cement delivery to Silo (Controlled)	0.0002	0.0001	0.0002	0.0001	
Cement Supplement delivery to Silo (Controlled)	0.0003	0.0002	0.0003	0.0002	
Weigh Hopper Loading	0.0079	0.0038	0.0079	0.0038	
Central Mix Loading	0.0628	0.0219	0.0031	0.0011	
Total	**0.0951**	**0.0373**	**0.0355**	**0.0165**	**E**

Based on truck and central mix emission factors of lb/1,000 lb of cement and cement supplement presented in section 5.2 and 5.3, emission factors of lb/1,000 lb material transferred from tables 19.1 through 19.4 and the following average composition of concrete as presented in Table 16.1.

Course Aggregate	1865 pounds
Sand	1428 pounds
Cement	491 pounds
Pozolan Material	73 pounds
Water	20 gallons

5.4 Notes for the Final Emission Factors

[a] The emission factors based on total cement and cement supplements (natural pozolans, NewCem™ or fly ash) are used to compute the final emission factors for truck mix loading and central mix loading. Most facilities should have an accurate record of the weight of these materials used to manufacture concrete. Emission factors based upon the weight of fine material in the batches may be a more reliable metric. However, this information would be more difficult to obtain for existing plants and to predict for new plants. Most of the emissions from concrete batching come from the "fines" that are used to make the concrete. Over 95% of the "fines" are composed of the dry cement and cement supplement. The remaining "fines" are contained in the course aggregate and sand and are partially bound to the larger material by surface moisture. Therefore, emission factors based upon the mass of cement and cement supplement may be useful for a broad range of facilities including those that specialize in a product composed of raw materials significantly different than typical concrete. As shown in Table 16.2 batch formulation summary statistics derived from reference 1 and 2 information indicates that over 90% of the batches contained between 9 and 18 weight percent cement and cement supplement. Batch formulations outside this range may be used at facilities that have a specialized product line but would constitute a minor portion of the typical concrete batch plants product line.

Since information on the amount of concrete produced may be more readily available than for the amounts of cement and cement supplements, the emission factor based on concrete will also be presented in the AP-42 section.

The emission factors based on cement are not used because they do not account for the relationship between the amount of **cement supplement** used and the amount of emissions released. This issue is significant since cement supplements are used in sizable quantities and are often "finer" than cement. The emission factors based on total dry materials used are not used because they do not accommodate formulations that may be used at some specialized but large facilities.

[b] The controlled cement silo filling emission factors derived from test runs that included emissions from the loading of transit-mix trucks are not used because of their apparent lack of precision and accuracy. Consequently, only "Run 7" is used from Reference 1, since it was the only Reference 1 test run that captured emission solely from the cement silo filling process.

[c] The controlled cement supplement silo filling emission factors derived from test runs that included emissions from the loading of transit-mix trucks are not used because of their apparent lack of precision and accuracy. Consequently, none of the emission factors from Reference 1 are used to develop these emission factors.

[d] These emission factors are based on the material transfer equation 1 in AP-42 section 13.2.4, *Aggregate Handling and Storage Piles*, (1/95) using average amounts of aggregate and sand used per yd^3 of concrete at References 1 and 2. These emission factors are rated D, since only two test references were used for estimating material moisture content and a wind speed of 10 mph.

[e] The calculated plant wide emission factors are rated E, since they are used in conjunction with the average composition of concrete from only two facilities.

Appendix A

Technical Notes for Reference 1 Tables

Tables 1.2, 1.3, 2.2, 2.3, 3.2, 3.3, 4.2, 4.3, 5.3, 5.4, 6.3, 6.4

1. Each of the estimated emission amounts due solely to silo fillings can be reproduced in the following stepwise manner. First, divide the total amount of "fines" (cement, NewCem™, and silt from sand and coarse aggregate) used during the particular silo filling and truck mix loading test run by one thousand. Next, multiply the resulting number by the average truck mix loading emission factor for the same type emission based on fines. Third, subtract this result from the total amount of emission from the particular silo filling and truck mix loading test. The result of this calculation is an estimate of the emissions form the silo filling.

2. The amount of cement or NewCem™ loaded during each of the silo loading test runs was approximated by analyzing information from Appendix B.2 and the Process Notes Section of the test report. Reproduction of each of these values can be accomplished stepwise as follows. First, compute the rate at which any relevant silo filling (a filling that occurred in part or whole during the test run of interest) was occurring by dividing the amount of material loaded by the time required for the loading to be accomplished. Next, multiply this rate buy the amount of time in which **both** the silo filling and emission testing were occurring simultaneously (this computation relies on the assumption that the loading rates were constant throughout the loading process). Repeat this procedure for each of the other relevant silo fillings that occurred during the test run of interest. Finally, sum the results together to determine the total amount of cement or NewCem™ loaded during the test run.

Tables 2.1 – 2.3, 4.1 – 4.3. 6.1 – 6.4

1. Each of the emission rates at the dust collector's outlet was estimated by averaging all of the outlet rates for the same emission type. The outlet rates were averaged because the individual outlet runs listed in the test report occurred over the course of several inlet runs. The outlet runs lasted longer than the inlet runs, since longer sampling times were required to collect measurable amounts of emissions from the outlet.

Tables 2.2, 2.3, 4.2, 4.3, 5.4, 5.5, 6.1 – 6.5

1. The designation "—" was substituted for every value in the tables that was less than or equal to zero.

Tables 3.1, 4.1

1. The following statistical method indicated that the emission rate for PM during test run 14 was an extreme value relative to the other central batch loading emission rates for PM. In this statistical method a value *r* is computed for a given number of observations as follows:

If *r* is greater than the **critical value** that is associated with the given number of observations, then the extreme value is outside the 99 percentile. Specific critical values for certain numbers of observations are given in the following table:[1]

Number of Observations, *n*	Critical Value
	=.01
3	.988
4	.889
5	.780
6	.698
7	.637

Tables 3.1 – 3.3, 4.1 – 4.3, 5.1 – 5.5, 6.1 – 6.5

The metal emission factors were based on the test report's "Case 2" emission rates. In "Case 2," the captured and/or the background metal concentrations from which the metal emissions rates were derived were designated to be zero when actual concentrations were below detection limits.

1. The metal emission rates at the inlet of the dust collector were given for several test runs at a time in the test report. As a result, the group of test runs used to develop the individual emission factors are listed above the names of the metals. Accordingly, the estimated capture efficiencies were developed by averaging the capture efficiencies of the listed runs.

Tables, 5.5, 6.5

1. The average metal emission factors were developed only from the emission factors with explicit numerical values

Reference for Appendix A

1. Dixon, Wilfrid J. and Massey, Frank J., Jr., *Introduction to Statistical Analysis*, Second Edition, McGraw-Hill Book Company, Inc., New York, NY, 1957.

Appendix B

Technical Notes for Reference 2 Tables

Tables 7, 8, 9, 10

1. The Estimated Capture Efficiency values were taken from the test report's capture efficiency averages weighted by the amounts and fly ash loaded.

Tables 8, 10, 14.1, 14.2

1. The outlet emission rates given the test report were for emissions coming from both the plant being examined (the Eerie Plant) and another adjacent plant (the Johnson Plant). Consequently, it was necessary to approximate the outlet emission rates due solely to the Eerie Plant during the inlet runs.

   These approximations relied on the assumption that the ration of the Outlet Emission Rate of the Eerie Plant (OERE) to the outlet emission rate of both plants (OERBP) was about the same as the ration of the actual air flow rate of the Eerie Plant (AFRE) to the actual air flow rate of both plants (AFRBP). The formula that shows how this assumption was used to approximate the outlet emission rate due to the Eerie Plant is as follows:

   However, the *AFRE* was measured for each inlet run, whereas the *OERBP* and *AFRBP* were measured for each outlet run. Therefore, the *OERBP* and *AFRBP* are not known for any given measurement of the *AFRE*, since each of the test report's outlet runs typically occurred over the course of several inlet runs. Consequently, the *OERBP* and the *AFRBP* during a particular inlet run were approximated by the *OERBP* and *AFRBP* that were measured for the outlet run that **included** emissions from the particular inlet run respectively.

   On the other hand, the metal inlet **rates** were typically given for several inlet runs at a time. Thus, when calculating the *OERE* for a particular metal inlet rate, the *AFRE* is simply the sum of the *AFRE*s that were measured for the individual inlet runs over which the metal inlet rate was measured. However, the group of inlet runs over which a metal inlet rate were measured does not usually correspond to any group of inlet runs over which an outlet run was preformed. Therefore, both the *OERBP* and *AFRBP* are not necessarily known for any particular metal inlet rate. Consequently, the *OERBP* and *AFRBO* that were used to determine the *OERE* for a particular metal emission rate were approximated by the average of **all** of the *OERBP*s for the same type of metal emission and the average of **all** of the *AFRBP*s respectively.

Table 11

1. Since the three silo emission test runs were performed on three separate days, it was assumed that a given test run collected the emissions resulting from all of the silo loadings that occurred on the day of the test run. Consequently, the "cement loaded" amount associated with each test run was assumed to be the same as the total amount of cement delivered on the particular day of the test run. The total amount of cement delivered on a given day was determined by summing together the amounts of cement delivered as indicated on the bills of sale for the given day. The bills of sale for each day were found in the Process Notes Section of the test report.

Table 12

1. The amount of fly ash loaded for each run was assumed to be the same for each run, since only one fly ash loaded amount was found in the Process Notes Section of the test report.

Tables 13.1 – 13.3, 14.1 – 14.3

1. The metal emission factors were based on the test report's "Case 2" emission rates. In "Case 2," the captured and/or the background metal concentrations from which the metal emission rates were derived were designated to be zero when the actual concentrations were below the detection limits.

2. The designation "- -" was substituted for every value in the tables that was less than or equal to zero

3. Each group of metal emission rates at the inlet were measured for several test runs at a time in the test report. As a result, the test runs over which a given group of metal emission rates were measured are listed above the group. Accordingly, the estimated capture efficiency associated with a particular group of metal inlet rates was developed by a straight average of the capture efficiencies of the test runs listed above the group.

Tables 13.3, 14.3

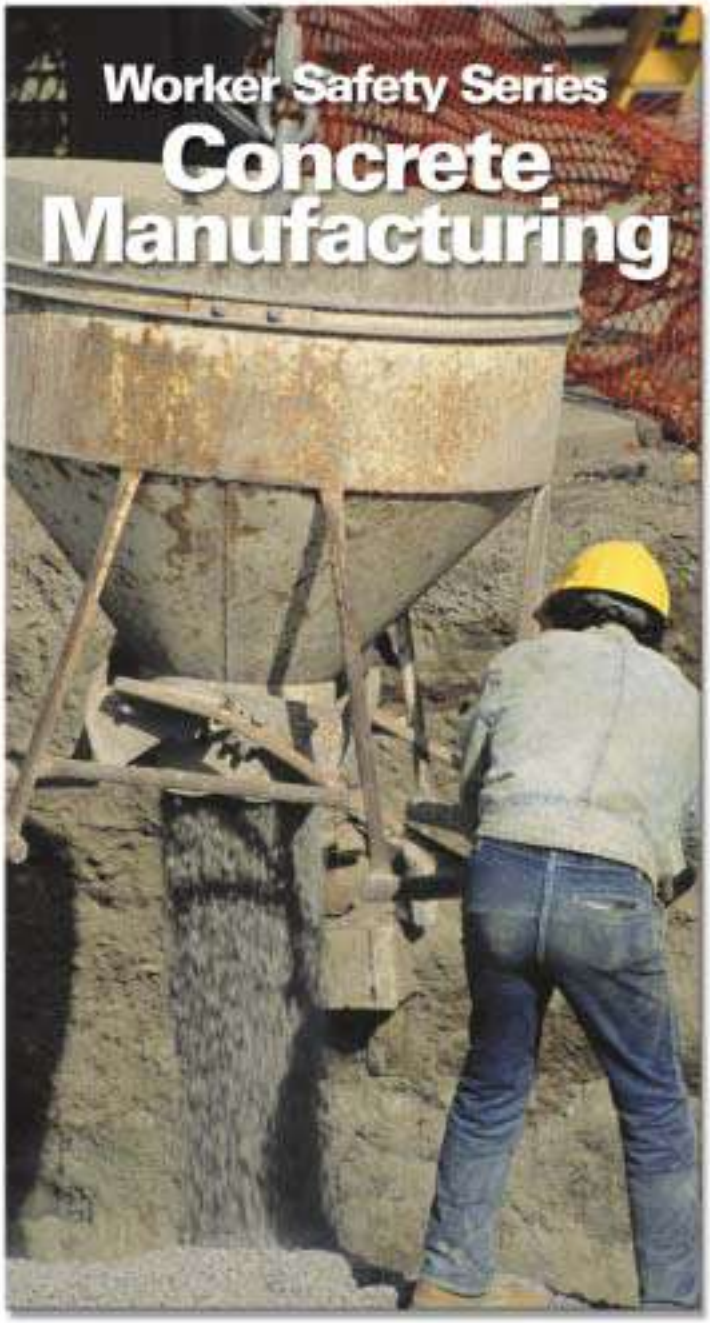
1. The average emission factors were developed from only those emission factors in the table with explicit numerical values.

Exhibit 4

OSHA POCKET GUIDE

Occupational Safety and Health Administration

www.osha.gov



OSHA 3221-12N 2004

Concrete Manufacturing

- More than 250,000 people work in concrete manufacturing.
- Over 10 percent of those workers — 28,000 — experienced a job-related injury or illness and 42 died in just one year.
- Potential hazards for workers in concrete manufacturing:
  - Eye, skin and respiratory tract irritation from exposure to cement dust;
  - Inadequate safety guards on equipment;
  - Inadequate lockout/tagout systems on machinery;
  - Overexertion and awkward postures;
  - Slips, trips and falls; and
  - Chemical burns from wet concrete.

Hazards & Solutions

Manufacturing concrete can pose health and safety risks for the worker. For concrete manufacturing, the 10 OSHA standards most frequently included in the agency's citations were:

1. Hazard communication
2. Lockout/tagout
3. Confined spaces
4. Respiratory protection
5. Guarding floor & wall openings and holes
6. Electrical wiring methods
7. Noise exposure
8. Forklifts
9. Electrical systems design
10. Machine guarding



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Cement Dust

Hazard: Exposure to cement dust can irritate eyes, nose, throat and the upper respiratory system. Skin contact may result in moderate irritation to thickening/cracking of skin to severe skin damage from chemical burns. Silica exposure can lead to lung injuries including silicosis and lung cancer.

Solutions:

- Rinse eyes with water if they come into contact with cement dust and consult a physician.
- Use soap and water to wash off dust to avoid skin damage.
- Wear a P-, N- or R-95 respirator to minimize inhalation of cement dust.
- Eat and drink only in dust-free areas to avoid ingesting cement dust.

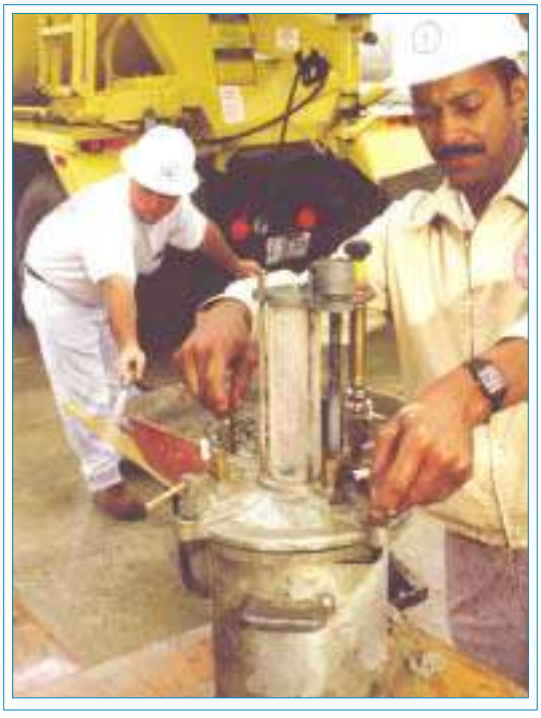


Wet Concrete

Hazard: Exposure to wet concrete can result in skin irritation or even first-, second- or third-degree chemical burns. Compounds such as hexavalent chromium may also be harmful.

Solutions:

- Wear alkali-resistant gloves, coveralls with long sleeves and full-length pants, water-proof boots and eye protection.
- Wash contaminated skin areas with cold, running water as soon as possible.
- Rinse eyes splashed with wet concrete with water for at least 15 minutes and then go to the hospital for further treatment.



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Machine Guarding

Hazard: Unguarded machinery used in the manufacturing process can lead to worker injuries.

Solutions:

- Maintain conveyor belt systems to avoid jamming and use care in clearing jams.
- Ensure that guards are in place to protect workers using mixers, block makers, cubers and metalworking machinery such as rebar benders, cutters and cage rollers.
- Establish and follow effective lockout/tagout procedures when servicing equipment.
- Be sure appropriate guards are in place on power tools before using them.

Falling Objects

Hazard: Workers may be hit by falling objects from conveyor belt systems, elevators or concrete block stacking equipment.

Solutions:

- Avoid working beneath cuber elevators, conveyor belts and stacker/destacker machinery.
- Stack and store materials properly to limit the risk of falling objects.
- Wear eye protection when chipping and cleaning forms, products or mixers.

Poor Ergonomics

Hazard: Improper lifting, awkward postures and repetitive motions can lead to sprains, strains and other musculoskeletal disorders.

Solutions:

- Use handtrucks or forklifts when possible.
- Lift properly and get a coworker to help if a product is too heavy.
- Avoid twisting while carrying a load. Shift your feet and take small steps in the direction you want to turn.
- Keep floors clear to avoid slipping and tripping hazards.
- Avoid working in awkward postures.



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Confined Spaces

Hazard: Mixers and ready-mix trucks have confined spaces that pose safety risks for workers.

Solutions:

- Follow established procedures for confined space entry and work to assure safety.
- Guard against heat stress when cleaning truck mixer drums.
- Wear appropriate protective equipment to avoid silica exposure when removing concrete residues from inside truck mixer drums.



Vehicles

Hazard: Poorly maintained or improperly handled vehicles can lead to crushing injuries at the plant site or other injuries for truck drivers.

Solutions:

- Make sure back-up alarms on all vehicles are functioning.
- Avoid overloading cranes and hoists.
- Use care with the load out chute on concrete mixers to avoid injuries to hands and fingers.
- Beware of hot surfaces on equipment and truck components.
- Guard eyes against splashes of aggregate materials during loading and unloading.
- Use hearing protection if needed to guard against excessive noise exposure during cement loading/unloading and while using pneumatic chippers inside truck mixer drums.



Other Hazards

- Welding operations can lead to flash burns.
- Makeshift ladders, platforms and stairs with improper or no guardrails make falls more likely.
- Workers can also be injured by falling concrete forms if the forms are improperly chocked, braced or cribbed.



Worker Safety Tips

General Precautions

- Be sure you understand how to perform all your tasks and how to use tools and equipment safely.
- Follow confined space procedures when cleaning and working in mixer drums, hoppers, tanks and other places with potentially serious mechanical hazards, such as blades or sloping sides which may entrap employees, or atmospheric hazards, such as oxygen deficiency.
- Wear appropriate personal protective equipment to avoid being injured by flying or falling objects.

Vehicle Safety

- Be sure that trucks and other vehicles are in good working order, including audible back-up warning signals, before operating them.
- Avoid overloading hoists, cranes and forklifts.



Machine Safety

- Use lockout/tagout procedures to de-energize conveyors and other machinery before attempting to free any jams.
- Secure chutes and hatches to reduce injuries from swinging parts.
- Make sure guards are in place to protect you from moving parts of machinery and tools before you operate the equipment.

Overhead Hazards

- Be sure that form work, casting and stressing operations are adequately braced and chocked to avoid sudden release of materials.
- Make certain that rigging is in place to protect against falling objects and materials during hoisting and stacking procedures.
- Do not walk or work under overhead loads.



Think Safety Checklists

The following checklists may help you take steps to avoid hazards that cause injuries, illnesses and fatalities. As always, be cautious and seek help if you are concerned about a potential hazard.

General Safety

- ☐ Implement a comprehensive safety and health management system to find and fix all hazards at the worksite.
- ☐ Establish a written hazard communication program to inform all employees about chemical hazards and hazardous substances, reporting of hazards, appropriate personal protective equipment and what to do in emergency situations.
- ☐ Train workers in safe work practices and methods for all work activities, procedures and equipment as well as how to recognize and respond to potential workplace hazards, including rendering first aid.
- ☐ Put in place personal protective equipment programs. Train workers in selecting, cleaning and maintaining equipment such as respirators, protective clothing and goggles.
- ☐ Use safe work practices and appropriate personal protective equipment for all welding, cutting and burning; handling of chemicals (e.g., moist concrete, epoxies, form release agents); and during grinding, chipping, wire brushing, scraping and cleaning.

- [ ] Ensure that all tools and equipment -- including forklifts, cranes, hoists and rigging -- are maintained in good working condition, are inspected regularly and are operated by thoroughly trained, tested and competent workers.

Physical Hazards

- [ ] Set up a noise control program to reduce noise sources. Include sound-level measurements, audiometric testing, training and/or hearing protection equipment.
- [ ] Implement machine guarding and lockout/tagout procedures for all equipment and machinery servicing and/or maintenance work to prevent workers from being injured.
- [ ] Establish a confined-space entry program to protect workers cleaning the inside of mixer drums, storage bins, hoppers and other confined spaces.

Health Hazards

- [ ] Avoid exposure to cement dust to prevent bronchitis and silicosis.
- [ ] Prevent burns and skin and eye irritation by avoiding skin contact and eye contact with cement dust or wet cement.
- [ ] Wear the appropriate personal protective equipment, such as gloves, boots, goggles or HEPA-filter respirators.
- [ ] Avoid dusty areas and wet down work areas, as appropriate, to reduce or eliminate dust.

- [ ] Use special HEPA vacuums to clean up dust instead of dry sweeping.
- [ ] Reduce silica exposures during chipping, drilling and sawing of concrete materials with engineering controls, such as wet methods and local exhaust ventilation.

Fall Hazards

- [ ] Identify and fix fall hazards, such as slippery surfaces, damaged ladders and walkways, and any loose or unsteady hand- or footholds used to climb up and down on trucks and other equipment.
- [ ] Make sure all portable ladders have safety feet and are the proper length for the specific task. Secure them or tie them off to prevent movement.
- [ ] Ensure scaffolding and walking/working surfaces have adequate guardrails, safe accessibility and no tripping hazards or holes.

Ergonomics

- [ ] Implement appropriate work practices and/or controls to help reduce or eliminate potential back injuries from twisting, turning, lifting, awkward postures and whole body vibration.
- [ ] Train workers in appropriate mechanical and manual materials handling techniques and safety procedures to help reduce or eliminate musculoskeletal injuries.
- [ ] Provide dollies, handtrucks and conveyors to help minimize, reduce or eliminate the need to bend and lift.

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Concrete Safety & Health Resources

Most resource materials can be found on the OSHA website at www.osha.gov

Physical Hazards

Confined Space
Downloadable electronic advisor software (1997), 2MB.
This software guides the user in identifying confined spaces and protecting workers who enter them.
http://www.osha.gov/dts/osta/oshasoft/csa.html

Control of Hazardous Energy (Lockout/Tagout)
OSHA Publication 3120 (2002), 174KB PDF, 45 pages.
This booklet provides guidance on protecting workers against unexpected energy releases from mechanical and electrical equipment.
http://www.osha.gov/Publications/osha3120.pdf

Lockout/Tagout e-Tool
Interactive online training program (1999).
This e-Tool offers an overview of OSHA's Lockout/Tagout standard, including interactive case studies.
http://www.osha.gov/dts/osta/lototraining/index.htm

Materials Handling and Storage
OSHA Publication 2226 (2002), 559KB PDF, 41 pages.
This booklet outlines OSHA requirements covering handling and storing materials, focusing on forklift safety and ergonomics.
http://www.osha.gov/Publications/osha2236.pdf

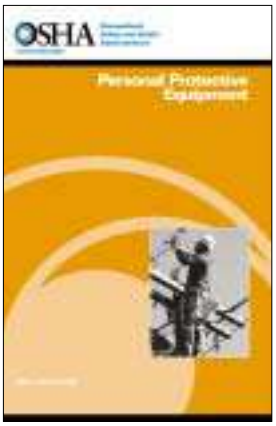
Permit-Required Confined Spaces
OSHA Publication 3138 (2004), 486KB PDF, 22 pages.
This booklet covers highlights of the OSHA standard for confined spaces.
http://www.osha.gov/Publications/osha3138.pdf

Safeguarding Equipment and Protecting Workers from Amputations
OSHA Publication 3071 (2001), 1.2MB PDF, 78 pages.
This booklet offers guidance on machine guarding and other safe practices to reduce the risk of amputations.
http://www.osha.gov/Publications/osha3170.pdf

Sling Safety
OSHA Publication 3072 (1996), 866KB PDF, 28 pages.
This booklet covers all aspects of sling safety.
http://www.osha.gov/Publications/osha3072.pdf

Stairways and Ladders
OSHA Publication 3124 (2003), 155KB PDF, 15 pages.
This booklet covers safety issues related to both fixed and movable stairs and ladders.
http://www.osha.gov/Publications/osha3124.pdf





Health Hazards

Crystalline Silica Exposure Card for General Industry
OSHA Publication 3176 (2003), 37KB PDF; OSHA Publication 3178 (Spanish) (2003), 42KB PDF.
This laminated pocket card offers workers a concise summary of silica health hazards and lists precautions to take to limit exposure.
http://www.osha.gov/Publications/osha3176.pdf
and
http://www.osha.gov/Publications/osha3178.pdf

Crystalline Silica
OSHA Fact Sheet (2002), 52KB PDF, 2 pages, also in Spanish (2003).
This Fact Sheet highlights the hazards of silica and provides guidance on preventing exposures.
http://www.osha.gov/OshDoc/data_General_Facts/crystalline-factsheet.pdf
and
http://www.osha.gov/OshDoc/data_General_Facts/crystalline-spanish.pdf

Silica e-Tool
Downloadable electronic software (1998).
This e-Tool describes the hazards of silica and offers guidance on protecting workers.
http://www.osha.gov/SLTC/etools/silica/index.html

Hazard Communication Guidelines for Compliance
OSHA Publication 3111 (2000), 112KB PDF, 33 pages.
This booklet provides an overview of OSHA's Hazard Communication standard and gives specific guidance on compliance.
http://www.osha.gov/Publications/osha3111.pdf

Hearing Conservation
OSHA Publication 3074 (2002), 157KB PDF, 32 pages.
The booklet explains how to establish an effective hearing conservation program that meets OSHA requirements.
http://www.osha.gov/Publications/osha3074.pdf

Personal Protective Equipment
OSHA Publication 3151 (2004), 629KB PDF, 46 pages.
This booklet offers guidance on when and how to use personal protective equipment to guard against occupational injuries and illnesses.
http://www.osha.gov/Publications/osha3151.pdf

Respiratory Protection
OSHA Publication 3079 (2002), 273KB PDF, 42 pages.
This booklet outlines OSHA requirements on respiratory protection and offers guidance on establishing an effective respiratory protection program.
http://www.osha.gov/Publications/osha3079.pdf

Respiratory Protection e-Tool
Downloadable electronic software (1998).
This e-Tool enables users to determine whether they need to establish a respiratory protection program and what type of respirators to use.
http://www.osha.gov/SLTC/etools/respiratory/index.html

Small Entity Compliance Guide for OSHA's Respiratory Protection Standard
OSHA (1999), 706KB PDF, 149 pages.
This booklet provides help for small businesses seeking to meet OSHA requirements for respiratory protection programs.
http://www.osha.gov/Publications/secgrev-current.pdf

OSHA
Occupational Safety and Health Administration

NIOSH Materials

The National Institute for Occupational Safety and Health (NIOSH) offers many useful publications available on its website at http://www.cdc.gov/niosh

Comprehensive Safety Recommendations for the Precast Concrete Products Industry. DHHS (NIOSH) Publication No. 84-103 (1984).

Elements of Ergonomics Programs: A Primer Based on Workplace Evaluations of Musculoskeletal Disorders. DHHS (NIOSH) Publication No. 97-117 (1997).

NIOSH Hazard Review: Health Effects of Occupational Exposure to Respirable Crystalline Silica. DHHS (NIOSH) Publication No. 2002-129 (April 2002).

NIOSH Alert – Preventing Worker Deaths from Uncontrolled Release of Electrical, Mechanical, and Other Types of Hazardous Energy. DHHS (NIOSH) Publication No. 99-110 (August 1999).

Other Sources

Ready Mixed Concrete Truck Drivers: Work-Related Hazards and Recommendations for Controls, Nancy Clark, Jonathan Dropkin and Lee Kaplan, Mt. Sinai – Irving J. Selikoff Center for Occupational and Environmental Medicine (Sept. 2001), available at http://www.elcosh.org

Concrete Industry Cooperative Programs

Voluntary Protection Programs

OSHA recognizes worksites with excellent safety and health management systems through its Voluntary Protection Programs (VPP). These model worksites are willing to share their expertise and many are available to mentor other businesses. For further information on how VPP participants can help you, contact the VPP manager in your OSHA Regional Office (see www.osha.gov for listings) or the Voluntary Protection Programs Participants' Association, 7600-E Leesburg Pike, Suite 440, Falls Church, VA 22043, telephone (703) 761-1146.

Alliance Program

Alliances enable organizations committed to workplace safety and health to collaborate with OSHA to prevent injuries and illnesses in the workplace. Two of OSHA's national Alliances have an impact on the concrete manufacturing industry.

OSHA
Occupational Safety and Health Administration

Mason Contractors Association of America
Reducing hazards related to wall bracing, falls, scaffolding and forklifts is the focus of OSHA's Alliance with the Mason Contractors Association of America. The joint effort will include developing education and training programs on these issues as well as developing and disseminating case studies illustrating the business value of safety and health.

American Concrete Pipe Association
OSHA's Alliance with the American Concrete Pipe Association (ACPA) focuses on reducing and preventing exposure to confined space hazards. Under this Alliance, OSHA and ACPA will develop and disseminate outreach materials, work together on eTools and participate in other efforts to reduce injuries or illnesses associated with confined space hazards.

Consultation

Every state offers a free, onsite consultation program to help small employers find and fix hazards and establish effective safety and health management systems. Funded primarily by OSHA, consultation is provided at no cost to small employers and is delivered by state authorities through professional safety and health consultants. More information on OSHA's Consultation Program appears on the agency's website at www.osha.gov.

A Success Story

NY Concrete Maker Improves Safety, Cuts Costs

Precast concrete manufacturer Oldcastle Precast's Manchester New York Division reduced its occupational injury and illness rate by 75 percent in three years. The Manchester facility cut its recordable injuries from 12 in the first year to just one in the third year.

Oldcastle experienced this incredible success by establishing a safety and health management system good enough to make it the first precast concrete facility to join OSHA's Merit Voluntary Protection Program (VPP).

Changing Culture

The process began when CRH, a multinational conglomerate that manufactures construction materials worldwide, sent new managers to the Building Systems Division of Oldcastle. The new managers brought cultural change and a renewed commitment to safety and health to the Manchester site.

Managers came to know all employees on a first-name basis. They encouraged employees to ask questions and voice any safety concerns so that management could address them immediately. The managers emphasized the importance of employees as a company asset and made clear that employee

participation is key to eliminating hazards and reducing employee injuries and illnesses.

"Having a safe work environment is just good business," according to the division's general manager. "We need to make the necessary commitment to safety at all levels of the company, and we are responsible to follow through with the safest route, no matter what the cost," he explained. In the process, Oldcastle learned that safety investments pay for themselves, time and again.

Aiming for VPP

Oldcastle decided to aim for VPP recognition, knowing that working toward this goal would drive the facility toward excellence. Typically, injury and illness rates for VPP sites are 51 percent below industry norms. To qualify, Oldcastle had to submit an application explaining the site's safety and health management system. Then OSHA examined the company's safety records, programs and history, and conducted a detailed onsite review. Once in the program, Oldcastle had to undergo periodic reviews to maintain its status.

To improve its safety program to qualify for VPP, Oldcastle set objectives and provided the necessary resources to accomplish them; they performed daily facility inspections and corrected any problems; and they informed employees, vendors and contractors of the program's status throughout the process. "We knew we had to boost existing programs and initiate new ones to comply. We knew our efforts would make our company a safer place to work and that was our goal," noted Oldcastle's safety manager.

Applying for VPP

After two years of preparation, Oldcastle applied for VPP recognition. OSHA evaluators spent four days assessing the facility. Their onsite visit included an opening and closing conference, employee interviews, industrial hygiene surveys and a complete evaluation of the site's safety and health management system.

One of the highlights of Oldcastle's program, according to Norman R. Deitch, OSHA's New York VPP Manager and the VPP Team Leader, was the company's effort to involve Spanish-speaking employees. Oldcastle also received high marks for its extensive use of digital photos to record unsafe conditions and the results of corrective actions for worker training.



Continuing to Improve

For the precast concrete industry (SIC 3272) in 2000, the nonfatal occupational injury and illness incidence rate was 13.7 per 100 full-time workers. When Oldcastle applied for VPP, its rate was 13.4. Now it is 2.0. Oldcastle found

that reducing worker injuries and illnesses is not only the moral and humanitarian thing to do, but it also reduces costs associated with workplace accidents while increasing the division's competitiveness.

Oldcastle's Accident Prevention Program remains effective because everyone—the general manager, department managers, supervisors, employees and the safety manager—takes a personal interest in accident prevention. Every effort is made to ensure that every worker knows, understands and observes the requirements of applicable laws, regulations and standards.

Giving Employees Credit

Oldcastle's plant manager credits employees on the shop floor. "We could be the best managers in the world, but the men on the front line need to embrace the safety culture," he observed.

The Manchester facility manufactures and installs hollowcore plank and precast concrete structural systems throughout Western New York. Some of the more than 2.58 million square feet of precast products weigh in excess of 25 tons each. The facility's sales manager related, "Either you make precast concrete pieces safely, or you don't make them for very long."

Oldcastle's safety manager spearheaded the division's commitment to safety and took charge of the VPP application process. She credits the plant employees for their hard work and continued dedication to their safety program.

Reaching for Star

Under the VPP, Merit worksites are recognized as having the potential and commitment to achieve Star status within three years. Oldcastle's goal is to reach Star status within twelve months. According to the safety manager, "This achievement is looked upon by Oldcastle as a positive step in achieving a safe workplace for our employees and will only further aid us in ensuring the complete safety of our workplace."

Additional information about OSHA's Voluntary Protection Programs is available on the agency's website at www.osha.gov, from regional OSHA VPP managers or local OSHA offices. The Voluntary Protection Programs Participants' Association (www.vpppa.org) administers a mentoring program for those worksites considering participation.



Oldcastle Precast's Manchester New York Division.

Employers are responsible for providing a safe and healthful workplace for their employees. OSHA's role is to assure the safety and health of America's workers by setting and enforcing standards; providing training, outreach, and education; establishing partnerships; and encouraging continual improvement in workplace safety and health.

This informational booklet provides a general overview of a particular topic related to OSHA standards. It does not alter or determine compliance responsibilities in OSHA standards or the *Occupational Safety and Health Act of 1970*. Because interpretations and enforcement policy may change over time, you should consult current OSHA administrative interpretations and decisions by the Occupational Safety and Health Review Commission and the Courts for additional guidance on OSHA compliance requirements.

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OSHA
Occupational Safety and Health Administration
U.S. Department of Labor
www.osha.gov

Journal of Physics: Conference Series

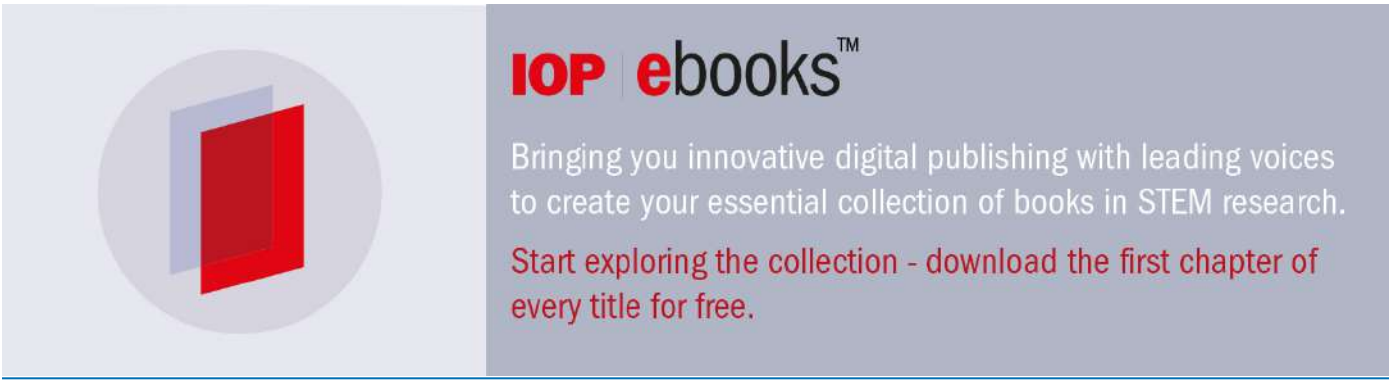
Exhibit 5

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Short review on air pollution from cement factories

To cite this article: M.E. Emetere and E Dania 2019 *J. Phys.: Conf. Ser.* **1299** 012033

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IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012033 doi:10.1088/1742-6596/1299/1/012033

Short review on air pollution from cement factories

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Abstract. The paper presents the challenge in the pollution in cement factories. The health implication is huge leading to unimaginable sickness. The review considers the impact of the pollution. Also, the paper considers legal framework to control the excess dispersion of cement pollutants into the factory. It is concluded that the risk of indiscriminate dissemination of cement factory pollution can be reduce if health institutions and government can synergize with stringent legal framework.

1. Introduction

Due to poor air quality, 4,000 deaths per day are recorded in China and this is caused by the release of harmful pollutants. The challenge of uncontrollable release of pollutants into the atmosphere includes release of harmful pollutants to the environment; **i**nhalation of these harmful gases into the body; release of fumes and gases which contain harmful toxins; release of acid rain which can be detrimental to health; radiation from harmful elements in pollutants; and the exposure to health challenges such as eye irritation, asthma, cough, chronic Bronchitis etc. In other to control air pollution, developed communities have enacted legal frameworks to guide pollution. Such legal framework includes London's Clean Air act of 1956 which required industries to build higher smokes funnels; Canadian Environmental protection Act, 1999; Environmental Protection Agency (EPA) Clean Air Acts; U.S. - Canada air Quality Agreement, 1986 etc.

Air pollution has become a salient discuss because it gives in-depth understanding on the release of harmful substances into the atmosphere (outdoor air pollution). However, air pollution can begin from closed or semi-closed system and it is referred to as the indoor air pollution. It can occur as a result of human activities or natural phenomenon such as burning biomass or fossil fuels, chemical emission from industries, agriculture-base pollution, Sahara dust influx and other secondary pollution source (Fig 1). It is one of the modern day curse i.e. a by-product of increasing industrialization. Air pollutants include Sulphur dioxide (SO_2), nitrogen oxides (NOx), ozone (O_3), particulate matter PM (small suspended particles of varying sizes), carbon monoxide (CO) and volatile organic compounds (VOCs)(Ritchie and Roser, 2019). Other pollutants are carbon dioxide, smoke, methane, soot, cigarette smoke etc. Air pollution is estimated to cause 7 million premature deaths yearly (Institute for Health Metrics and Evaluation, 2017). In a bid to curb the increase in air pollution and its harmful effect on nature and man, several international environmental agreements have been formulated and are legally binding for countries that have formally ratified them. Some of these agreements include the Montreal Protocol on ozone protection, UN Framework convention on climate change, International Environment Protection act of 1983, London's clean air act of 1956 etc.

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Figure 1: Sources of air pollution. 1-Agricultural activities, 2-Energy production and distribution, 3-Natural phenomena, 4-Waste and mining, 5-Road transport, 6-Fuel combustion (EEA Signals, 2013).

2. Pollution from cement factory

A typical source of pollution is the cement factory and its uncontrolled emission of toxic aerosols into the atmosphere. Cement factory has the appropriate machinery, Equipment, technology, materials, manpower and management required to produce cement and other related products. The processes involved in the making of this cement result in release of harmful waste products to the environment such as Carbon dioxide and concrete dust. There is now a rise in concrete recycling due to the hazards it poses toward environmental health and also due to economic considerations, public awareness and legislation. Cement factory pollution refers to the harmful effects of cement making factories on the environment. In the main pollutants from cement industry includesradioactive dust, nitrogen oxides, hydrogen chloride, hydrogen fluoride, sulphur dioxide, organic compounds, dioxins,carbon monoxide, furans and ammonia. The most commonly used techniques to reduce the contaminants resulting from the combustion are SCR catalysts for the removal of nitrogen oxides and electrical precipitators for the removal of solid waste and aerosols. However Organic pollutants and other combustible compounds like carbon monoxide can be found in these fumes. Around the globe, concrete is the most common building material, but it is harmful to the environment, adding very much to the greenhouse gas emissions during the production process. Cement a main ingredient in concrete, is the second highest industrial source of carbon dioxide on earth.



Figure 2: Pollution from cement factory

The dust flying from cement production process are transported through the air and are deposited in an area close to the manufacturing plants and or far away to distanced places. This includes villages, towns, green area, recreational places, natural vegetation and agricultural land. The depositions interfere with the natural metabolic system of agricultural production, which ultimately affect food quality and quantity. [9]. WHO and other environmental protection programs have placed sanctions on Industry emissions so as to curb the level of emission. Areas such as India and China that produce one of the largest amounts of cement per year experience have more polluted atmospheres than other countries.In Nigeria, indigenes of Ewekoro local government indicated high levels of respiratory diseases due to the excess release of nitrogen dioxide, carbon monoxide and Sulphur dioxide due to the level of industrialization in the community. It was reported that abouttwo thousand (2,000) Macedonians living in Skopje die each year due to a noxious mix of smoke arising from cement making factories and other major air pollutants. [6]

3. Impact of cement pollution

Dr. Ming Zhang and Dr. Mauri McSaveney stated that landslides in China which resulted in the deaths of up to 4000 people was caused by Acid rain which developed as a result of air pollution from Factories in China (Gabbatiss, 2017). Shefali Kesarwani of the department of Environmental science and NRM, SHUATS, Allahabad, Uttar Pradesh India stated that long-exposure to the pollutants released from cement factories and other industries can result in Chronic Bronchitis, Heart disease, Asthma attacks and even premature death (Shefali and James, 2017). Jacobson of Stanford University in his research on the link between carbon dioxide emissions and human mortality started that the 30 percent of 1000 deaths in California due of rise in temperatures were caused by carbon dioxide emissions which also affects the general health of indigenes of America as a whole (Lious, 2008). Ogedengbe and Oke (2011) studied the environmental pollution in the western region of Nigeria (Ewekoro) where three major cement factories are located. The air and water samples were tested and the results shows that the cement dusts released into the atmosphere were rich in heavy metals. Hence, it can be affirmed that a typical industrial source of air pollution is the cement industry. Cement is the basic component of concrete required in civil engineering constructions and buildings; it is one of the most significant manufactured material (Devi et al., 2017). Al Smadi et al., 2009, named concrete as the second most consumed substance on earth after water. Emissions from cement industries include

heavy metals, CO_2, NOx, SO_2, VOCs, PM, noise, dust and bad odor from plans and animals that die from the life threatening effects of emissions from these industries undergoing decay (Zimwara et al., 2012). These emissions result in global warming, acid rain, loss of biodiversity, reduced crop yield and adverse health effect such as chest discomfort, chronic bronchitis, asthma attacks, cancers etc. (Pariyar, 2013;Mehraj, 2013).

Particulate matter (PM), a mix of solid and liquid droplets are high from cement plants and affects humans greatly. $PM_{2.5}$ are atmospheric aerosol particles with diameters less than or equal to 2.5µm that on inhalation can penetrate deeply into the lung. Most components of these aerosols are cytotoxic and carcinogenic (McNeill, 2019). Oguntoke et al., 2012 reported a significantly higher than permissible levels of both PM_{10} and $PM_{2.5}$ within and around cement plants in a local government area in Nigeria. Ritchie and Roser, 2019 reported the statistics of $PM_{2.5}$ exposure from air pollution and death rate by country and region respectively (Fig 3). Air pollution is responsible for 3.1% of global disability-adjusted life (Lim et al., 2012). The relationship between long term exposure to air pollution and cardiovascular mortality has been established (Pope et al., 2004). There is an increase in report of the association between air pollution and lung cancer. A study by the American Cancer society (ACS) showed an increase of 8-14% in lung cancer in association with 10µg/m^3 increase in $PM_{2.5}$ (Pope et al., 2002).

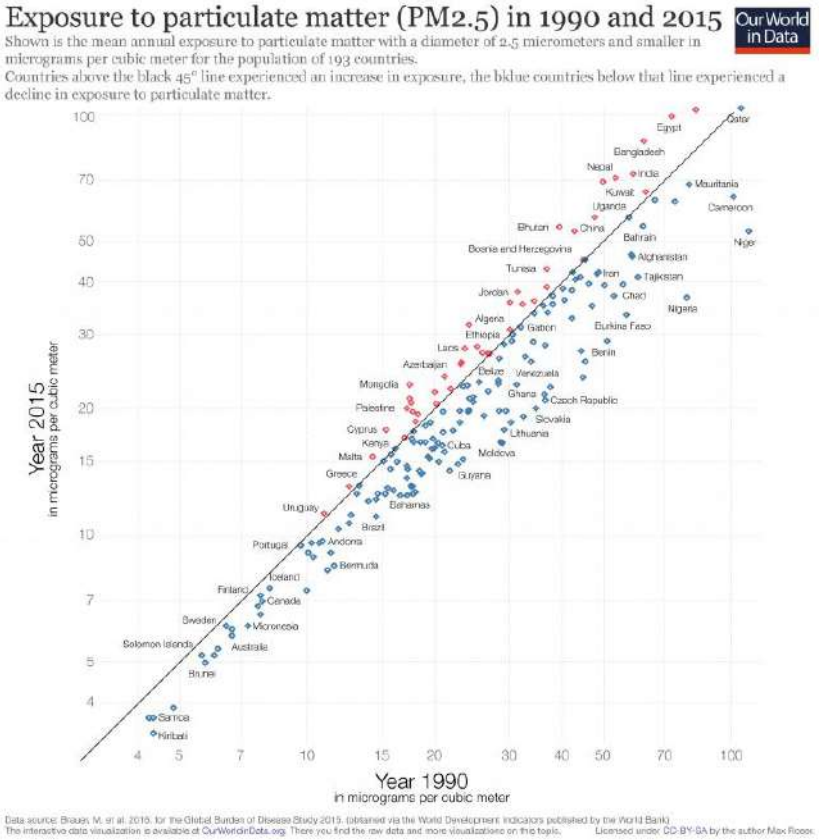


Figure 3: Exposure to particulate matter

4. Conclusion

In this study, the impact and dynamics of pollution from cement factory was discussed. Based on the findings, it is recommended that: there should be the use of catalysts which remove dangerous pollutants such as Nitrogen oxides, aerosols and other harmful pollutants in order to reduce the level of contamination to the atmosphere; a proper recycling system will enable less contamination because some of the pollutants can be used as fuels and making use of cleaner chemicals in cement factories; the adoption of computational models and technology such as Wet Scrubbers, Electrostatic

Precipitators, Flexible Pulse Jet Filters to reduce the level of greenhouse gases that are emitted from the cement factories; adoption of laws and legislation which provide a measure for air pollution. Implementation of laws that prevent industries from over polluting the environment will help control the level of harmful gases that are released daily; and raising awareness of the dangers of air pollution through factories.

Acknowledgements
The authors wish to acknowledge the financial support offered by Covenant University.

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Exhibit 6

An inventory of primary air pollutants and CO2 emissions from cement production in China, 1990–2020

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Citation	Lei, Yu, Qiang Zhang, Chris Nielsen, and Kebin He. 2011. "An Inventory of Primary Air Pollutants and CO2 Emissions from Cement Production in China, 1990–2020." Atmospheric Environment 45 (1) (January): 147–154. doi:10.1016/j.atmosenv.2010.09.034.
Published Version	doi:10.1016/j.atmosenv.2010.09.034
Citable link	http://nrs.harvard.edu/urn-3:HUL.InstRepos:34730508
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Atmospheric Environment 45 (2011) 147–154

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

An inventory of primary air pollutants and CO_2 emissions from cement production in China, 1990–2020

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ARTICLE INFO

Article history:
Received 11 February 2010
Received in revised form
15 September 2010
Accepted 17 September 2010

Keywords:
Cement industry
Emission inventory
China
Technology-based methodology

ABSTRACT

Direct emissions of air pollutants from the cement industry in China were estimated by developing a technology-based methodology using information on the proportion of cement produced from different types of kilns and the emission standards for the Chinese cement industry. Historical emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter (PM) and carbon dioxide (CO_2) were estimated for the years 1990–2008, and future emissions were projected up to 2020 based on current energy-related and emission control policies. Compared with the historical high (4.36 Tg of $PM_{2.5}$, 7.16 Tg of PM_{10} and 10.44 Tg of TSP in 1997), PM emissions are predicted to drop substantially by 2020, despite the expected tripling of cement production. Certain other air pollutant emissions, such as CO and SO_2, are also predicted to decrease with the progressive closure of shaft kilns. NO_X emissions, however, could increase because of the promotion of precalciner kilns and the rapid increase of cement production. CO_2 emissions from the cement industry account for approximately one eighth of China's national CO_2 emissions. Our analysis indicates that it is possible to reduce CO_2 emissions from this industry by approximately 12.8% if advanced energy-related technologies are implemented. These technologies will bring co-benefits in reducing other air pollutants as well.

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1. Introduction

China is the largest cement producing and consuming country in the world. Cement production in China was 1.39 billion metric tons in 2008 (CMIIT, 2009), which accounted for 50% of the world's production (USGS, 2009). Enormous quantities of air pollutants are emitted from cement production, including SO_2, NO_X, CO, and PM, and result in significant regional and global environmental problems. In China, the cement industry has been identified as an important source of pollution. For example, it is the largest source of PM emissions, accounting for 40% of PM emissions from all industrial sources (CEYEC, 2001) and 27% of total national PM emissions (Zhang et al., 2007a). Cement production also releases large amounts of CO_2 from both fuel combustion and the chemical process producing clinker, where calcium carbonate ($CaCO_3$) is calcined and reacted with silica-bearing minerals. According to the National Greenhouse Gas Inventory of China (NDRC, 2004), cement production contributed 57% of CO_2 process emissions (distinct from combustion emissions) from China's industrial sources in 1994.

There are two main kiln types in China: shaft kilns and rotary kilns. With higher productivity and efficiency, rotary kilns have dominated the cement industry in Western countries since the middle of the 20th century. Starting in the 1980s in China, however, small but easy-to-construct shaft kilns were built all over the country to meet the rapidly increasing demands of the construction industry. By the mid-1990s, they accounted for 80% of production (Lei, 2004). The extremely rapid increase in the number of shaft kilns resulted in poor operating practices within the Chinese cement industry. There were more than 7000 cement plants in China in 1997 (Zhou, 2003), most of them small and releasing high emissions. At the end of the 1990s, China began to restrict construction of new shaft kilns and instead promoted precalciner kilns, which are the most advanced rotary cement kilns. Consequently, the production from precalciner kilns increased very rapidly and by 2008 they accounted for more than 60% of cement production (CMIIT, 2009).

Since China's cement industry is an important emission source of several types of air pollutants, the systematic and reliable estimation of its emissions is essential for atmospheric modeling and

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doi:10.1016/j.atmosenv.2010.09.034

air pollution policy-making. From the perspective of criteria air pollutants, existing emission inventories for China usually treat the cement industry as a part of the industrial sector, roughly estimating its emissions based on coal consumption (Streets et al., 2003; Ohara et al., 2007). These emission inventories, however, are not capable of providing to the atmospheric modeling community reliable emission trends of China's cement industry. Moreover, there are shortcomings in future emission estimates because the effects from technology replacement and emission control measures were not taken into account. From the perspective of greenhouse gas (GHG) emissions, there have been some estimates made at a national level (He and Yuan, 2005; Liu et al., 2009; NDRC, 2004; Zhu, 2000) or as a part of a global analysis (Boden et al., 1995, 2009; WBCSD, 2002; Worrell et al., 2001). Most of these studies, however, have focused on a specific year and are not able to reflect changes in emissions due to technology replacement and energy efficiency improvement in China's cement industry. Our previous studies have addressed concerns over the technology-based emission estimates from the cement industry for specific air pollutants, such as PM (Lei et al., 2008) and NO_X (Zhang et al., 2007b) or for a specific year (Zhang et al., 2009), however, a historical trend of emissions from China's cement industry is still missing. In this work, we developed a historical emission inventory of major air pollutants from China's cement industry for the period 1990–2008 to explore the effects of recent regulations and technologies on these emissions, and we predict future emissions up to 2020 in light of existing and possible future regulations.

2. Methodology and data

2.1. Bottom-up methodology

The emission inventory developed here includes four gaseous air pollutants (SO_2, NO_X, CO and CO_2) and PM in three different size ranges: $PM_{2.5}$ (particulates with diameter less than 2.5 μm), PM_{10} (particulates with diameter less than 10 μm) and TSP (total suspended particulates). Only direct emissions from cement production were considered in this inventory. The indirect emissions, such as which from power consumption during manufacture and the transportation of raw materials and end products are not included. Kilns are the major source of most air pollutants in the cement production process. In this study, cement kilns are classified into three groups: shaft kilns, precalciner kilns, and other rotary kilns.

Emissions from the cement industry of each province in China were calculated based on province-level cement outputs and emission factors (EFs), and then summed to give estimates at a national level. The approaches used for estimating emissions of different pollutants are listed in Table 1. The burning of fuel in the kilns is the sole source of SO_2, NO_X and CO emissions. The emissions of these pollutants were estimated based on coal consumption as almost all cement kilns in China use coal as fuel. In addition to fuel combustion, calcination of carbonate such as limestone is the other important source of CO_2 emissions, which we calculated separately in our analysis. PM emissions were more complicated to estimate because: (1) besides kiln emissions, there are several other emission sources such as quarrying and crushing, raw material storage, grinding and blending, and packaging and loading; and (2) abatement efficiency varies a lot between the different PM emission control technologies. Taking the multiple sources and control technologies into account, a dynamic methodology was developed to estimate the inter-annual emissions of PM.

2.2. Activity rates

Total cement production by province from 1990 is available from the *China Statistical Yearbook* (NBS, 1991–2008). A breakdown of national cement production by kiln type was estimated from the historical capacity of precalciner kilns and other rotary kilns (Kong, 2005; Lei, 2004; Zeng, 2004), as shown in Fig. 1. There are no statistical data for clinker production or coal consumption for the cement industry in China as a whole. We therefore estimated these by using typical clinker to cement ratios and energy efficiency data of the Chinese cement industry.

In general, cement is produced by mixing auxiliary materials with milled clinker. In China in the 1990s, the national average clinker to cement ratio varied within the range 0.701–0.738 (Zhou, 2003) and so for this study we used a value of 0.72. The energy efficiency of China's cement industry has improved considerably in last two decades. The average energy intensity of the whole industry dropped from 5.27 MJ $tonne^{-1}$-clinker in 1990 (Liu et al., 1995) to 4.77 MJ $tonne^{-1}$-clinker in 1998 (Zhou, 2003). And the current energy efficiency of China's precalciner kilns is around 3.51 MJ $tonne^{-1}$-clinker, a value that is recommended as the basic level for clean production of cement (MEP, 2009). Based on this information, the historical energy efficiency of different kiln types was interpolated, which enabled coal consumption to be calculated, as shown in Table 2.

2.3. Emission factors (EFs)

SO_2 mainly comes from the oxidation of sulfur in coal. In precalciner kilns, approximately 70% of SO_2 is absorbed by reaction with calcium oxide (CaO) (Liu, 2006), while much less is absorbed in other rotary kilns and in shaft kilns (Su et al., 1998). Utilization of

Table 1
Emission sources of air pollutants from the cement industry and equations used for estimating estimations.

Pollutants	Combustion	Calcination	Other sources	Equation for emissions estimation[a]
SO_2	√	–	–	$E_j = \sum_{i,m} CC_{i,j,m} \times EF_m$
NO_X	√	–	–	$E_j = \sum_{i,m} CC_{i,j,m} \times EF_m$
CO	√	–	–	$E_j = \sum_{i,m} CC_{i,j,m} \times EF_m$
CO_2	√	√	–	$E_j = \sum_{i,m} CC_{i,j,m} \times EF_m + \sum_i CP_{i,j} \times EFC$
PM	√	√	√	$E_{j,y} = \sum_{i,m} P_{i,j,m} \times ef_{j,m,y}$, $ef_{j,m,y} = EFR_m \times F_{m,y} \times \sum_n C_{m,n,j} \times (1 - \eta_{n,y})$

[a] i, j, m and n represent the province, year, type of kiln or emission source and type of PM control technology respectively; y represents the three size categories of PM: $PM_{2.5}$, PM > 2.5 μm but < 10 μm ($PM_{2.5-10}$), and PM > 10 μm ($PM_{>10}$); E is the total emissions; CC is the coal consumption; CP denotes the clinker production; P is the cement production; EF is the emission factors from coal combustion; EFC denotes the emission factor of CO_2 from calcination during clinker production; ef is the final emission factor of PM; EFR is the unabated emission factor of PM prior to the effect of PM control devices; F_y is the fraction of all PM in size range y with $\sum_y F_y = 1$; C_n is the penetration rate of the PM control technology n with $\sum_n C_n = 1$; η is the PM removal efficiency of the control technology.

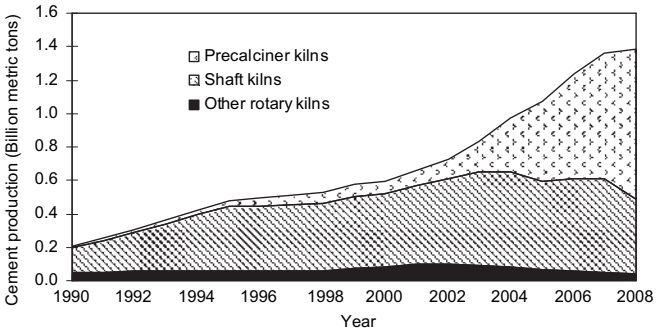


Fig. 1. Cement production in China from different types of kiln from 1990 to 2008.

Table 3
Emission factors of SO_2, NO_X and CO from cement kilns (g kg^{-1} of coal combusted in kilns).

	SO_2[a]	NO_X	CO
Precalciner kilns	2.9	15.3	17.8
Other rotary kilns	12.3	18.5	17.8
Shaft kilns	12.3	1.7	155.7
1990 average	11.6	7.3	108.1
1995 average	11.5	4.9	127.8
2000 average	11.4	6.1	116.9
2005 average	8.7	8.7	88.0
2008 average	6.8	10.8	64.3

[a] These are national average SO_2 emission factors weighed by provincial coal consumption. Different SO_2 emission factors are applied for different provinces according to sulfur content of coal from that province.

baghouse filters, as required with new precalciner kilns, can further reduce SO_2 emissions. Assuming that SO_2 absorption is 80% for the entire precalciner kiln process and 30% for other types of kilns (Liu, 2006), we estimated SO_2 emissions by province using a mass balance approach and based on the average sulfur content of coal in each province (Liu, 1998).

Generation of NO_X and CO is highly dependent on temperature and oxygen availability. Compared to shaft kilns, rotary kilns produce much more NO_X and less CO because of their higher operation temperature and stable ventilation. Based on local test results, our previous studies have estimated the EFs of NO_X (Zhang et al., 2007b) and CO (Streets et al., 2006) from different types of kilns in China. These EFs were used in this study, and the average NO_X and CO EFs of the cement industry as a whole were calculated based on the historical balance of kiln type, as listed in Table 3.

CO_2 EFs were given in quite a few studies estimating CO_2 emissions from the cement industry in China (Boden et al., 1995; Cui and Liu, 2008; He and Yuan, 2005; NDRC, 2004; Wang, 2009; Worrell et al., 2001; Zhu, 2000). In this work, we used CO_2 EFs from the study by Cui and Liu (2008) who followed the approach recommended by the International Panel on Climate Change (IPCC, 2006) and calculated the EFs based on the typical practices of the cement industry in China. Their estimates of the CO_2 EFs were 0.55 kg kg^{-1} clinker from the calcining process, and 1.94 kg kg^{-1} coal from coal combustion. The CO_2 EFs from different published works are compared in Sect. 3.3 to assess the reliability of our CO_2 emission estimates.

The EFs of PM is dependent on both the characteristics of unabated emissions from the overall production process and the effectiveness of PM emission control devices. Our previous study (Lei et al., 2008) reviewed prior research and calculated the unabated PM EFs for different types of kilns and other emission sources, such as quarrying, crushing and other mechanic processes, as summarized in Table 4.

PM control devices can reduce PM emissions by 10–99.9%, depending on the type of control technology employed and the size distribution of PM in the raw flue gas (Lei et al., 2008). Although more efficient PM control technologies require higher investment and have higher operational costs, improving emission standards is driving the promotion of these technologies within the industry. The standard value for the PM concentration in kiln flue gas dropped from 800 to 50 mg m^{-3} in 20 years, according to progressive editions of the air pollutant emission standards for the cement industry (SEPA, 1985, 1996b, 2004). Based on the PM concentration requirements of the three successive emission standards, penetration rates of the different PM control technologies in newly built cement plants are estimated for four periods: before 1985, 1985–1996, 1997–2004, and after 2004. Although the emission standards published in 1996 and 2004 allow 3–10 years for existing plants to reduce their PM emission rates, reduction is not likely to be significant in existing plants as there are few measures to enforce the standard. In this work, we assume that all plants retrofit their whole production line every 15 years, and in doing so meet the present standards for new plants. We then calculate the penetration rates of PM control technologies across the cement industry for the period 1990–2008, and estimate the corresponding PM EFs, as shown in Fig. 2. Over the 18-year period, the EF of TSP from the cement industry dropped by 88%, from 27.93 g kg^{-1} to 3.31 g kg^{-1}. The reduction in PM_{10} and $PM_{2.5}$ EFs is also considerable: 18.08–2.53 g kg^{-1} and 10.65–1.61 g kg^{-1}, respectively.

3. Results and discussion

3.1. Emissions from 1990 to 2008

Fig. 3 and Table 5 show emissions of gaseous air pollutants and PM from China's cement industry for the period 1990–2008. The emissions in 2005 are also compared with China's total emissions from all anthropogenic sources in Table 5. The cement industry is a major source of PM in China, contributing more than a quarter of $PM_{2.5}$ and PM_{10} in 2005. As a significant contributor to GHG emissions in China, the cement industry produces approximately one eighth of China's total anthropogenic CO_2 emissions. The

Table 2
Cement and clinker production and energy consumption in China, 1990–2008.

Year	Cement production (Tg)			Clinker production (Tg)	Average coal intensity (MJ kg^{-1} clinker)			Coal consumption (Tg)
	PC kilns[a]	Shaft kilns	OR kilns[b]		PC kilns	Shaft kilns	OR kilns	
1990	14	143	53	151	4.07	4.83	5.85	36
1995	34	385	57	343	3.92	4.62	5.65	77
2000	78	435	84	430	3.78	4.39	5.41	92
2005	473	526	70	770	3.63	4.10	5.21	146
2008	902	443	43	999	3.54	3.92	5.06	177

[a] PC kilns: precalciner kilns.
[b] OR kilns: other rotary kilns.

Table 4
Unabated PM emission factors for cement production (g kg^{-1} cement).

Emission sources		Total PM	$PM_{2.5}$	$PM_{2.5-10}$	$PM_{>10}$	EF range from references (EPA, 1995; Jiao, 2007; SEPA, 1996a)
Kilns	Precalciner kilns	105	18.9	25.2	60.9	58.2–317.9
	Other rotary kilns	98	14.0	21.0	63.0	24–330
	Shaft kilns	30	3.3	6.0	20.7	13.4–91.2
Other sources as a whole		140	9.5	23.8	107.7	63–235

cement industry is also very important from the perspectives of China's SO_2, NO_X and CO emissions, contributing approximately 5.1%, 6.4% and 7.7% of national anthropogenic emissions in 2005, respectively.

Emissions of SO_2 increased from 0.42 Tg in 1990 to 1.39 Tg in 2007, then dropped to 1.21 Tg in 2008 (a reduction of 12.6%). The decline in SO_2 emissions in 2008 is attributed to two factors. First, the global economic recession suppressed the construction industry and saw the annual rate of increase in cement production drop from 10% in the previous year to 2% in 2008. Second, nation-wide replacement of shaft kilns with precalciner kilns from 2007 to 2008 led to a 20% of reduction in cement production from shaft kilns, which emit several times more SO_2 per mass unit of cement.

The trend observed for CO emissions is similar to that of SO_2. In contrast, NO_X emissions increased much faster than any other pollutant. During the 1990s, NO_X emissions doubled, and the 2000 emissions were three times higher by 2008. With the recent rapid expansion of precalciner kilns in China, the average annual increase in NO_X emissions from the cement industry from 2003 to 2008 was over 220 Gg. This accounts for about 20% of the incremental NO_X emissions seen for China as a whole according to the INTEX-B emission inventory (Zhang et al., 2009). As awareness grows of China's increasing NO_X emissions and its consequences for ozone pollution and acidification (Zhao et al., 2009), policies to combat acid rain pollution will inevitably have to specifically address the cement industry.

Emissions of CO_2 increased 5.8 times, from 153 Tg in 1990 to 892 Tg in 2008. The proportion of CO_2 emissions from fuel combustion compared to that from calcination of carbonates decreased from 46.0% in 1990 to 38.6% in 2008, representing improved energy efficiency in the cement industry. Our estimates of CO_2 emissions are lower than the results delivered by some researchers such as Boden et al. (2009), Liu et al. (2009) and Worrell et al. (2001). The main reasons of the differences are discussed in Section 3.3.

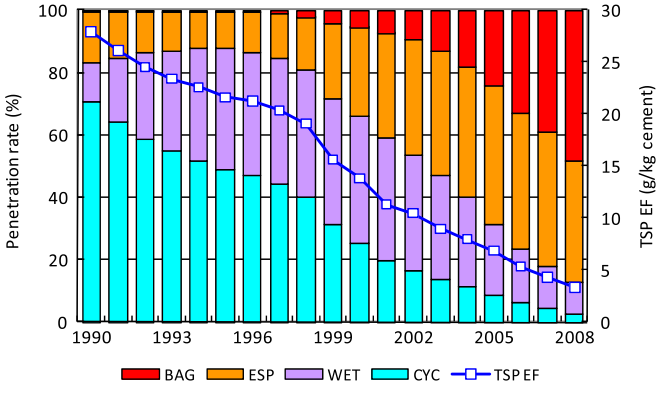


Fig. 2. PM emission factors (g kg^{-1} cement) for all cement producing processes in China's cement industry for the years 1990–2008. Bars represent the penetration rate of PM control technologies within the industry (BAG: baghouse filter; ESP: electrostatic precipitator; WET: wet scrubber; CYC: cyclone.), and line represents the net emission factor of TSP.

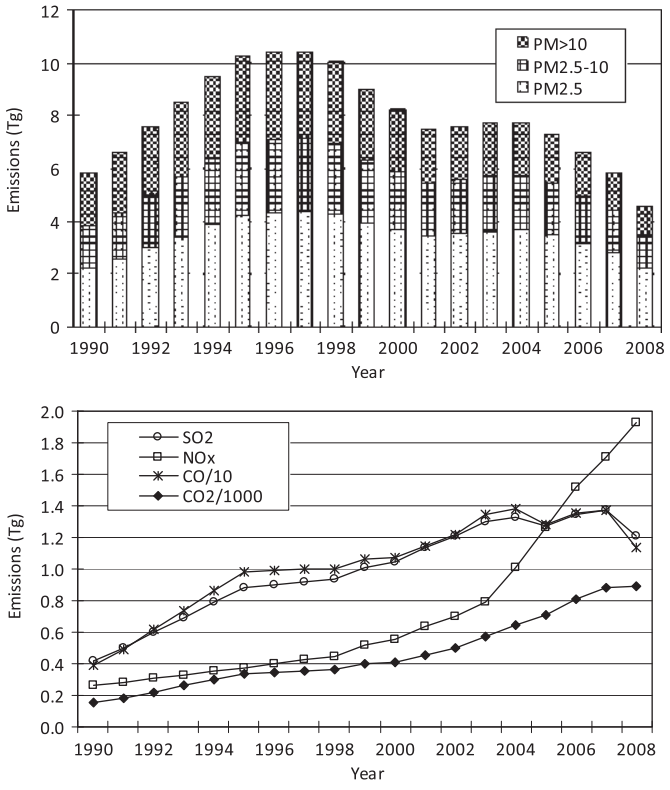


Fig. 3. Emissions of air pollutants (top panel, PM; bottom panel, SO_2, NO_X, CO, CO_2) from China's cement industry from 1990 to 2008.

Emissions of PM rose rapidly from 1990 to 1995, when cement production developed with an average annual increase of 17.8%. In the second half of the 1990s, expansion of China's cement industry slowed and the new emissions standard released in 1996 promoted the application of electrostatic precipitators (ESPs) in shaft kilns, resulting in an industry-wide decrease in PM emissions. After 2000, although the average annual increase in cement production was greater than 12%, PM emissions gradually decreased due to the replacement of shaft kilns by precalciner kilns and the application of high-performance PM removal technology, especially after 2004. Over the whole period, PM emissions reached a peak in 1997, with 4.36 Tg of $PM_{2.5}$, 7.16 Tg of PM_{10} and 10.44 Tg of TSP.

3.2. Spatial distribution of emissions

The spatial distribution of emissions changed year-by-year. Using 2005 as a base year, cement production from 5294 plants was collected from the China Cement Association (CCA), including the capacity of 612 clinker production lines installed with precalciner kilns. These plants accounted for almost all precalciner kilns and more than 95% of cement production in China in that year. The location of these plants and production lines is determined at county-level from cement plant registration information (CCA, 2006). Thus emissions of $PM_{2.5}$, SO_2 and NO_X from the cement industry in 2005 are mapped onto an $18' \times 18'$ grid of China, as shown in Fig. 4.

In different ways, the distribution of $PM_{2.5}$, SO_2 and NO_X emissions reflect regional operational differences and kiln combinations within China, a point illustrated by the following examples. The grid cells indicating high $PM_{2.5}$ emissions show a greater

Table 5
Estimated emissions of air pollutants from China's cement industry (1990–2008) compared to emissions from all anthropogenic sources (Tg).

Year	SO_2	NO_X	CO	CO_2	$PM_{2.5}$	PM_{10}	TSP
1990	0.42	0.27	3.93	153.33	2.23	3.79	5.86
1995	0.89	0.38	9.81	336.74	4.21	6.97	10.28
2000	1.04	0.56	10.70	413.31	3.68	5.90	8.25
2005	1.29	1.26	12.83	704.83	3.48	5.47	7.33
2008	1.21	1.92	11.41	892.14	2.23	3.52	4.59
All sources in 2005	25.5[a]	19.8[b]	167[b]	5626[c]	12.9[d]	18.8[d]	34.3[d]
Percentage contribution of cement in 2005	5.1%	6.4%	7.7%	12.5%	26.9%	29.0%	21.4%

[a] SEPA, 2007.
[b] Zhang et al., 2009.
[c] Boden et al., 2009.
[d] Lei et al., 2010.

concentration in north China. The provinces of Shandong, Hebei and Henan account for 31.5% of total $PM_{2.5}$ emissions. By consuming coal with much higher sulfur content than other provinces, Sichuan has the second highest provincial emissions of SO_2, after Shandong. Shandong, Zhejiang, Jiangsu and Anhui are the largest contributors to NO_X emissions, which is due to a number of clinker-producing centers using large precalciner kilns in these provinces. The highest $PM_{2.5}$, SO_2 and NO_X emissions are all located in the same grid cell in Shandong province, where the city of Zaozhuang is found.

3.3. Comparison of CO_2 emissions with other studies

Some studies have been conducted to quantify CO_2 emissions from cement production in China, but few of them have observed the effects of developments in technology on CO_2 emissions in China. We compare our estimates with some results from other studies in Table 6. All CO_2 emission estimates were converted to CO_2 EFs in the comparison.

Generally speaking, estimates of China's CO_2 emissions as a part of global studies (e.g., WBCSD, 2002; Boden et al., 2009) are much higher than estimates made from domestic studies because some parameters used in global studies doesn't fit the real situation of Chinese cement industry. For example, a higher clinker to cement ratio was used in global studies (83–100%) than in domestic ones (72–75%). Higher energy intensity was assumed in global studies as well, which led to higher EFs of CO_2 from energy consumption. The other factor leads to higher results in global studies is that indirect CO_2 emissions from electricity consumption are usually included in those analyses. The national average electricity intensity of China's cement industry is 110–115 kwh/tonne cement (Liu et al., 1995; MEP, 2009). Therefore electricity consumption during cement production leads to additional indirect CO_2 emissions of 0.102–0.107 kg CO_2/kg cement.

Our estimates of CO_2 emissions are generally comparable with most domestic studies. However, the recent studies by Cui and Liu (2008) and Wang (2009) indicate much lower values of CO_2 emission than our study, as their estimations were based on the working practices of advanced precalciner cement plants. These lower EFs indicate that China's cement industry shows promising potential to reduce CO_2 emissions.

4. Future emissions and mitigation potential

Since emissions from China's national cement industry contribute significant levels of several air pollutants, accurate emission projections are necessary to inform Chinese national strategies on air pollution control and GHG mitigation. In this study, the future emissions from the cement industry for the period 2010–2020 were estimated, and the potential of mitigation technologies to reduce the emission is analyzed.

4.1. Emissions projection

Cement production in China exceeded 1.63 billion metric tons in 2009, and the available statistical data show another 19% increase in the first 5 months of 2010 (http://www.stats.gov.cn/tjsj/), in comparison with the same period of 2009. Expert opinion from the CCA indicates that cement production may reach approximately 1.8 billion tons in 2010 (personal communication), but projecting as far ahead as 2020 reveals large differences between the available predictions: the Chinese Academy for Environmental Planning predicted production to be 2.1 billion metric tons based on future investment in fixed assets; Ho and Jorgenson (2007) modeled China's economy with a computable general equilibrium (CGE) economic model that included 33 production sectors and one household sector, and predicted production to be 1.7 billion metric tons in 2020; Wei and Yagita (2007) coupled cement production with future rates of urbanization and building area and predicted production to be 1.2 billion metric tons by the same date. Considering the large uncertainties involved in predicting the development of China's cement industry over the next 10 years, our emission projections are based on these three studies' predictions of cement production by 2020, representing scenarios of high, medium and low production, respectively.

The key technological features of the cement industry are projected based on the existing policies on industry structure (NDRC, 2006), energy saving (MEP, 2009) and emission control (SEPA, 2004). Assuming no new policy will come into effect before 2020, future EFs of air pollutants from the cement industry were estimated using the same methodology described in Sect. 2, as listed in Table 7. Generally speaking, the continued replacement of shaft kilns by precalciner kilns will lead to a decrease in both coal intensity and in CO_2 EFs. Higher penetration of precalciner kilns will also result in a decrease in SO_2 and CO EFs, and an increase in NO_X EFs. PM EFs are predicted to fall with the progressive construction of new cement plants which meet the requirement of the latest emission standards.

According to our estimates (Table 8), the emissions of SO_2, CO and PM from China's cement industry will decrease in all of the three scenarios; however, emissions of NO_X and CO_2 will increase until 2020 in the high-production scenario. Emissions of NO_X will be considerable, compared with SO_2 and PM emissions. The ratio of NO_X to SO_2 will increase from 2.07 in 2010 to 3.14 in 2020, indicating that greater focus should be given to NO_X emission control in order to prevent pollution from acid rain. The differences in CO_2 emissions between 2010, 2015 and 2020 are less than those of other pollutants. This is because under current policies the EF of CO_2 will

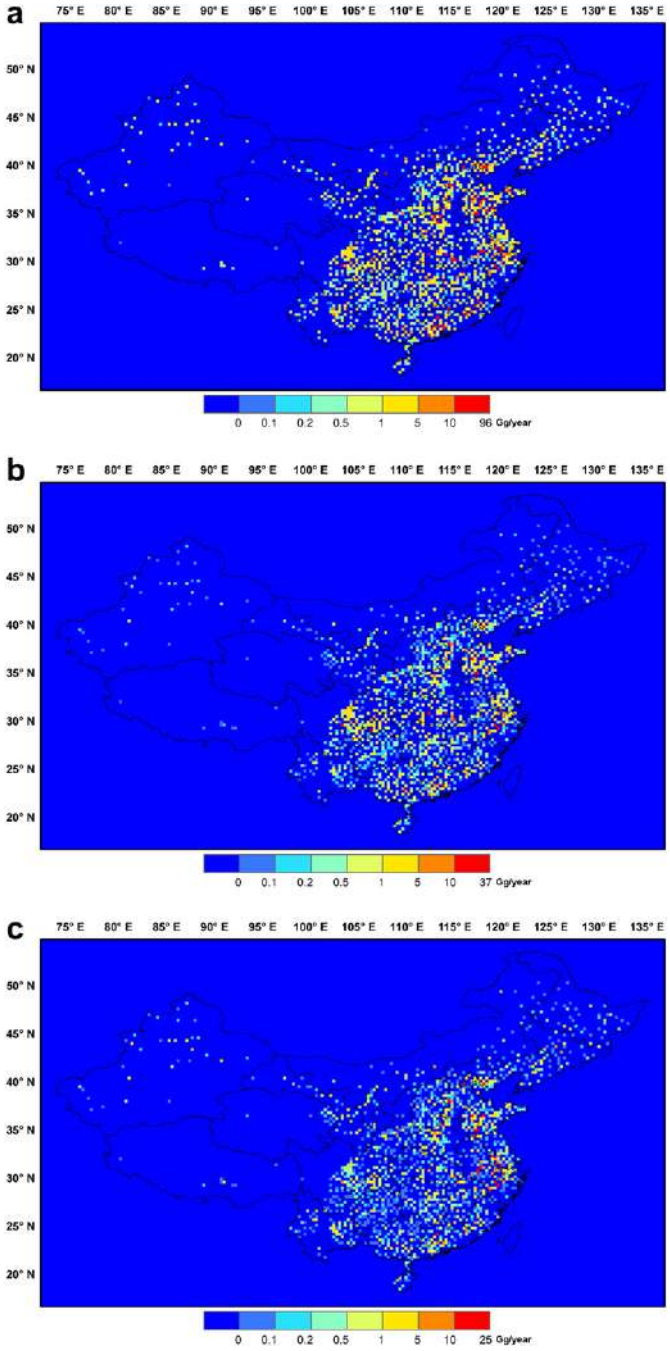


Fig. 4. Emissions of $PM_{2.5}$, SO_2 and NO_X from the cement industry in China plotted on an 18′ × 18′ grid; provincial boundaries are shown. (a) $PM_{2.5}$; (b) SO_2; (c) NO_X.

not change as much as other pollutants. However, as CO_2 emissions mitigation is of serious concern, more policies should be considered to reduce CO_2 EFs from China's cement industry.

4.2. Potential for CO_2 mitigation

Several studies have addressed potential reductions in CO_2 emissions from China's cement industry. The World Business Council for Sustainable Development (WBCSD, 2009a) has summarized the recent studies and pinpointed four areas of technology for the reduction of CO_2 emissions: thermal and electric efficiency, alternative fuels, clinker substitution, and carbon capture and storage (CCS). Following the technology roadmap laid out by WBCSD (2009a), we analyzed the potential for CO_2 mitigation by China's cement industry in 2020, as listed in Table 9. Thermal efficiency could be improved by replacing small shaft kilns by large precalciner kilns. On a global level, top 10% advanced kilns can currently operate at a average thermal efficiency of 3.10 MJ kg^{-1}-clinker (MEP, 2009; WBCSD, 2009a), and although the clinker to cement ratio in China is already lower than the global average (WBCSD, 2009b; Worrell et al., 2001), the predicted increase of power plants and iron and steel plants will increase the availability of by-products which can be used as substitutes for clinker. It is estimated that the clinker to cement ratio could drop to 65% (CCA, personal communication). A few cement plants in China have begun to use solid waste as a fuel in kilns as a substitute for coal. WBCSD (2009a) projected that the share of alternative fuel in clinker fuel use in Asia could increase at an annual rate of 0.6%. CCS technologies are long-term approaches to carbon management and are not likely to be accessible by 2020; therefore we do not include them in our analysis.

Our analysis indicates that the potential for CO_2 mitigation by clinker substitution is likely to be much larger than that possible by improvements in thermal efficiency and from the use of alternative fuels. If these three technologies are implemented together, CO_2 emissions from cement production could be reduced by 12.8% by 2020. Using the mid-level scenario of predicted increase in cement production, mitigation of CO_2 emissions will be 130 Tg of CO_2, equivalent to the emissions of CO_2 from the usage of 67 Tg of coal.

Table 6
Comparison of EFs used for the estimation of CO_2 emissions (kg CO_2/kg cement).[a]

	Energy consumption	Calcining process	Total
This study[b]	0.248–0.336	0.395	0.643–0.731
Zhu, 2000[c]	0.367–0.393	0.365	0.732–0.758
Worrell et al., 2001[d]	(0.467)	0.415	(0.883)
WBCSD, 2002[e]	–	–	(0.900–0.950)
NDRC, 2004	–	0.374	–
He and Yuan, 2005	–	–	0.671–0.913[f]
Cui and Liu, 2008	0.168 (0.259)	0.395	0.563 (0.654)
Boden et al., 2009	–	0.496–0.507	–
Wang, 2009	(0.226)	0.427	(0.653)

[a] The values in parentheses refer to EFs that include indirect CO_2 emission from power consumption.
[b] The lower value in the range is the EF in 2008, and the upper value is the EF in 1990.
[c] The lower value in the range is the EF in 1997, and the upper value is the EF in 1990.
[d] The EF is used to estimate CO_2 emission in 1994.
[e] The lower value in the range is the EF in 1995, and the upper value is the EF in 1990.
[f] The range represents the different EF values for different type of kilns.

Table 7
The key features and EFs of China's cement industry in 2010, 2015 and 2020 (projections based on existing policies).

	2010	2015	2020
Proportion of precalciner kilns (%)	75	85	90
Coal intensity (MJ kg^{-1}-clinker)	3.58	3.39	3.22
Clinker to cement ratio	72	72	72
SO_2 EF (k kg^{-1} coal consumed)	5.8	4.8	4.4
NO_X EF (k kg^{-1} coal consumed)	12.0	13.1	13.8
CO EF (k kg^{-1} coal consumed)	51.8	40.2	32.8
CO_2 EF (kg kg^{-1} cement)	0.634	0.621	0.610
$PM_{2.5}$ EF (k kg^{-1} cement)	0.80	0.58	0.47
PM_{10} EF (k kg^{-1} cement)	1.26	0.94	0.78
TSP EF (k kg^{-1} cement)	1.55	1.16	0.97

Table 8
Future output and coal consumption of China's cement industry, and associated emissions of air pollutants (Tg) for three production scenarios of high, medium and low cement production (see text for details).

	High			Medium			Low		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
Cement production	1800	2010	2140	1800	1850	1660	1800	1580	1170
Coal consumption	222	234	237	222	216	184	222	184	130
SO_2 emissions	1.29	1.12	1.04	1.29	1.04	0.81	1.29	0.88	0.57
NO_X emissions	2.67	3.07	3.28	2.67	2.83	2.54	2.67	2.41	1.79
CO emissions	11.51	9.42	7.79	11.51	8.67	6.04	11.51	7.40	4.26
CO_2 emissions	1141	1248	1305	1141	1149	1013	1141	981	714
$PM_{2.5}$ emissions	1.44	1.17	1.01	1.44	1.07	0.78	1.44	0.92	0.55
PM_{10} emissions	2.27	1.89	1.67	2.27	1.74	1.29	2.27	1.49	0.91
TSP emissions	2.79	2.33	2.08	2.79	2.15	1.61	2.79	1.83	1.13

4.3. Potential for emission control of other air pollutants

Current emission standards have promoted the use of advanced emission control technologies; however, the level of emission control in China's cement industry is still lower than that of advanced countries. If state-of-the-art control technologies are used, there is potential to substantially further reduce the emission of air pollutants from the cement industry in China.

PM emissions have been the major focus of air pollution control from the cement industry for years. As of 2010, all new cement plants are required to meet an emission standard of 50 mg m^{-3} flue gas (SEPA, 2004), which equates to a PM EF for the whole production process of approximately 1 g kg^{-1} cement (CRAES, 2003). This emission level could be even lower, however, when baghouse filters replace PM control devices that are relatively inefficient. If all of China's cement plants used baghouse filters in major production processes, the average PM EF could drop to 0.7 g kg^{-1} cement.

Deployment of baghouse filters will benefit SO_2 emission control as well. However, emissions of NO_X would not be reduced unless selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) technology is used. Although BREF documents state that NO_X emissions could be as low as 200–500 mg m^{-3} if the best available technologies (BAT) are used, actual NO_X emissions from most European cement plants using SNCR technology are 500–800 mg m^{-3} (Jiao, 2007). If China's cement plants could reduce the average NO_X emission level to 500 mg m^{-3} in 2020, the corresponding NO_X EF would be 9.7 k kg^{-1} coal.

The technologies used to mitigate CO_2 emissions are also effective in reducing emissions of PM, SO_2 and NO_X. Based on mid-scenario emissions of these pollutants in 2020, we estimated the potential for emission reduction from each mitigation technology, as listed in Table 10. Our estimates indicate that there is the potential for China's cement industry to reduce air pollutants substantially. Baghouse filters and SCR/SNCR technologies are likely to be the most effective in controlling PM and NO_X emissions, respectively, and technologies to abate CO_2 emissions will also bring significant benefits in terms of SO_2 emission control.

Table 9
Estimated emission reduction potential from major CO_2 mitigation technologies in 2020.

Technology category	Improvement of performance	CO_2 reduction (%)
Thermal efficiency	Thermal intensity drops from 3.22 MJ kg^{-1} clinker to 3.10 MJ kg^{-1} clinker	1.3
Clinker substitution	Clinker to cement ratio drops from 72% to 65%	9.7
Alternative fuels	Share of alternative fuel increases by 6%	2.1

Table 10
Emission reduction potential of PM, SO_2 and NO_X in 2020.

Technology category	$PM_{2.5}$	PM_{10}	TSP	SO_2	NO_X
Baghouse filters	39.8%	32.0%	28.0%	8.6%	–
SCR/SNCR	–	–	–	–	29.4%
Thermal efficiency	–	–	–	3.7%	–
Clinker substitution	6.5%	5.5%	4.1%	9.7%	9.7%
Alternative fuels	–	–	–	6.0%	–
All	44%	36%	31%	25%	36%

5. Conclusions

The cement industry plays an important role in emissions of many air pollutants in China. This study estimates the direct emissions of major air pollutants from cement production based on information on the development of production technologies and rising emission standards in China's cement industry. Our analysis shows that with the replacement of old shaft kilns by precalciner kilns, there is an opportunity to reduce PM emissions through the implementation of stricter emission standards and the promotion of high-performance PM control technologies. Other air pollutants such as CO and SO_2 will also decrease as shaft kilns are gradually retired. However, the promotion of precalciner kilns within China and a rapid increase in cement production has led to greatly increased NO_X emissions. Future NO_X emission could be reduced if SCR or SNCR technologies are introduced within the cement industry, although the cost of introduction is likely to be considerable.

Although energy-use efficiency in China's cement industry has improved significantly in recent years, the industry still contributes approximately one eighth of the nation's CO_2 emissions. Our analysis indicates that it may be possible to reduce CO_2 emissions by 12.8% by 2020 if advanced energy-related technologies are implemented, and that the substitution of clinker with other material is likely to be the most effective technology in this regard. These energy-related technologies are likely to bring additional benefits by reducing the emission other air pollutants as well.

Acknowledgements

The work was supported by China's National Basic Research Program (2005CB422201) and China's National High Technology Research and Development Program (2006AA06A305). K.B. He would like to thank the National Natural Science Foundation of China (20625722) for financial support.

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African Journal of Microbiology Research Vol. 4(22) pp. 2418-2425, 18 November, 2010
Available online http://www.academicjournals.org/ajmr
ISSN 1996-0808 ©2010 Academic Journals

Exhibit 7

Full Length Research Paper

Effect of cement dust pollution on microbial properties and enzyme activities in cultivated and no-till soils

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Accepted 12 October, 2010

Cement dust pollution is one of the sources of atmospheric pollution. The main impacts of the cement activity to the environment are the broadcasts of dusts and gases. The objective of this study is to determine the effects of cement dust pollution, which was generated by cement plant, on soil microbial population, microbial respiration, and some enzyme activities in cultivated wheat (CT) and no-till (NT) soils. The fields are located at distances of 1, 3, 5, 7, 10 and 15 km away from the cement plant. In dominant wind direction, three replicated 36 soil samples were taken from a depth of 0 to 20 cm and analyzed for chemical, physical and microbiological properties. Soil microbial population and CO_2-C production showed significant ($p < 0.05$) positive correlation in CT and NT soils. The highest microbial population and CO_2-C production was observed at 15 km away from the cement plant in CT and NT soils. Acid phosphatase, urease and dehydrogenase enzyme activities of the soils showed significant ($p < 0.01$) positive correlation with distance in CT and NT (r^2 = 0.80-0.86; r^2 = 0.90 to 0.92; r^2 = 0.79 to 0.82, respectively). There was negative correlation between alkaline phosphatase enzyme activity and distance in CT and NT (r^2 = 0.60, r^2 = 0.68; $p < 0.05$).

Key words: Microbial respiration, CO_2-C production, microbial population, cement dust pollution, soil enzyme activity.

INTRODUCTION

Air pollutants generated by the cement manufacturing process consist primarily of alkaline particulates from the raw and finished materials. The direct effects of cement dust pollution are the alkalization of the ecosystem and the changing of the chemical composition of soils (Mandre, 1995). The main impacts of the cement activity on the environment are the broadcasts of dusts and gases. The pollutant particles can enter into soil as dry, humid or occult deposits and can undermine its physicochemical properties (Laj and Sellegri, 2003). Thus, cement dust pollution has a negative effect on the physico-chemical properties and the biological activity of the soil. Soil microbial activity is important for the nutrient biogeochemical cycling and it is negatively affected by the cement dust pollution (Ocak et al., 2004; Nowak et al., 2003). The most commonly used microbial activity indicators for soil health monitoring are microbial biomass, soil respiration and soil enzyme activity (Nielsen and Winding, 2002).

Microorganisms are the main source of enzymes in soils. It is well known that all biochemical reactions are catalyzed by enzymes, which are proteins with catalytic properties owing to their power of specific activation. Soil enzyme activities are often used as indices of microbial growth and activity in soils. Enzyme activities play key roles in the biochemical functioning of soils, including soil organic matter formation and degradation, nutrient cycling, and decomposition of xenobiotics (Frankerberger and Dick, 1983; Chen et al., 2003; Acosta-Martínez et al., 2007). Their activity may correlate well with nutrient availability and soil fertility (Nannipieri et al., 2003; Baum et al., 2003).

Soil enzymatic activities depend on optimum conditions of moisture, pH, temperature and substrate concentration. Soil pH can affect enzyme activity by influencing the concentration of inhibitors or activators in the soil solution and the effective concentration of the substrate. Enzymatic activities may vary under stress when soil is contaminated

by heavy metals (Dick, 1997; Dick et al., 2000). Enzyme activities have been found to be very responsive to different agricultural soil conservation practices such as non-tillage (Bergstrom et al., 1998), organic amendments, and crop rotation (Miller and Dick, 1995). The difference in microbial dynamics and population, due to soil management practices, may also be reflected in the differences in enzyme activities of soils. Although it has been demonstrated that adoption of long-term cropping system may affect several soil properties, limited information is available about the effect of tillage on enzyme activities of soils. Tillage and management practices may lead to significant changes in biological, chemical and biochemical properties of soils and alter the composition, distribution, and activities of soil microbial community and enzymes (Dick, 1984; Dick et al., 1988). Acid phosphatase, alkaline phosphatase, arylsulfatase, invertase, amidase, and urease activity in 0 to 7.5 cm surface soils were significantly greater in soils from no-till plots, as compared with those from conventional tillage plots (Dick, 1984).

Phosphatase enzymes can be a good indicator of the organic phosphorus mineralization potential and biological activity of soils (Dick and Tabatabai, 1993). Phosphatase activity, which is related to soil and vegetation conditions, responds to changes in management (Herbien and Neal, 1990), and can be related to seasonal changes in soil temperature and moisture (Speir and Cowling, 1991). The phosphatases are significantly affected by soil pH, which controls phosphorus availability in soil, and this could occur despite the level of organic matter content or disturbance (Acosta-Martínez et al., 2007). Studies showed that acid phosphatase is predominant in acidic soils but alkaline phosphatase is predominant in alkaline soils (Deng and Tabatabai, 1997). The inverse relationship between phosphatase activity and soil pH suggests that the rate of synthesis and release of this enzyme by soil microorganisms or the stability of this enzyme are related to soil pH. Since higher plants are devoid of alkaline phosphatase activity, the alkaline phosphatase activity in soils seems derived totally from microorganisms (Dick et al., 1983).

Urease is a ubiquitous cell-free exoenzyme in nature that is produced by plants and microorganisms. Urea is the most widely used nitrogenous fertilizer in world agriculture today. It is hydrolyzed enzymatically by soil urease and the resulting release of ammonia and rise in pH can lead to some problems. These problems are accentuated in alkali soils where the high soil pH can induce appreciable ammonia volatilization (Brynes and Frency, 1995). Alkali soils have low amounts of organic carbon and nitrogen and low levels of urease and dehyrogenase activity (Rao and Ghai, 1985).

Dehydrogenase activity is commonly used as an indicator of biological activity in soil (Beyer et al., 1992). Dehydrogenase enzymes play a significant role in the biological oxidation of soil organic matter by transferring protons and electrons from substrates to acceptors (Dick and Tabatabai, 1993). According to Frankenberger and Dick (1983), dehydrogenase activity is often correlated with microbial respiration when exogenous C sources are added to soil. Skujins (1973) and Casida (1977) reported close correlations of dehydrogenase activity with CO_2 release and O_2 uptake, respectively. The highest activity occurred in top 3 cm of an arid soil, but there was no correlation with microbial number because the dehydrogenase activity depends on the total metabolic activity and soil microorganisms. The value of metabolic activity and soil microorganisms in different soils, containing different populations, does not always reflect the total numbers of viable microorganisms that are isolated on a particular medium.

In this study, we aimed to detect possible impacts of cement dust pollution, which are generated by cement factory, on microbial population (bacteria and fungi), microbial respiration (CO_2-C production) and some enzyme (acid, alkaline phosphatase, urease and dehydrogenase) activities in cultivated with wheat and no-till soils.

MATERIALS AND METHODS

Experimental site, soil sampling and soil analysis

The study was conducted in the vicinity of Askale town cement plant (39°54' N and 41°13' E at 1883 m above mean sea level), west of the Erzurum, Turkey. Based on area distribution within a soil-mapping unit, the sampling sites at 1, 3, 5, 7, 10 and 15 km away from the Askale cement plant were randomly selected in cultivated (CT) vs. no-till (NT) soils. The chimney height of the Askale cement plant was 50 m. The composition of emissions for cement plant were particle matter (48 kg h^{-1}), CO (146 kg h^{-1}), NO_2 (186 kg h^{-1}) and SO_2 (6 kg h^{-1}). The dominant wind direction is north-west, and soil sampling was coincided with the same wind direction. The minimum and maximum temperatures were 11.4 and 26.5°C respectively, and average annual temperature was 15.4°C. The mean relative humidity, wind speed, daily sunshine, total precipitation, and total evaporation were in order 57.42%, 4.71 m s^{-1}, 11.12 h, 61.4 mm, and 389.4 mm in 2008 (1 May to 29 Sept.). Three replicated sub-plots were selected within each site. Total 36 sampling sites (6 distance x 2 tillage x 3 replications) were selected for soil collection. The soil was classified as Askale series (ustorthents) according to the USDA soil taxonomy (Soil Survey Staff, 1999). The experiment area soil texture classes were determined loam to clay. The site has a semiarid climate and average annual rainfall of 427 mm. The major crops grown in this area are wheat, barley, secale, maize, cabbage, cotton, sugar beat, and potatoes.

In this research, soil samples were taken from 0 to 20 cm depth (tillage layer) in September 2008. The samples were composited and 2-mm sieved to remove stones, roots, and large organic residues and analyzed. Total organic matter (SOM) content was determined by following the standard loss-on-ignition (LOI) method (Nelson and Sommers, 1996). The $CaCO_3$ content was determined by using the pressure calcimeter method (Leoppert and Suarez, 1996). Total N content of soil was measured by the micro-Kjeldahl method (Bremner, 1996). Soil pH was determined by using a glass electrode meter in 1:2.5 soil: water ratio (Handershot et al., 1993). Effective cation exchange capacity was calculated as the sum of exchangeable cations (Sumner and Miller, 1996). Melich I solution was used to extract exchangeable cations and determined by atomic absorption spectrophotometer (Hanlon and DeVore, 1989). The available P in soil was determined by following ammonium molybdate-ascorbic acid

method (Knudsen and Beegle, 1988). Microelements in the soils were determined by DTPA extraction method (Lindsay and Norvell, 1978). Soil particle size distribution was determined by the hydrometer method (Gee and Bauder, 1986). Soil textural class was determined by following the USDA textural triangle. Electrical conductivity was measured in saturation extracts according to Rhoades (1996). The soils were analyzed for selected physical and chemical properties (Table1).

Soil biological analysis

Culturable bacteria and fungi cells were enumerated by using spread soil dilution plate method. For bacteria and fungi, each dilution of the series (10^6–10^7) in PBS (0.15 M potassium phosphate 0.85% NaCl, pH 7.2) was prepared and placed onto Petri-dishes (Zuberer, 1994). Soil extract agar (SEA) was used for bacterial incubation at 30ºC for 7-d (Zuberer, 1994), dextrose-peptone agar (DPA) was used for fungal incubation at 25ºC for 7-d (Parkinson, 1994). After the incubation, the average colony forming units (CFU) per gram of oven-dried equivalent (ODE) of field-moist soil was calculated by using an automated colony counter (Madigon et al., 2006) (Table 2).

Basal respiration (BR), as a measure of soil biological activity, was determined by using in vitro static incubation of unamended field-moist soil (Islam and Weil, 2000). About 20 g ODE of field-moist soil adjusted at 70% water-filled porosity (WFP) was taken in 25 ml glass beakers. Each soil sample was placed in a 1 L mason jar along with a glass vial containing 10 mL of distilled deionized water to maintain humidity and a plastic vial containing 10 mL of 0.5 M NaOH to trap CO_2 evolved from the incubated soil. The mason jars were sealed airtight and incubated in the dark at 25 ± 1°C for 20 days. The CO_2 evolved over time was absorbed in the 0.5 M NaOH followed by precipitation as $BaCO_3$ by the addition of excess 1M $BaCl_2$. The remaining NaOH in each vial was then titrated to the phenolphthalein endpoint with a standardized 0.5 M HCl solution (Table 2). The BR rate was calculated as below:

BR rates (mg CO_2/kg soil) = (CO_2soil - CO_2air)/20 days

Urease enzyme (UE) activity was assayed by using urea solution and expressed as µg NH_4-N per g soil and incubation time (2 h). Acid phosphatase (AcdP) and alkaline phosphatase (Alk-P) activities were assayed by using substrate pNPP (para-nitrophenyl phosphate) and expressed as l µg pNPP per gram soil and incubation time (hours). Dehydrogenase enzyme (DHE) activity was determined with TTC (triphenyl tetrazolium chloride) and expressed as µg TPF per gram soil and incubation time (24 h) according to Tabatabai (1994) (Figure 1a,b, 2, 3).

Statistical analysis

Statistical analysis was done for soil microorganism population and CO_2-C production using repeated measures analysis of variance (ANOVA). Comparison of means was performed, when the F-test for treatment was significant at the 5% level, using Duncan's multiple means tests. In addition, we tested effects of cement dust pollution on soil enzyme activities by calculating regression equation and simple linear correlation coefficient (r) procedures. SPSS 17.0 package was used for all statistical tests.

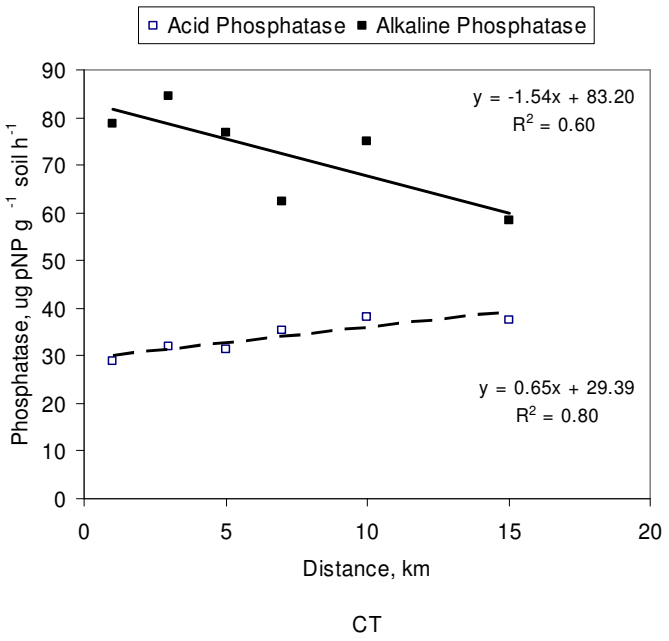


Figure 1a. Acid phosphatase enzyme activities vs. polluted distance by cement dust in CT soils.

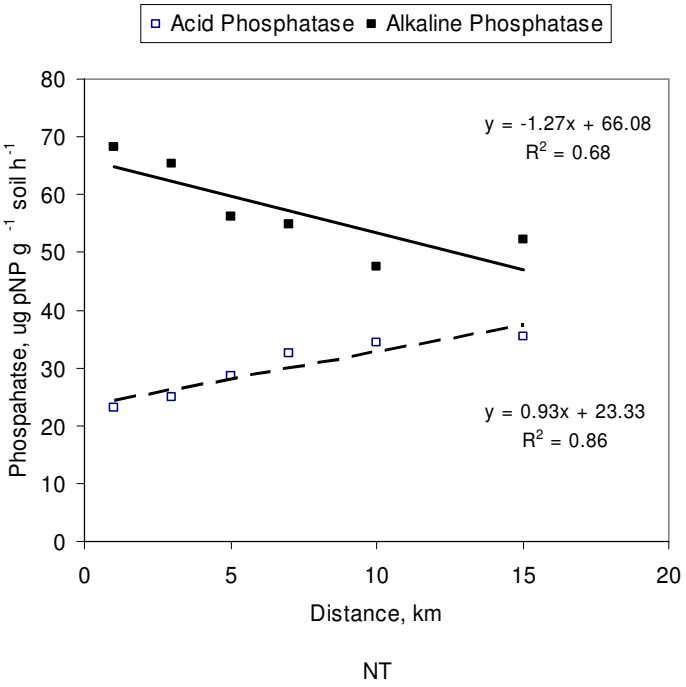


Figure 1b. Alkaline phosphatase enzyme activities vs. polluted distance by cement dust in NT soils.

RESULTS

Some chemical and physical properties of the studied soils are given in Table 1. According to Table 1, most soils had an alkaline reaction between pH 7.40 to 9.24. Soil pH values at a distance of 1 km were 8.83 in CT and 8.52 in NT and at distance of 15 km 7.40 in CT and NT soils. Increasing distance from cement plant decreased soil pH in CT and NT soils. The soils did not exhibit any salinity

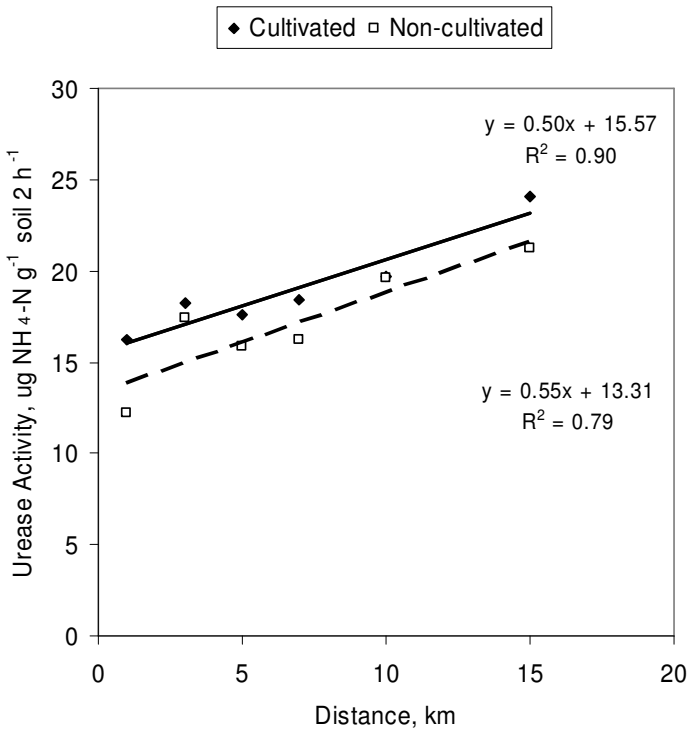


Figure 2. Urease enzyme activities vs. polluted distance by cement dust in CT and NT soils.

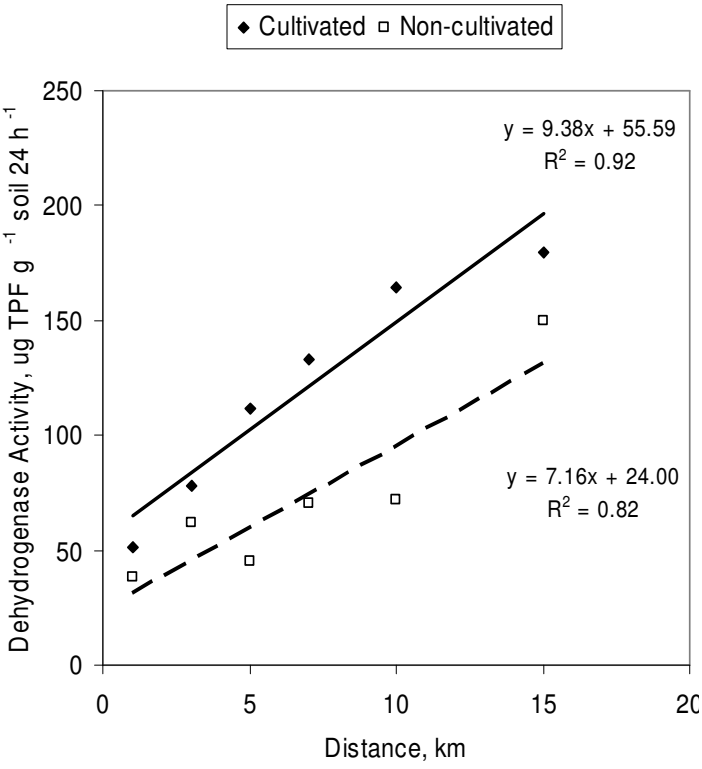


Figure 3. Dehydrogenase enzyme activities vs. polluted distance by cement dust in CT and NT soils.

problem but there was enough lime (3.42 to 5.63%) present in the soil to be classified calcareous soils. Contents of organic matter of the soils were determined between 1.45 to 2.86% (low-middle), total nitrogen between 0.1 to 0.29% and contained sufficient N, available phosphorus between 11.50 to 18.70 mg kg^{-1} (low) (FAO, 1990), and cation exchangeable capacity between 30.34 to 38.42 cmol kg^{-1} .

Effects of spatial variation on microbial population and co_2-c production

The quantitative analysis of bacteria, fungi, and soil CO_2-C production in CT and NT soils are given in Table 2. According to the results of ANOVA, significant ($p < 0.05$) differences on average number of bacteria and fungi were observed among different distances from the cement factory in CT and NT soils.

The highest number of bacteria were observed at distance of 15 km (387.2 x 10^6 CFU g^{-1} soil) from the cement plant in CT and the lowest were observed at distance of 1 km (296.3x10^6 CFU g^{-1} soil) from the cement plant in CT. The highest number of bacteria were obtained at a distance of 15 km (370.6 x 10^6 CFU g^{-1} soil) in NT and the lowest were obtained at distance of 1 km (215.7 x 10^6 CFU g^{-1} soil) from the cement plant in NT soils. Average numbers of bacteria were higher in CT (332.5x10^6 CFU g^{-1} soil) soils than in NT (282.8 x 10^6 CFU g^{-1} soil) soils. Soil microbial population showed a significantly positive correlation with distance in CT and NT ($r^2 = 0.53$; $r^2 = 0.56$, $p < 0.05$) soils.

Significant ($p < 0.05$) differences in average number of fungi were observed among different distances from the cement factory in CT and NT soils. The highest number of fungi was obtained at distance of 7 km and the lowest was obtained at a distance of 1 km from the cement plant in CT (37.2 x 10^4; 21.6 x 10^4 CFU g^{-1} soil) and NT (71.4 x 10^4; 42.6 x 10^4 CFU g^{-1} soil) soil. Average number of fungi was determined 58.1 x 10^4 CFU g^{-1} soil in NT and 29.7 x 10^4 CFU g^{-1} soil in CT soils. Number of fungi showed significant positive correlation with distance in CT ($r^2 = 0.58$; $p < 0.05$) and NT ($r^2 = 0.74$, $p < 0.05$) soils (Table 2).

According to Table 2, statistical results showed a significant ($p < 0.05$) differences between distance and average CO_2-C production depending on distance from the cement factory. Increasing distance increased CO_2-C production in CT and NT soils. The highest CO_2-C production was observed at distance of 15 km from cement factory in CT (31.5 mg CO_2-C m^2 h^{-1}) and NT (21.8 mg CO_2-C m^2 h^{-1}) soils. The lowest CO_2-C production was observed at distance of 1 km from cement factory in CT (21.6 mg CO_2-C m^2 h^{-1}) and NT (16.0 mg CO_2-C m^2 h^{-1}) soils. The average CO_2-C production was determined 27.2 mg CO_2-C m^2 h^1 soil in CT, and 19.3 mg CO_2-C m^2 h^{-1} soil in NT soils. Average soil CO_2-C production showed significant positive correlation with distance in CT and NT ($r^2 = 0.94$, $p < 0.01$) soils.

Table 1. Some chemical and physical properties of CT and NT soils.

Soil properties		Polluted distance by cement dust											
		1 km		3 km		5 km		7 km		10 km		15 km	
		CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT
pH (1:2.5) (soil/water)		8.83	8.52	9.24	8.71	8.54	8.21	8.24	7.85	7.82	8.12	7.40	7.40
Organic matter, %		1.96	1.62	2.04	2.21	2.00	2.26	2.42	2.86	2.01	1.45	2.54	2.32
$CaCO_3$. %		5.49	3.70	3.83	4.20	4.66	5.26	5.63	4.21	4.38	3.75	4.63	3.42
Total N, %		0.15	0.10	0.19	0.14	0.25	0.21	0.26	0.17	0.29	0.21	0.19	0.25
Available P, mg kg^{-1} soil		14.23	10.20	18.70	14.20	16.47	18.00	16.47	13.40	17.21	13.70	15.30	11.50
Exchageable Cations,	Ca^{+2}	23.11	25.46	20.18	24.53	21.65	23.45	21.65	18.46	21.16	21.45	17.56	18.63
cmol kg^{-1} soil	Mg^{+2}	9.70	7.87	8.48	9.56	9.09	8.23	9.09	6.85	8.89	7.23	6.05	7.26
	K^{+1}	3.17	4.12	2.76	3.74	2.97	1.86	2.97	2.76	2.90	3.25	3.56	4.85
	Na^{+1}	0.38	0.26	0.31	0.28	0.35	0.21	0.35	0.18	0.33	0.48	0.31	0.29
Micro Elements, ppm	Fe	24.11	25.45	20.54	23.05	21.37	25.93	23.17	17.95	23.30	24.15	21.85	22.83
	Cu	2.56	3.66	2.57	3.60	2.63	3.21	3.48	2.89	4.46	4.99	4.59	3.01
	Zn	2.85	2.19	1.60	1.91	1.23	2.17	2.30	1.06	2.93	2.30	2.82	2.76
	Mn	8.29	9.63	11.19	9.03	13.14	9.15	6.58	11.17	11.16	10.87	13.30	13.83
CEC, cmol kg^{-1}soil		36.29	38.24	35.77	38.42	36.03	34.59	36.03	30.65	35.94	33.25	30.34	33.24
Texture, %	Clay	32.45	36.18	33.20	36.20	28.75	34.33	28.35	33.97	27.33	33.69	33.99	34.55
	Silt	20.25	30.56	25.46	29.50	31.12	28.56	32.00	27.93	28.56	31.05	26.07	21.24
	Sand	47.30	33.26	41.34	34.30	40.13	37.12	39.65	38.10	44.11	35.26	39.94	44.21
Texture class		L	CL	CL	L	CL	CL	L	CL	CL	CL	L	L

CT : Cultivated wheat, NT : No-Till soil, L : Loam, CL : Clay loam.

Table 2. Effects of cement dust pollution on population of bacteria and fungi, CO_2-C production, Duncan test results and correlation coefficient values (r).

Distance (km)	Bacteria x10^6 (CFU g^{-1})		Fungi x10^4 (CFU g^{-1})		CO_2-C Production (mg C m^{-2} h^{-1})	
	CT	NT	CT	NT	CT	NT
1	296.3 b	215.7 b	21.6 b	42.6 b	21.6 b	16.0 b
3	315.7 ab	281.5 ab	25.4 b	58.7 ab	24.6 ab	18.4 ab
5	362.5 a	243.0 b	29.8 b	42.2 b	25.6 ab	18.6 ab
7	337.6 ab	343.2 a	37.2 a	71.4 a	29.7 a	20.2 a
10	297.6 b	243.5 b	37.1 a	65.5 a	30.3 a	21.1 a
15	387.2 a	370.6 a	27.0 b	68.4 a	31.5 a	21.8 a
Average	332.5 A	282.8 B	29.7 B	58.1 A	27.2 A	19.3 B
r-values	0.53*	0.56*	0.58*	0.74*	0.94**	0.94**

CT: Cultivated wheat , NT: No-Till Soil, † The means with the same letter are not statistically significant ($p < 0.05$). *, ** : Indicate significance at the 5 and 1%, respectively.

Effects of spatial variation on some soil enzyme activity

We also monitored the activities of four enzyme groups: AcdP, AlkP, urease (UE) and dehydrogenase (DHE) at different distance from the cement plant in CT and NT soils. According to our results, phosphatase enzyme activities varied widely in relation to distance CT and NT soils. The highest AcdP enzyme activity was observed at distance of 15 km (37.6 µg pNP g^{-1} soil h^{-1}) in CT and the lowest AcdP enzyme activity was observed at distance of 1 km (29.0 µg pNP g^{-1} soil h^{-1}) away from the cement factory in CT soils. Similarly, the highest AcdP enzyme activity was obtained at distance of 15 km (35.3 µg pNP g^{-1} soil h^{-1})

in NT soils and the lowest AcdP enzyme activity was obtained at distance of 1 km (23.0 µg pNP g^{-1} soil h^{-1}) away from the cement factory in NT soils. AcdP enzyme activity showed a significant positive correlation with distance in CT (r^2 = 0.80, $p < 0.01$) and NT (r^2 = 0.86, $p < 0.01$) soils (Figure 1a and b).

The highest AlkP enzyme activity was observed at distance of 2 km (84.60 µg pNP g^{-1} soil h^{-1}), and the lowest AlkP enzyme activity was observed at distance of 15 km (58.40 µg pNP g^{-1} soil h^{-1}) away from the cement factory in CT soils. The highest AlkP enzyme activity was observed at distance of 1 km (68.10 µg pNP g^{-1} soil h^{-1}) and the lowest AlkP enzyme activity was observed at distance of 10 km away from the cement factory (47.50 µg pNP g^{-1} soil h^{-1}) in NT soils. The results in this particular case showed a significant negative correlation between cement dust pollution and distance in CT (r^2 = 0.60, $p < 0.05$) and NT (r^2 = 0.68, $p < 0.05$) soils. AcdP enzyme activity was significantly lower than AlkP enzyme activity in CT and NT soils (Figure 1a and b).

Urease enzyme activity was highly correlated with the distance of CT and NT soils. The regression equations and simple correlation coefficients for these relationships are shown in Fig. 2. The highest UE activity was observed at distance of 15 km (24.08 mg NH_4-N kg^{-1} soil $2h^{-1}$) and the lowest was observed at distance of 1 km (16.25 mg NH_4-N kg^{-1} soil $2h^{-1}$) away from the cement factory in CT soils. The highest UE activity was observed at distance of 15 km (21.24 mg NH_4-N kg^{-1} soil 2 h^{-1}) and the lowest was observed at distance of 1 km (12.20 mg NH_4-N kg^{-1} soil 2 h^{-1}) away from the cement factory in NT soils. UE activity showed a significant positive correlation with distances in CT (r^2= 0.90, $p < 0.01$) and NT (r^2= 0.79; $p < 0.01$) soils.

Maximum variation based on distance from the cement factory was observed for dehydrogenase activity in various soils. The highest DHE activity was determined at 15 km distance (180 mg TPF kg^{-1} soil 24 h^{-1}) and the lowest was determined at 1 km distance (51.16 mg TPF kg^{-1} soil 24 h^{-1}) away from the cement factory in CT soils. The highest DHE activity was observed at distance of 15 km (150 mg TPF kg^{-1} soil 24 h^{-1}) and the lowest was obtained at a 1 km distance (37.88 mg TPF kg^{-1} soil 24 h^{-1}) from the cement factory in NT soils. Strong positive correlation among DHE enzyme activity and distances was observed in CT (r^2 = 0.92, $p < 0.01$) and NT (r^2 = 0.82, $p < 0.01$) soils (Figure 3).

DISCUSSION

Our findings that soils under cement dust have lower enzyme activity, compared to the CT and NT soils, are due to the negative impacts of the cement dust on soil properties including the microbial populations and activities. The effects of cement dust on soil microbial population and CO_2-C fluxes were significantly correlated with distance in CT and NT soils. Increasing distance increased the average number of bacteria, fungi and soil CO_2-C production and decreased lime contents of the soil in CT and NT soils (Table 1 and 2). The increases in amount of lime were related to the increase of soil pH.

Microorganism activity was affected negatively by cement pollution and the other environmental conditions resulting from cement pollution; it most likely would have negative effects on the other ecosystem functions (Bayhan et al. 2002; Nowak et al. 2003; Fabbri et al. 2004; Ocak et al. 2004).

The pH affected the activity of enzymes as amino acid functional groups that alter conformational and chemical changes of amino acids essential for binding and catalysis were very sensitive to pH range (Dick et al., 2000). Phosphomonoesterases such as AcdP and AlkP significantly were affected by changes in soil pH (Table 1 and Figure 1) and each enzyme was observed more predominant in acidic and alkaline soils, respectively (Deng and Tabatabai, 1997). Changing soil pH is connected with content of cement dust of the soil. Cement dust pollution effected soil pH directly, and affected soil acid phosphatase enzyme activity in directly. AcdP responded negatively to the soil acidity and the tested enzymes were ordered according to their susceptibility of soil acidity as follows: dehydrogenases>urease>alkaline phosphatase>acid phosphatase (Wyszkowska et al., 2006).

The highest urease activity was observed around pH = 7.4 and the lowest urease activity was at pH = 8.8 (Table 2). Optimum pH for soil UE activity was 8.8 to 9.0 (Tabatabai and Bremner, 1972; May and Douglas, 1976). However, Singh and Nye (1984) reported that soil pH for UE activity was around 6 for the overall reaction and 6.8 for the high affinity reaction. Alkaline soils have low amounts of organic carbon and nitrogen and low levels of urease and dehydrogenase enzyme activity. Urease enzyme activity was significantly correlated not only with organic carbon and $CaCO_3$, but also with pH (Rao and Ghai, 1985). Urease turned out to be more resistant to soil acidity than dehydrogenases (Wyszkowska et al., 2006). Phosphatase and urease enzyme activities were greater in CT soils than NT soils (Gupta and Bhardwaj, 1990). Especially, urease activity was much lower in NT soils than in CT soils. When compared to the corresponding undisturbed or less-disturbed soils, our results are in agreement with previous studies showing enzyme activity values reported by Acosta-Martinez et al. (2004) and Fenn et al. (1992).

Dehydrogenase enzyme activity showed a positive correlation with decreasing cement dust, $CaCO_3$, and pH in CT and NT soils (Figure 3, Table 1). The maximum dehydrogenase enzyme activity was observed at pH 7.4 under wheat vegetation. Similar results were observed in pH 6.6-7.2 during barley vegetation under different air-water conditions (Brzezinska et al., 2001). We determined positive correlation between dehydrogenase enzyme activity and pH. Similarly, Moore and Russell (1972) and Onet et al. (2007) observed that there was strong correlation between dehydrogenase enzyme activity and

organic matter (Khan, 1999) and weakly positive with pH and nitrogen. Dehydrogenase enzyme activity in CT (Ph 7.4-8.52) soils was greater than NT (pH 7.4 to 9.24) soils. Dehydrogenase enzyme activity decreased significantly with the decline in soil pH values in acidic soils. These results are in agreement with that reported by Rao and Ghai (1985) and Aoyama and Nagumo (1996).

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Exhibit 8

2019 REPORT ON AIR POLLUTION AND HEALTH RESEARCH

UTAH PHYSICIANS for a HEALTHY ENVIRONMENT

AIR POLLUTION AND HEALTH: SUMMARY OF THE 2019 MEDICAL RESEARCH

compiled by
Utah Physicians for a Healthy Environment

In 2019 the medical research on air pollution strengthened and expanded our understanding of just how hazardous it is to public health and the damage it is doing to individual lives. Several well-respected studies were truly alarming. Today we highlight what we feel are the most important ones.

The authors of two new studies describe the impacts of air pollution in nearly the exact terms that UPHE has been using for several years. Air pollution is the world's fifth leading risk factor for death. Tissue damage may result directly from pollutant toxicity because fine and ultrafine particles can gain access to organs, or indirectly through systemic inflammatory processes. It can harm any organ in the body. Air pollution is a danger to everyone's health, but some people are more susceptible than others, either because of genetics, socioeconomics, race, or ethnicity.

Public health is damaged at levels far below those previously considered to be safe.[1,2]

The relationship between particulate pollution and death has been repeatedly studied for at least three decades. Almost from the beginning studies have yielded consistently alarming, but slightly different statistics. This year a meta-analysis of all the important previous studies has allowed us to narrow those differences, and has provided even more solid evidence that increases of just 1 ug/m3 of PM2.5 chronic exposure increases community deaths rates about 1%.[3] Acute spikes of PM2.5 will add additional mortality, as will ozone. This study adds strong confirmation to the statement UPHE has made for several years that between 1,000 and 2,000 people die prematurely every year in Utah because of our air pollution.

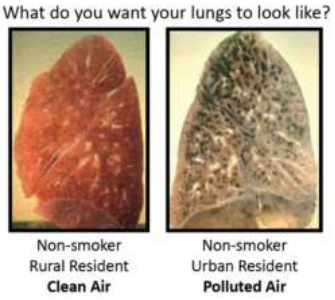
A new BYU study[4] significantly strengthens the contention

A new BYU study significantly strengthens the contention that UPHE has been making for more than a decade–that our air pollution shortens the life span of Utah residents an average of two years, and nearly one in four residents lose 5 years of more. The same study estimates that air pollution costs our economy about $1.8 billion a year, although other national studies found that number to be even higher, i.e. $7.4 billion.[5,6,7,8]



Of the two high volume pollutants–ozone and particulate matter–ozone has historically been considered the "weaker sister." Nonetheless, ozone has been associated with almost all the health consequences of particulate matter, if only to a slightly lesser extent. Ozone is a powerful oxidizing agent and has been proven to cause a decrease in lung function and damage to lung tissue. But a new study shows that the lung is exquisitely sensitive to even small increments of ozone. Researchers followed nearly 7,000 patients and found emphysematous destruction of lung tissue and loss of lung function (measured by CAT scans and spirometry) in both smokers and non-smokers at this shocking rate: Just 3 ppb increase in ozone exposure over ten years caused as much lung damage as smoking a pack a day of cigarettes for 29 years.[9]

Short term exposure to PM2.5 and risk of hospital admission were found for several prevalent but rarely studied diseases, such as septicemia (blood infections), fluid and electrolyte disorders, and acute and unspecified renal failure. Positive associations were also found between risk of hospital admission and cardiovascular and respiratory diseases, Parkinson's disease, diabetes, phlebitis, thrombophlebitis, and thromboembolism.[10]



We have seen the emergence of studies proving that particulate matter is embedded in the critical organs of virtually all humans. Pollution particles contaminate human brain tissue, at the rate of millions per gram of brain tissue. Other studies have found the particles embedded in the lining of blood vessels and even the placentas of pregnant mothers. This year researchers studied dozens of people at autopsy who had been residents of Mexico City. The average age was 25, the youngest was only three years old. Astonishingly, they found between 2 billion and 22 billion nanoparticles of air pollution embedded in the heart, per gram of heart tissue, in all patients, even the children. Those people who had lived in highly polluted Mexico City had between 2 and 10 ten times as many pollution particles as those that lived in less polluted environments.[11] The clinical significance of this finding is almost undoubtedly impaired performance of the heart's pumping mechanism and disruption of the electrical impulses that control heart rate and rhythm.







Many other studies have shown that air pollution does indeed impair the normal electrical signaling of the heart. That is one way that air pollution causes sudden death. This study suggests that damage to the heart's electrical activity begins in infancy.[12] Even newborns exposed to more air pollution have higher blood pressure.[13]

Published in one of the most prestigious medical journals, this study of 4.5 million US veterans found that 99% of the deaths related to air pollution occur in populations where the air pollution meets the EPA's standards. This puts a definitive stamp on the concept that there is no safe level of air pollution, and that those standards, which are supposed to be updated every 5 years, are far too lax. Also, nine causes of death related to air pollution were identified, including causes not previous connected to air pollution—kidney disease, dementia, and type II diabetes.[14]

A new study demonstrates that the benefits of cleaner air occur almost immediately. Respiratory symptoms, hospitalizations, school absenteeism, and mortality start to drop within a few weeks, although they may not drop back to normal. And there is additional benefit to making already clean air even cleaner.[15]

For several years numerous studies have shown the toxicity of air pollution to brain function and development, even changing brain architecture. New studies provide more detail. A critical area of the brain for memory, the hippocampus, is smaller in adults exposed to more air pollution.[16] Air pollution changes the physical development of the brain in utero, including reducing the size of certain parts of the brain like the corpus callosum, the bridge between both hemispheres. This abnormality is associated with behavioral disorders.[17] Another new study provided more evidence that air pollution, prenatal or during infancy, is associated with increased risk of autism.18

Numerous other studies showed the clinical consequences of air pollution showing impaired memory. For example, for every 2.81 µg/m3 of PM2.5, the annual decline rate in a certain type of memory capability was accelerated by 19.3%.[19] Chronic exposure to more HAPs (hazardous air pollutants) was found to be associated with worse academic performance among school children in reading, math, and science through the third grade.[20]

One study focused on particulate pollution



associated with Mountain Top Removal mining, something that is directly relevant to Utah given the close proximity of the Kennecott mine to our largest population center. The study found that air pollution from mining contributes to dramatically increased risk for dementia related mortality.[21]





Previous studies have shown that air pollution can acutely reduce the performance of children in school. A new study also shows the reverse. Reducing air pollution in school classrooms improves test scores substantially. One study found that even from a baseline of low level pollution (well below the EPA's annual standard) a classroom air purifier capable of reducing PM 2.5 90%, improved students' test scores more than reducing class size by 30%, i.e. a 0.20 standard deviation improvement in Math and English scores.[22]

There were many new studies showing that air pollution is associated with virtually every type of mental illness, like depression, behavioral disorders, unethical behavior, violent crime, and increased rates of hospitalizations and emergency room visits for mental illness for pediatric, adolescent and adult patients.[23,24,25] Several studies have even shown that pollution decreases stock market returns by decreasing mood and trading activity among brokers.[26]

Numerous new studies added confirmation to the already substantial research showing the multiple ways that air pollution can harm pregnancy and fetal development, including increasing the incidence of hypertensive disorders,[27] gestational diabetes, [28] premature rupture of membranes (a disorder that puts both the baby and mother at risk for infection), for premature birth,[29] and still birth.[30]



Significant progress was made in the past year showing that air pollution increases the risk for metabolic and endocrine diseases, like diabetes, both type I and type II, and impaired thyroid function.[31,32,33,34,35]Thyroid function is critical to good health at any age, and especially critical for normal fetal development, especially brain development. New studies show that air pollution impairs thyroid function in pregnant mothers and in turn impairs fetal thyroid development, which may contribute to the well established connection between air pollution and low birth weight.36,37,38

More studies that show air pollution is associated with higher rates of lung, breast, and nasopharyngeal cancer.[39,40,41,42] About 30% of lung cancer is now attributable to air pollution.[43]

By promoting inflammation, particulate pollution was found to contribute to rheumatoid and osteoarthritis, higher levels of auto antibodies, severe bone density decrease, bone

demineralization, cartilage wear, and structure damages.[44,45,46,47]



We have seen numerous studies showing that air pollution exposure early in life (in utero and infancy) can have lasting impacts on health, like heart and lung function, that don't show up for decades. A new study expanded that concept finding that early life exposure is even associated with higher rates of arthritis in adulthood, especially rheumatoid arthritis.[48]

Sleep disorders are increasingly recognized as very common, as well as very important contributors to overall poor health. This year more evidence was published that air pollution is associated with sleep disorders, especially sleep apnea.[49,50]

The length of chromosome end caps, called telomeres, is a marker of aging at the molecular level. Another study was published showing that air pollution exposure during pregnancy was associated with shorter telomeres measured at the age of eight.[51]

2019 RESEARCH HIGHLIGHTS

1. Air pollution kills 1,000 to 2,000 Utah residents every year, from at least nine different causes of death. Shortens life span in Utah an average of two years, some as much as five years.

2. Costs to the economy are between $2 billion and $7.4 billion.

3. Because cleaner air has such a profound benefit to brain function, classroom air purifiers are the most cost effective way of improving public education.

4. Extremely small increases in ozone damage lung tissue and function as much as smoking does.

5. Just 3 ppb increase in ozone exposure over ten years caused as much lung damage as smoking a pack a day of cigarettes for 29 years.

6. Particulate pollution provokes disease by contaminating all major organs, like the heart, lungs, brain, kidneys, blood vessels, placenta. For example, between 2 billion and 22 billion nanoparticles per gram of heart tissue.

7. 99% of air pollution deaths occur where the air pollution meets the EPA's standards. All air pollution matters.

8. Cleaning up the air has almost immediate health benefits.

WHAT WE SHOULD DO NEXT

1. It's time for free public transit: like Kansas City, Oslo, Amsterdam, Winnipeg, Melbourne, Athens, Geneva, Scotland, Pittsburgh, Philadelphia

2. Emissions testing of all commercial diesel trucks and heavy equipment, on road and off.

3. Room air purifiers in all school class rooms.

4. Repeal the Port

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Exhibit 9

ASSESSMENT OF THE RISK FOR SILICOSIS AND LUNG CANCER ASSOCIATED WITH RESIDENTIAL EXPOSURE TO RESPIRABLE CRYSTALLINE SILICA ORIGINATING FROM THE "POINT OF THE MOUNTAIN" GRAVEL QUARRY

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Updated: December 4, 2018

Roles, Responsibilities, and Capacity of the Environmental Epidemiology Program

The Environmental Epidemiology Program (EEP) has three primary roles:

- Provide a public resource of health data and monitoring data associated with environmental health concerns;
- Provide assessment and interpretation of data to characterize potential environmental risks, and recommend actions to monitor and mitigate those risks;
- Develop and maintain administrative rules on injury surveillance and public health sanitation standards.

To meet these responsibilities, the EEP staff includes expertise in epidemiology, toxicology, risk assessment, risk communication, biostatistics, geomatics, health education and environmental health sciences.

The EEP does not have the role, responsibility or capacity to:

- Conduct permitting or regulating activities, or enforce rules;
- Conduct sampling and testing of soil, water, air, or homes for environmental contaminates (except at a very limited level).

Defining a Public Health Concern

The Centers for Disease Control and Prevention (CDC) has adopted the Vilnius-Dandoy criteria (CDC 2013; Vilnius & Dandoy 1990) for evaluating and establishing public health priorities. The Vilnius-Dandoy criteria were researched and established at the request of the Utah Department of Health (UDOH). Dr. Dandoy served as the Executive Director of the UDOH at the time. Those criteria are as follows:

- **Size of the risk**:
  Epidemiologic Measurement of Risk: Epidemiologists measure risk as a comparative ratio of disease burden measures (for example, the rate of disease) between two populations. There are a number of types of risk ratios including: odds ratios (OR), relative risks (RR), standardized incidence ratios (SIR), or standardized mortality ratios (SMR). The odds ratio (a measure of the probable association of a risk factor to a health outcome) is a commonly used measurement for exposure risk assessment. All of the risk

measures are comparative ratios, comparing a study group to a "comparison" group. The study group might be a population exposed to respirable crystalline silica (rc-silica). The comparison population could be one that is not exposed to rc-silica. If the disease burdens of the two groups are equal, the risk ratio will be 1.0. If the study group (the exposed group) has a higher disease burden compared with the comparison group, the risk ratio will be greater than 1.0. If this comparison is in the form of an odds ratio, then the exposure risk is considered to be "associated" with the health outcome. Good epidemiology is seldom able to declare that a risk factor is "causal" without the assistance of other disciplines such as toxicology (Greenland et al. 2008; Griffith et al. 1993).

Because there is a lot of random variation in the association of risk factors to health outcomes (consider, for example, the variation in the association between tobacco use and lung cancer) a "95% confidence interval" (95% CI) is applied to the risk ratio. Occasionally another percentage is used, such as 99%. The real interpretation is actually the lower limit. If the lower limit of 95% CI is greater than 1.0, then the risk is considered "significantly associated." If the lower limit of the 95% CI is less than 1.0, then we generally say there is no significant association. Some epidemiologists may say there is a weak association (Greenland et al. 2008; Griffith et al. 1993).

One way to interpret a risk ratio is as a magnitude of excess risk. A risk ratio of 1.0 is interpreted as a no excess risk. A risk ratio of 2.0 can be interpreted to mean the study population has twice as much risk as the comparison population. Conversely, a risk ratio of 0.5 can be interpreted to mean the study population has half the risk as the comparison population.

Meaningful Risk Standard: The CDC recommends a "meaningful" criterion to the size of the risk. The EEP applies this guideline. Much of environmental epidemiology is driven by cancer concerns, so the recommendations used by environmental epidemiology often come from cancer investigations which are then applied to other types of investigations.

In the 1990's, a risk ratio needed to be in the 50s to be considered meaningful (Bender et al. 1990). Fortunately, more government public health agencies have since relaxed the meaningful criteria. Currently, the EEP uses the recommendation of Thun and Sinks (2004) which considers a risk ratio above 3.0 to be meaningful. These criteria are open to change as the literature evolves and as directives to the EEP are issued.

Toxicological Measurement of Risk: Toxicologists measure risk as a comparison of effect levels and effects (dose-response). Toxicological investigation of effect levels attempts to determine the dose where an effect starts or stops manifesting. These levels are known as the "lowest observable effect level" (LOEL) or the "no observable effect level" (NOEL). If there are both positive and negative effects associated with an exposure,

toxicologists will distinguish a "lowest/no observable *adverse* effect level" (LOAEL or NOAEL, respectively).

From these dose-response levels, and considering the potency, exposure routes, frequency, and the susceptibility of the exposed individual, toxicologists develop an exposure reference dose (RfD). Typically, the RfD is the NOEL or NOAEL divided by several orders of magnitude (i.e., 10, 100, 1000, etc.) to account for uncertainty. The degree of uncertainty is based on the nature of the studies used to find the dose-response relationship. For example, was the finding a NOEL or a LOEL? How close to humans was the animal model used – human subjects, apes, rabbits, mice, etc.? Additional uncertainty is added because of the variability in humans in their response to exposures. Thus, if the NOAEL for a respiratory exposure to a chemical was found to be 1.0 mg/m^3 (read 1.0 milligrams of chemical per cubic meter of air), the RfD might be set at 0.001 mg/m^3, or a thousand times below the known "no observable adverse effect level" (Faustman & Omenn 1996).

Toxicologic Risk Level: The US Occupational Health and Safety Administration (OSHA) has established many 8-hour time-weighted-average (TWA) permissible exposure limits (PELs) for contaminants in the workplace. The OSHA TWA PEL for rc-silica is 50 $\mu g/m^3$ (read 50 micrograms silica per cubic meter of air). OSHA has also established an action level of 25 $\mu g/m^3$ (OSHA 2017). Air levels at or above the action level require that the work site start monitoring and mitigating the air exposure. Air levels above the PEL result in a regulatory action (i.e., a fine, an order to mitigate, etc.).

The US Environmental Protection Agency (EPA) data and guidelines suggest the dose-response for a continuous (24-hour) exposure of 8 $\mu g/m^3$ would pose about the same risk in the general public as an 8-hour exposure of 22.4 $\mu g/m^3$ does in an occupational setting (EPA 1996). While this research did not establish a federal standard for non-occupational exposure to respirable silica, it does suggest that the OSHA TWA PEL can be interpolated to 18 $\mu g/m^3$ (50 $\mu g/m^3$ x 8 $\mu g/m^3$ / 22.4 $\mu g/m^3$ = 17.9 $\mu g/m^3$) averaged over a 24-hour period.

In 2005, the California Office of Environmental Health Hazards set a chronic reference exposure level (cREL) for $PM_{4.0}$ at 3.0 $\mu g/m^3$ (Richards et al. 2009). While the EEP uses federally established standards or recommendations to interpret public health risk, we do consider what other states are using.

- **Seriousness of the outcome**: This criterion has two factors – urgency and severity. All of the health outcomes (silicosis, chronic obstructive pulmonary disease [COPD], lung cancer, gastrointestinal cancer, kidney damage, autoimmune disease [particularly rheumatoid arthritis], increased risk for contracting tuberculosis [if exposed], etc.) associated with rc-silica exposure are severe (ATSDR 2017; Bernstein et al. 2013). All of these outcomes have long latent periods of 5–30+ years (i.e., the time between an exposure and the onset of a disease or symptoms). Since 1990, the residents of Traverse

Mountain (or the city of Lehi when we do not have the ability to resolve the data to Traverse Mountain) have experienced the following disease burdens:

Health Outcome	Data Source	Resolution	Rate per 10,000 population/year	Standardized Incidence Ratio (95% CI)
Silicosis	Hospital Discharge Database	City of Lehi	0.00	NA
COPD	Hospital Discharge Database	City of Lehi	5.6	0.43 (0.34 – 0.55)
Lung & Bronchial Cancers	Utah Cancer Registry	Traverse Mountain	0.2	0.11 (~0.0 – 0.61)
Gastrointestinal Cancers (stomach, small and large intestines, & rectum)	Utah Cancer Registry	Traverse Mountain	1.4	0.41 (0.15 – 0.90)

The comparison population is the rest of the state of Utah. If there is a sudden dramatic change in the rates or risk ratio, that could indicate an emerging public health concern. They are also useful in educating the public about the health status in the neighborhood.

In this case, for interpretation, there have been too few cases of silicosis in the city of Lehi to make a statistical evaluation. The rate of COPD in the city of Lehi is about half what the rest of the state is experiencing, and that difference ***is*** statistically significant. However, the only data available to the EEP are those cases admitted for treatment at a hospital. The rate is likely underestimated. If the assumption that the ratio of hospitalized cases versus outpatient cases is approximately equal for both the city of Lehi and the state of Utah, then the SIR will remain an accurate assessment of the risk difference between the city Lehi and the State.

Similarly, the cancer incidence rates among Traverse Mountain residents are significantly lower than the rest of the state (the upper limit of the 95% CI is below 1.0). The cancer data currently available to the EEP is through 2015. We have just received and are processing 2016 data. The number of cases were too small to evaluate trends. Most of the growth in Traverse Mountain appears to have occurred after 2001 and all of the cases are scattered through the 2001–2015 time frame. For reference, the EEP's cancer statistical review procedures are found at:

health.utah.gov/enviroepi/cancerstudies/Documents/Utah_Cancer_Investigatio_Protocol_Final_2May2016.pdf

The data presented in the table are incidence rates—meaning that the residential address at the time of initial diagnosis was in Traverse Mountain. We assume the prevalence rates (which counts cases diagnosed in Traverse Mountain residents and cases diagnosed elsewhere and moved in) would be higher. Both lung cancer and GI tract cancer have long latencies, typically in the 15–30+ year range (Nalder & Zurbenko 2014; Thun et al. 2018). We think the triggering events (the combination of genetics, life choices, environmental exposures, infections, medical treatments, and random chance) (Thun et al. 2018) occurred prior to residency in Traverse Mountain for most, if not all, incident cases.

Incidentally, Traverse Mountain residents have a non-significant elevated rate of skin cancers (SIR=1.13; 95% CI = 0.18-3.57), breast cancer (1.31; 0.33-3.41), prostate cancer (1.72; 0.43-4.49), and thyroid cancer (1.46; 0.23-4.60) during the last five years (2011-2015) of data.

- **Political will to address the problem**: This criterion has two components—public concern and availability of resources. This is an area where citizen activism has the most value. The governor or the state legislature (through the enactment of law) can direct the UDOH or the EEP to designate an issue as a public health concern. For example, initially, the cancer rates in Monticello did not meet the criteria for a concern. A citizen's group successfully influenced the governor's office to make the Monticello cancer rates a public health concern. In the end, the city of Monticello, with the assistance of the EEP, were able to obtain federal grant money to increase their local capacity to screen for cancers. In another example, the EEP evaluated the risk of a type of chicken feed containing arsenic to be a public health problem. The manufacturer lobbied state leadership which then directed the EEP to retract our report about the concern. In both cases, interested parties used the political system to establish a political will the EEP addressed.

- **An intervention**: The EEP does not have the authority to shut down rock quarry operations, nor does it have the authority to make recommendations to shut it down. That authority lies with the Utah Department of Natural Resources (UDNR) and the Utah Department of Environmental Quality (UDEQ). The kinds of interventions the EEP can recommend would focus on residents themselves, and protective actions they can take. For example, the EEP has recommended that all residents:
    - Avoid smoking or using tobacco products
    - Minimize alcohol consumption
    - Participate regularly in physical exercise or deep breathing exercises
    - Help prevent respiratory infections through regular hand washing, good oral hygiene, and staying current on vaccinations
    - Get regular healthcare checkups

- Minimize exposure to air pollution as much as possible
  - Stay indoors if no protective equipment (i.e., an effective respirator mask) is available
  - Use protective equipment if outdoor activity is necessary
  - Choose less strenuous activities when air pollution levels are high

We believe these recommendations reduce the risk of developing silicosis and subsequently developing lung cancer.

- **Health disparities**: The EEP's practice is to reduce the threshold for meaningfulness if the exposed population is socially or economically deprived. The EEP does this because these populations typically have less access to health care and ability to manage their concerns privately.

Understanding the Risk: Approach 1 – Literature Review

The EEP was asked by the Lehi City Council to address rc-silica. The EEP has reviewed a number of other gravel and sand quarries in the state of Utah in the past, including the one in Box Elder County (ATSDR 2006).

The EEP has not addressed, nor been asked to address, other potential air pollution hazards associated with the Point of the Mountain.

- **Respirable crystalline silica (rc-silica)**: rc-silica < 10 µm (micrometers) in size are able to penetrate to the alveolar sacs of the lungs (ATSDR 2017; Bernstein et al. 2013; Pinkerton & Southard 2005). Deposition of rc-silica occurs by two mechanisms. Approximately 60% of particles < 0.1 µm in size deposit in the alveolae by diffusion. Approximately 60% of particles between 1.0 and 2.5 µm deposit in the alveolae by impaction. Particles in the range of 0.1 to 1.0 are not able to deposit by either mechanism and are predominately exhaled. Particles larger than 2.5 µm deposit higher up (mouth and nasal cavity, pharyngeal area, trachea, the bronchi, and the bronchioles) in the respiratory tract (Bezemer & Pieters 2009; Brown 2015; Frohlich et al. 2016; Heyder 2004; Hussain et al. 2011; Lin et al. 2009; Namati et al. 2008; Rissler et al. 2017; Shulz et al. 2000).

Figure 2. Total and regional deposition of unit-density spheres in the human respiratory tract predicted by the ICRP deposition model for oral inhalation at rest.

The red graphic represents the alveolar deposition. Note the x-axis is logarithmic. (*figure from Heyder 2004*)

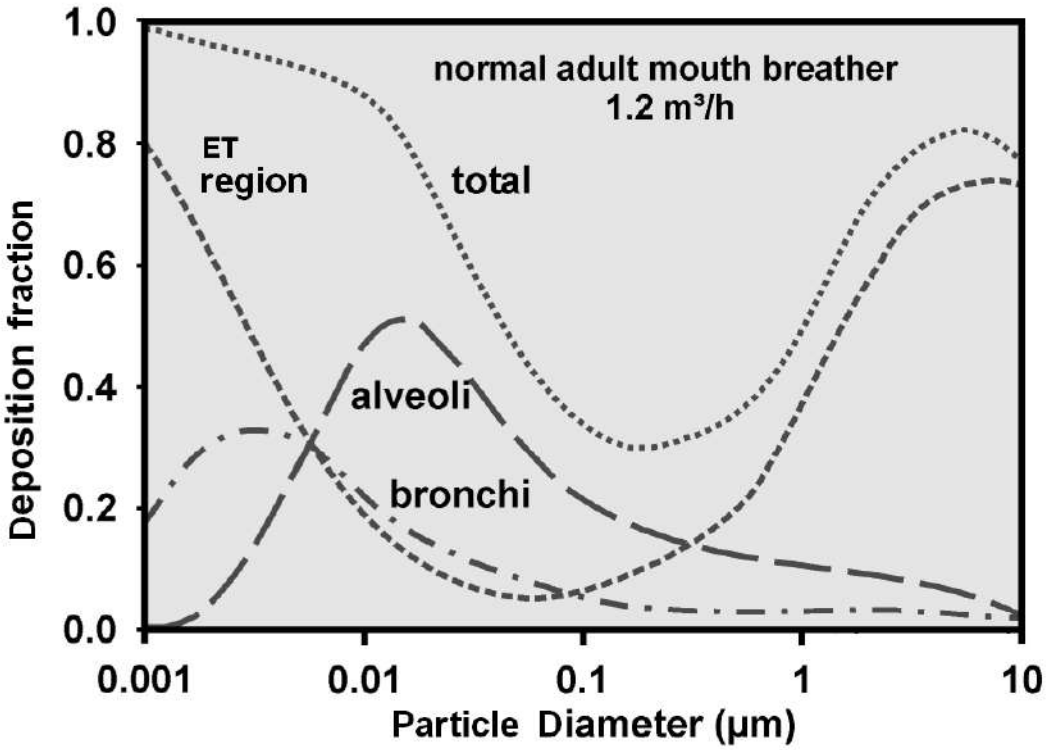


Figure 6: Average predicted total and regional lung deposition based on ICRP [1] deposition model for nose breathing for light exercise breathing condition. Highest deposition (ET region for 0.001 and 10 µm particles, bronchi region for 0.005 to 0.007 µm particles and alveolar region for 0.01 to 0.05 µm particles).

Note x-axis is logarithmic. (*figure from Hussain et al. 2011*)

rc-Silica is poorly soluble. Deposition results in irritation that initiates a number of pulmonary clearance processes. If the level of rc-silica is high enough to overload the clearance processes, then encapsulating processes are initiated. The encapsulating processes result in the development of the fibrotic condition known as silicosis (Bevan et al. 2018).

- **Silicosis**: Silicosis is a progressive, irreversible lung disease. Only rc-silica that is able to penetrate the alveolar sacs causes silicosis. Amorphous silica does not cause silicosis. rc-Silica that is too large to penetrate to the alveolar sacs does not cause silicosis (ATSDR 2017; Bernstein et al. 2013; Thomas & Kelley 2010; Yang et al. 2006).

  Chronic silicosis is a progressive disease that presents first as simple silicosis (also known as Stage I silicosis), characterized by tiny round scar lumps developing in the alveolar

dense regions of the lungs. Simple silicosis progresses to progressive massive fibrotic silicosis (PMF or Stage II), characterized by large fibrotic masses that develop in the lung tissues. PMF silicosis may progress to PMF Stage III silicosis characterized by *cor pulmonale* (abnormal enlargement of the heart). All forms of chronic silicosis are characterized by stressed breathing. The average latency period for developing silicosis is 22.9 years after the start of exposure in the occupational setting (persistent unprotected exposure lasting up to 8-hours a day). Approximately 48% of cases of simple silicosis progress to PMF (Steenland & Ward 2014; Yang et al. 2006).

The EEP uses several health-based searchable literature search engines such as PubMed and ToxNet. These search engines provide an index of peer-reviewed scholarly articles. A search of PubMed for "silicosis" listed 6,024 articles 1923 and through the most recent publication in November 2018. Of those, a little over 180 articles address risk magnitude associated with rc-silica exposure. The EEP reviewed those articles.

The exposure-response relationship of rc-silica to chronic silicosis is non-linear (Calvert et al. 2003; EPA 1996; Mannetje et al. 2002).

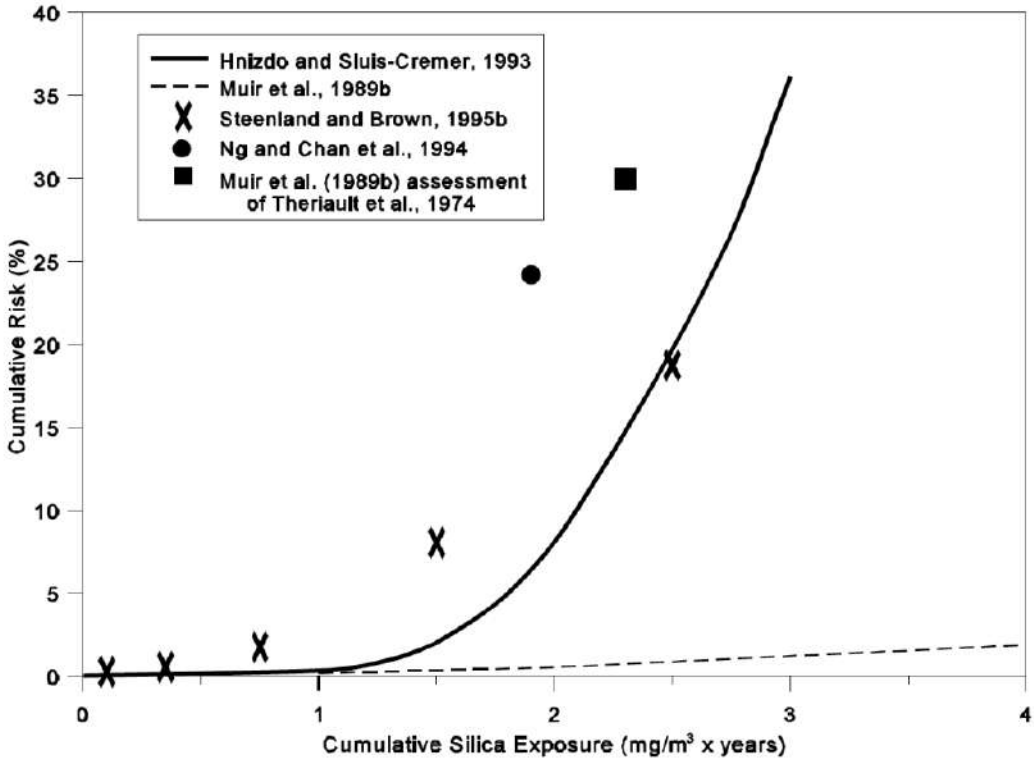


Figure 7-1. Cumulative silica risk curves estimated for South African gold miners (—) (Hnizdo and Sluis-Cremer, 1993) and Canadian hardrock miners (– –)(Muir et al., 1989b); cumulative silica risk points estimated for South Dakota gold miners (✗) (Steenland and Brown, 1995b), Hong Kong granite workers (●) (Ng and Chan, 1994), and Vermont granite miners (■) (Theriault et al., 1974c; Muir et al., 1989b).

(*figure from EPA 1996)*

We interpret the figure above to suggest that exposures below 1 mg/m^3-years (read as 1 mg exposure per cubic meter of air per year) pose minimal risk. A 1 mg/m^3-year exposure is equivalent to 1,000 µg/m^3-years (read as 1,000 micro grams exposure per cubic meter of air per year). Risk begins to rise from 1.0 to 1.5 mg/m^3-years (1,000-1,500 µg/m^3-years), and greater than 1.5 mg/m^3-years (>1,500 µg/m^3-years) the risk increases substantially. These studies are for a 30-year cumulative exposure.

Calvert et al. (2003) found that the risk of developing silicosis to be OR = 2.9 (2.4 – 3.5) when exposed to the OSHA TWA PEL (50 µg/m^3 over 8 hours; read as exposure to an average of 50 µg per cubic meter of air for 8 hours). The odds ratio increased to 6.8 (5.7 – 8.2) when the exposure was twice the PEL (100 µg/m^3) and to 30.5 (18.4 – 50.5) when the exposure was five times the PEL (250 µg/m^3).

Similarly, a persistent occupational exposure (8 hours/day) lasting 30 years to 50 µg/m^3 results in a less than 5% increased lifetime risk for silicosis, whereas, a 30-year persistent occupational exposure of 100 µg/m^3 results in a 25% increased lifetime risk for silicosis (Finkelstein 2000; Mannetje 2002).

Vacek et al. (2018) reports an increasing trend in the risk as cumulative exposure increases. The study assessed a cohort of 1,902 workers from 40 different work sites in 22 different states. Workers with cumulative exposures between 500 and 1,500 µg/m^3-years had an odd ratio of developing silicosis of OR = 1.10 (0.26 – 4.64). For exposures between 1,500 and 3,000 µg/m^3-years, the OR = 2.06 (0.55 – 7.79). For exposures greater than 3,000 µg/m^3-year, the OR = 12.57 (2.08-55.47).

Chronic silicosis has been associated with the development of COPD (chronic bronchitis and emphysema are examples of COPD), lung cancer, gastrointestinal cancer, kidney damage, autoimmune disease, and an increased risk for contracting active tuberculosis if exposed to the bacteria (for example, rheumatoid arthritis) (ATSDR 2017; Bernstein et al. 2013).

Exposures at extreme levels may result in acute silicosis or accelerated silicosis which are usually fatal due to anoxia a few months to years after exposure (ATSDR 2017; Bernstein et al. 2013; Yang et al. 2006).

- **Lung cancer from rc-silica exposure**: The only health outcome the EEP was asked to address was the development of lung cancer from rc-silica exposure.

  Nature of Public Research: Unlike some of the more exact sciences, epidemiologic research into the association of a specific risk factor to a specific health outcome is subject to high variability. For example, despite the evidence that rc-silica is associated with the development of silicosis, Checkoway et al. (1997) studied a large occupational

cohort (2,342 workers) and found no significant risk for cancer deaths (SMR = 1.1; 0.9 – 1.2) and a low significant risk for deaths from respiratory disease (1.8; 1.4 – 2.2).

A meta-analysis found the reported relationship between silicosis and lung cancer to range from statistically significant and meaningful (SMR = 6.03; 4.38 – 8.09) to statistically insignificant (1.37; 0.95 – 1.91). In that analysis of 31 individual studies, seven (23%) had insignificant findings. Twenty-four (77%) showed a significant association of silicosis exposure to lung cancer, but only two (6%) resulted in meaningful findings by the EEP's current definition (Lacasse et al. 2005).

Similarly, the meta-analysis by Poinen-Rughooputh et al. (2016) included studies that ranged from 0.90 (0.51 – 1.47) to 6.03 (5.29 – 6.77). In that report, 23% of the included studies were statistically insignificant and 9% were of a magnitude to meet the EEP's "meaningfulness" threshold.

Because of this variability, the EEP preferentially (but not exclusively) uses meta-analytical reports. Meta-analysis is a statistical process of summarizing the wide-ranging body of literature into a single assessment. Using meta-analytical reports has several advantages, in that it ensures the interpretation of the assessment has the statistical power of the combined reports, and ensures that an incomplete literature review is not guilty of "cherry-picking" reports to support a predetermined conclusion (Hedges & Olkin 1985).

Non-Occupational Exposure: Unfortunately, there is a scarcity of studies on non-occupational exposures. Here, reports on occupational exposure are considered and, where possible, extrapolated to non-occupational exposures.

Meta-analysis of the association of rc-silica exposure to the development of lung cancer: The following meta-analytic reports are from the occupational setting.

	Erren et al. 2011	Poinen-Rughooputh et al. 2016	Smith et al. 1995
Number of studies	38	10	29
Lung cancer risk among silicotic cases	2.1 (2.0 – 2.3)	2.3 (1.9 – 2.8)	2.2 (2.1 – 2.4)
Lung cancer risk in non-silicotic cases not adjustments	1.2 (1.0 – 1.4)	1.2 (0.9 – 1.6)	
Lung cancer risk in non-silicotic cases adjusting for smoking	1.0 (0.8 – 1.3)		

All of the above ratios are relative risks (RR) with 95% confidence intervals.

The three meta-analyses presented here may have some overlap in which individual studies they included. They are consistent in their findings that lung cancer development is about twice as high in silicotic cases but not significant in non-silicotic cases. In other words, the development of silicosis after rc-silica exposure in the occupational setting is associated with the development of lung cancer. However, rc-silica exposure is not directly associated with lung cancer development.

Steenland et al. (2001; 2014) in a meta-analytic report that examined 10 studies suggested that a lifetime occupational exposure to 0.10 mg/m^3 (100 µg/m^3) of rc-silica results in increased lifetime lung cancer risk of 1.1% to 1.7% above background risk.

The EEP replicated meta-analysis using 181 reports of risk magnitude and found similar pooled results. Each of the authors cited above, and EEP noted (using the funnel diagram) in its own analysis that there is a significant publication bias associated with these studies. Publication bias is effect caused when researchers and publishers do not publish insignificant or negative findings, thus biasing the pooled effect towards a positive finding.

Meta-analysis of the association of rc-silica exposure and death by lung cancer:
These meta-analytic reports are in the occupational setting.

	Lacasse et al. 2005	Poinen-Rughooputh et al. 2016	Smith et al. 1995
Number of studies	31	85	29
Lung cancer deaths among silicotic cases without adjustment	2.5 (1.6 – 3.7)	2.3 (1.9 – 2.8)	2.7 (2.3 – 3.2)
Lung cancer deaths among silicotic cases adjusting for smoking	1.6 (1.3 – 1.9)		
Lung cancer deaths among in non-silicotic cases without adjustment		1.8 (1.1 – 3.0)	

All of the above ratios are standardized mortality ratios (SMR) with 95% confidence intervals.

The three meta-analyses presented here may have some overlap in which individual studies they included. They are consistent in their findings that lung cancer deaths occur two to three times more often among silicotic cases (not adjusted for smoking).

Calvert et al. (2003) found that the risk for developing lung cancer from occupational silicosis was OR = 0.88 (0.87 – 0.90) when exposed at the OSHA TWA PEL level. This risk

increased to 1.1 (1.1 – 1.2) for exposures twice as high, but did not change for exposures five times as high.

The data suggest that silica exposure is a risk effect modifier of tobacco use the development of silicosis, COPD and lung cancer. However, the data is limited (Hessel et al. 2003, Tse et al 2014). An effect modifier is a factor that enhances the primary effect of another risk factor. In this case, tobacco use is the primary risk. Silica exposure increases the harm done by tobacco use.

- **Other findings**:
    - Two studies found that the number of aerosol particles that reached the lower pulmonary regions in children was the same or lower than in adults. This finding is attributed to the lower tidal volume and inhalation pressure of children, allowing the particles to impact in the extra-thoracic part of the respiratory tract (Albuquerque-Silva 2014; Rissler et al. 2017). Our assessment is that both studies are a start, but too weak (3 and 7 subjects, respectively) to be definitive.
    - In addition to basic comparative measures of risk (odds ratios, relative risk, etc.), epidemiologists have a number of useful tools to measure the attribution of risk to various factors when a combination of risk factors are present. For example, the risk factors for lung cancer include tobacco exposure, radon exposure, exposure to heavy metals (e.g., arsenic, beryllium, cadmium, etc.), exposure to organic compounds (i.e., vinyl chloride), certain dietary supplements, genetics, combustion engine exhaust, radiation therapy, and a number of other factors (CDC 2018). The basic measures of risk are problematic in that they conceal the background or confounding risks (Suissa 1999). A large cohort study (58,677 workers) estimated that the excess relative risk (ERR) per dust-year associated with silicosis was 0.061 (95% CI = 0.039 – 0.083) for exposures > 10 mg/m^3-year (10,000 µg/m^3-year). This study confirms a small positive exposure-response relationship between silica and lung cancer for very high exposures (Sogl et al. 2012).
    - Individuals with genetic variations in certain genes (the tumor necrosis factor (TNF-alpha), and interleukin cytokine (IL-10) genes) have increased risk of developing silicosis after rc-silica exposure (Kurniawidjaja 2014).

- **Research by Utah Physicians for a Healthy Environment (UPHE)**: As we have previously stated, we applaud the work done by UPHE. They have been able to address concerns much more broadly than the EEP has been authorized to do. We encourage policymakers to consider their work in parallel with ours.

Understanding the Risk: Approach 2 – Air Dispersion Modeling

- **Point of the Mountain**: The rock formations in the quarries at Steep Mountain, Sage Canyon, and other nearby areas (collectively referred to as “the Point of the Mountain”)

are highly fractured orthoquartzite with some limestone and calcareous sandstone. Quartzite is approximately 90% quartz crystal (cristobalite or tridymite), which is in turn predominately crystalline silica (c-silica) (JBR 2009).

Geneva Rock is the largest of a number of companies operating at the Point of the Mountain and is permitted to emit up to 128.86 tons of PM_{10} per year (read as particulate matter smaller than or equal to 10 microns in size per year) (JRB 2009). There was no mention of a permitted level for total solid particulate matter (TSP). It is quite possible that the air opacity is affected by a range of air buoyant particle sizes up to about 500 microns.

In addition to rock quarry operations, the Point of the Mountain site includes concrete batch production, hot mix asphalt production, as well as fuel farms and maintenance operations.

Using inhouse geographic information systems (GIS) and the most recent satellite imagery, the site includes approximately 2,939,910 square meters of de-vegetated or excavated land.

- **Sand and gravel sources of silica**: Huggins and Meyers (1986) investigated the size distribution of respirable particles from 29 mines (including at least 15 sand and gravel quarries) and found that about 60% of the particles in the respirable size range (0 to 15 µm) were in the alveolar deposition size range (0 to 3.0 µm). Cauda et al. (2014), investigating mines across the nation, found that, on average, only 9.4 to 11.7% of the total dust cloud mass was rc-silica.

  Richard et al. (2009) found that the PM_4 fraction (read as particulate matter smaller than or equal to 4 microns in size) of the dust from California screening operations, tertiary crushers, and conveyor transfer points comprised 0.000006 to 0.000110 lbs/ton (pounds per ton) of the total dust cloud mass. They further found good correlation between the proportion of rc-silica in the dust cloud mass and the proportion of c-silica in the source material. Using this correlation slope, the EEP estimates that for a source that is 90% orthoquartzite, rc-silica dust would comprise 0.0003 lbs/ton of the total dust cloud mass.

- **Other dust sources**: Within three miles (5,000 meters) of the Traverse Mountain residential area are at least 15 large agriculture fields that are plowed and harvested periodically. Within three miles of the Traverse Mountain residential area, including within the Traverse Mountain community itself, there are a number of housing development areas with active excavation and earth pilling.

  Surveys of crystalline silica levels, while not extensive, suggest that air concentrations between 1 to 10 $\mu g/m^3$ are common in both urban and rural settings and are thought to be from natural sources. Silica is the most common material found on the earth. For this

reason, the EPA has put off issuing a reference dose for non-occupational exposures. (Hardy & Weill 1995).

- **Windrose data**: Windrose data indicates that in the Lehi area, about 25% of the year the wind is from the N (3%), NNW (4%), NW (6%), WNW (7%), or W (5%). The Windrose provides an estimation of windspeeds: averaging 1.5 mph for 6% of the year, 5 mph for 12% of the year, 10 mph for 5% of the year, and 15 mph or faster for 1% of the year. The remaining 75% of the year, the wind is either in a direction away from the Traverse Mountain residential area or is calm.

- **Worst case scenario area source exposure modeling**: The EEP used the SCREEN3 air quality dispersion modeling tool to estimate the area-based dispersion of fugitive dust from the quarry site to various distances toward Traverse Mountain.

  The SCREEN3 model gives generic pollutant concentrations at points that are various distances from the source. It is a screening model and is designed to overestimate the pollutant concentration. If the screening results are above a threshold of concern, a more robust model that can account for the meteorological, terrain, and structural conditions is used before making any conclusions (EPA 1995; Bruce et al. 2014; Till & Meyer 1983; Reed 2005; Turner 1994).

  In using this model, the following assumptions were applied (these represent worst case conditions for dust exposure):
  - The sky was always noon-time sunny, no cloud cover, and no precipitation for 100% of the year (the worst-case stability class).
  - The dust cloud mass is 100% rc-silica in the <0.01 µm or the 1.0-2.5 µm size.
  - Any wind speed is able to lift and transport at 100% capacity.
  - The rc-silica is eternally buoyant (no deposition). Deposition is an interesting concern. In reality, as the dust cloud moves downwind the mass is reduced by deposition, but the ratio of rc-silica to total mass increases because the heavier materials will deposit earlier than the lighter materials (Aluko & Noll 2006).

  The annual average exposure levels for the three modeled distances are as follows:

400 feet (122 meters)	Closest resident	9.19 µg/m^3-year
1,660 feet (506 meters)	Closest resident to large pit	9.57 µg/m^3-year
4,900 feet (1,494 meters)	School	8.87 µg/m^3-year

  The overall annual average exposure level across the Traverse Mountain residential area is <10 µg/m^3. This is below the OSHA TWA PEL (50 µg/m^3) and the EPA interpolated equivalent (18 µg/m^3). It is above the California cREL (3.0 µg/m^3).

Next Steps: We have proposed acquiring several portable PM2.5 monitors and conducting spot checks of locations around the perimeter of the site and in the Traverse Mountain residential area (i.e., near the closest homes, near the school, etc.).

- **Investigation of heavy metals**: With a petition to conduct a formal investigation, we could look at this in more depth. As a preliminary assessment, assuming a total dust exposure level of 10 µg/m^3 (0.000010 g/m^3), this is what we might find:

Metal	Weight Volume (µg/g)	Exposure Level (µg/m^3)	ATSDR chronic-duration inhalation MRL (µg/m^3)
Aluminum	1,800	0.0018000	4,500
Arsenic	13.8	0.0000138	2
Barium	82.3	0.0000823	500
Beryllium	0.187	0.0000002	2
Cadmium	0.28	0.0000003	0.01
Chromium	7.24	0.0000072	0.3 (assuming all is Cr-6)
Cobalt	1.23	0.0000012	0.1
Lead	4.34	0.0000004	50
Manganese	96.9	0.0000969	0.3
Molybdenum	0.751	0.0000008	0.4
Strontium	32.4	0.0000324	0.5
Tin	1.1	0.0000011	2,000 (assuming is inorganic)
Titanium	43.0	0.0000430	0.1
Uranium	10.8	0.0000108	0.8
Vanadium	6.96	0.0000070	0.1
Zinc	22.2	0.0000222	1,000

MRL is a Minimal Risk Level, and is interpreted similarly to a RfD.

The metals that are micro-nutrients or were not detected were not evaluated. The above data from a very preliminary assessment. Our preliminary conclusion is that the metal levels from this one sample are not at a high enough concentration to cause concern.

Conclusion: The EEP was asked to address construction dust with consideration of silica, and the risk of silicosis and lung cancer. We have not addressed any other potential pollutant or health outcome.

Based on our literature review, the EEP cannot state that exposure to rc-silica is "safe." Indeed, long-term exposures at or above 1000 µg/m^3-year have an increasing risk approximately twice that of an unexposed community.

However, the literature review, and subsequent modeling of the Point of the Mountain quarry, suggests to us that the exposures to rc-silica originating from the quarry that are experienced

by Traverse Mountain residents are transient (25% of the time of the year) in nature, and well below (approximately 100 times below) the levels where observable effects occur. The modeling also suggests that the exposure levels to rc-silica originating from the quarry and experienced by Traverse Mountain residents are below (about one half) the EPA recommended residential exposure interpolation of the OSHA occupational threshold.

Previous investigations: The EEP referenced the "Brigham City Sand and Gravel Pits" (ATSDR 2006) as one example of several of prior investigative experiences. That investigation was conducted as part of a cooperative agreement UDOH had with the Agency for Toxic Substances and Disease Registry (ATSDR) and is therefore published online. We feel there has been some misinterpretation of that report. Similar to this situation, that investigation focused on particulate matter. In that assessment, the EEP found that particulate matter (PM_{10}) ". . . are a nuisance, but do not pose a health concern . . .". Similarly, the data suggested that total solid particulates were ". . . a nuisance and do not pose a health concern." Those reading the report have focused on a recommendation the EEP made because the investigation focused on particulate matter. We recognized then, and continue to recognize now, there are other concerns that were not investigated.

Residents' concerns: We recognize and appreciate that the residents have individual and community level concerns. We encourage your efforts to continue to work within your political jurisdiction to voice those concerns. We feel that the best policy decisions are made when many voices contribute to the process.

Recommendations

The EEP recommends that either the city of Lehi or residents of Traverse Mountain, through the Utah County Health Department, petition the EEP to conduct a more thorough investigation of the site, to include additional potential air pollutants (i.e., VOCs, PAHs, heavy metals, etc.) and to consider more adverse health outcomes (i.e., cancers, cardiovascular disease, other respiratory disease, reproductive health, children's health, etc.).

Additionally, either the city of Lehi or the Utah County Health Department can propose thresholds of concern for the EEP to use that are lower than a risk ratio of 3.0 or the OSHA TWA PEL (or the EPA interpolation of that PEL for residents).

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Exhibit 10

U.S. Department
of Transportation

Federal Highway Administration

FHWA
Roadway Construction Noise Model
User's Guide

FHWA-HEP-05-054
DOT-VNTSC-FHWA-05-01

Final Report
January 2006







Prepared for
U.S. Department of Transportation
Federal Highway Administration
Office of Natural and Human Environment
Washington, DC 20590

Prepared by
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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	January 2006	Final Report January 2004–January 2006

4. TITLE AND SUBTITLE
FHWA Roadway Construction Noise Model, Version 1.0 User's Guide

5. FUNDING NUMBERS
HW-66/CS036

6. AUTHOR(S)
Reherman, Clay N.[3], Rochat, Judith L.[3], Thalheimer, Erich S.[2], Lau, Michael C.[3], Fleming, Gregg G.[3], Ferroni, Mark[1], Corbisier, Christopher[1]

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Research and Innovative Technology Administration
John A. Volpe National Transportation Systems Center
Environmental Measurement and Modeling Division, DTS-34
Cambridge, MA 02142

8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FHWA-05-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Federal Highway Administration
Office of Natural and Human Environment
Washington, DC 20590

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FHWA-HEP-05-054

11. SUPPLEMENTARY NOTES

(1) U.S. Department of Transportation
Federal Highway Administration
Office of Natural and Human Environment
Washington, DC 20590

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75 Arlington St.
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(3) U.S. Department of Transportation
Research and Innovative Technology Administration
John A. Volpe National Transportation Systems Center
Environmental Measurement and Modeling Division
Cambridge, MA 02142

12a. DISTRIBUTION/AVAILABILITY STATEMENT
This document is available to the public through the National Technical Information Service, Springfield, VA 22161

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The Roadway Construction Noise Model (RCNM) is the Federal Highway Administration's (FHWA) national model for the prediction of construction noise. Due to the fact that construction is often conducted in close proximity to residences and businesses, construction noise must be controlled and monitored to avoid impacts on surrounding communities. In addition to community issues, excessive noise can threaten a construction projects' progress. Each project needs to balance the community's need for peace and quiet with the contractor's need to progress the work.

During the Central Artery/Tunnel (CA/T) project in Boston, Massachusetts, the project's noise control program developed the Construction Noise Control Specification 721.560, the most comprehensive noise specification ever developed in the United States. As part of the CA/T project noise control program, a construction noise prediction spreadsheet was developed. Because the CA/T prediction tool can benefit other state and local governments, the FHWA developed the RCNM, which is based on the noise prediction calculations and equipment database used in the CA/T prediction spreadsheet. The RCNM provides a construction noise screening tool to easily predict construction noise levels and determine compliance with noise limits for a variety of construction noise projects of varying complexity.

14. SUBJECT TERMS
construction noise, noise levels, dBA, noise models, community impact, Federal Highway Administration

15. NUMBER OF PAGES
28

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he) = 4,000 square meters (m^2)

MASS – WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gm)
1 pound (lb) = 0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup © = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres

MASS – WEIGHT (APPROXIMATE)

1 gram (gm) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

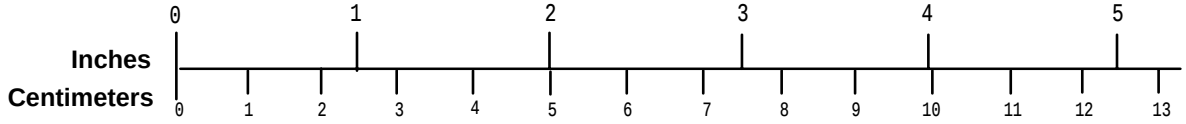
VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

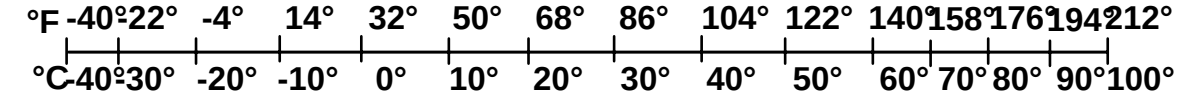
TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION



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Updated 6/17/98

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1 Introduction

The Roadway Construction Noise Model (RCNM) is the Federal Highway Administration's (FHWA) national model for the prediction of construction noise. Due to the fact that construction is often conducted in close proximity to residences and businesses, construction noise must be controlled and monitored to avoid impacts on surrounding communities. In addition to community issues, excessive noise can threaten a construction project's progress. Each project needs to balance the community's need for peace and quiet with the contractor's need to progress the work.

The Central Artery/Tunnel (CA/T) project in Boston, Massachusetts, which began in the early 1990s, is the largest urban construction project ever conducted in the United States. Its noise control program developed the Construction Noise Control Specification 721.560, the most comprehensive noise specification ever developed in the United States [1]. As part of the CA/T project noise control program, a construction noise prediction spreadsheet was developed [2]. Because the CA/T prediction tool can benefit other state and local governments, the FHWA developed the RCNM, which is based on the noise prediction calculations and the equipment database used in the CA/T prediction spreadsheet. The RCNM provides a construction noise screening tool to easily predict construction noise levels and to determine compliance with noise limits for a variety of construction noise projects of varying complexity.

2 Background

The RCNM is a national model based on the noise calculations and extensive construction noise data compiled for the CA/T Project. The basis for the national model is a spreadsheet tool developed in support of the CA/T project [2]. The CA/T predictions originated from Environmental Protection Agency (EPA) noise level work [3] and an Empire State Electric Energy Research Corp. Guide [4] which utilizes an "acoustical usage factor" to estimate the fraction of time each piece of construction equipment is operating at full power (i.e., its loudest condition) during a construction operation. Table 1 presents a construction equipment noise database compiled through the CA/T project [2]. This database is used to predict construction noise within the RCNM. The noise levels listed represent the A-weighted maximum sound level (Lmax), measured at a distance of 50 feet from the construction equipment.

Table 1. CA/T equipment noise emissions and acoustical usage factors database.

CA/T Noise Emission Reference Levels and Usage Factors					
filename: EQUIPLST.xls					
revised: 7/26/05		Acoustical	Spec 721.560	Actual Measured	No. of Actual
	Impact	Use Factor	Lmax @ 50ft	Lmax @ 50ft	Data Samples
Equipment Description	Device ?	(%)	(dBA, slow)	(dBA, slow)	(Count)
				(samples averaged)	
All Other Equipment > 5 HP	No	50	85	-- N/A --	0
Auger Drill Rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Bar Bender	No	20	80	-- N/A --	0
Blasting	Yes	-- N/A --	94	-- N/A --	0
Boring Jack Power Unit	No	50	80	83	1
Chain Saw	No	20	85	84	46
Clam Shovel (dropping)	Yes	20	93	87	4
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Concrete Batch Plant	No	15	83	-- N/A --	0
Concrete Mixer Truck	No	40	85	79	40
Concrete Pump Truck	No	20	82	81	30
Concrete Saw	No	20	90	90	55
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Drill Rig Truck	No	20	84	79	22
Drum Mixer	No	50	80	80	1
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19
Generator (<25KVA, VMS signs)	No	50	70	73	74
Gradall	No	40	85	83	70
Grader	No	40	85	-- N/A --	0
Grapple (on backhoe)	No	40	85	87	1
Horizontal Boring Hydr. Jack	No	25	80	82	6
Hydra Break Ram	Yes	10	90	-- N/A --	0
Impact Pile Driver	Yes	20	95	101	11
Jackhammer	Yes	20	85	89	133
Man Lift	No	20	85	75	23
Mounted Impact Hammer (hoe ram)	Yes	20	90	90	212
Pavement Scarafier	No	20	85	90	2
Paver	No	50	85	77	9
Pickup Truck	No	40	55	75	1
Pneumatic Tools	No	50	85	85	90
Pumps	No	50	77	81	17
Refrigerator Unit	No	100	82	73	3
Rivit Buster/chipping gun	Yes	20	85	79	19
Rock Drill	No	20	85	81	3
Roller	No	20	85	80	16
Sand Blasting (Single Nozzle)	No	20	85	96	9
Scraper	No	40	85	84	12
Shears (on backhoe)	No	40	85	96	5
Slurry Plant	No	100	78	78	1
Slurry Trenching Machine	No	50	82	80	75
Soil Mix Drill Rig	No	50	80	-- N/A --	0
Tractor	No	40	84	-- N/A --	0
Vacuum Excavator (Vac-truck)	No	40	85	85	149
Vacuum Street Sweeper	No	10	80	82	19
Ventilation Fan	No	100	85	79	13
Vibrating Hopper	No	50	85	87	1
Vibratory Concrete Mixer	No	20	80	80	1
Vibratory Pile Driver	No	20	95	101	44
Warning Horn	No	5	85	83	12
Welder / Torch	No	40	73	74	5

Exhibit 11



Guide to Air Quality Permitting for Concrete Batch Plants

First Edition, Fall 2018

The University of Texas at Austin
Environmental Clinic
School of Law

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Purpose and Acknowledgments

This Guide provides an overview, but is by no means a comprehensive description of concrete batch plant air permitting in Texas. As a result, while every effort has been made to make these materials as accurate as possible, these materials are not to be used as a substitute for the advice of an attorney. Persons reviewing this Guide should not act upon the information without seeking the advice of an attorney.

Special thanks to Kathryn Kalinowski and Sarah Beach at University of Texas School of Law for their edits to this guide.

Cover Photo: Air Alliance Houston

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Attachment C – TCEQ, Amendments to the Concrete Batch Plants Air Quality Standard Permit (2012)

Attachment D – U.S. EPA, Emission Factors Documentation for AP-42 Section 11.12-Concrete Batching (2006)

Attachment E – TCEQ, General Permit for Stormwater Discharges from Concrete Batch Plants

INTRODUCTION

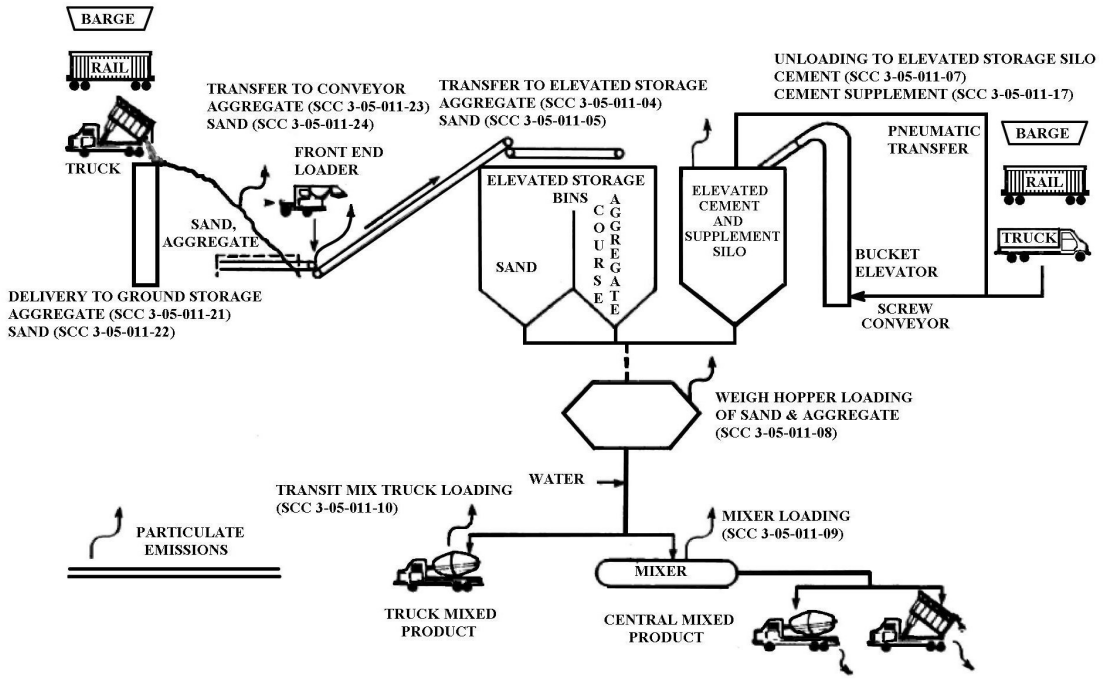
Due to the ubiquity of concrete batch plants, many communities throughout Texas are suffering from the pollution caused by concrete batch plants. Neighbors report particulate emissions coating their homes and cars and causing respiratory problems. They also object to the diesel trucks that cut through their communities and emit toxic air pollutants while idling outside concrete batch plants waiting to load.

Most people do not know, however, how to engage in the permitting process to attempt to require better controls and reduced pollution at concrete batch plants. This guide is intended to provide an overview of the Texas air permitting process for concrete batch plants and the types of pollution controls that communities could seek through that process.

WHAT ARE CONCRETE BATCH PLANTS?

A typical concrete batch plant mixes water, cement, fine aggregate (e.g., sand) and coarse aggregate (e.g., gravel) and a small amount of supplemental materials in a very large drum to create concrete.[1] At most commercial-scale concrete plants, the cement is stored in silos and fed on a conveyor belt to a loading point where feeds of sand, gravel, and supplement join the cement feed. The feeds are dropped together through the drum into concrete trucks where they are combined with water. The concrete truck then drives to the construction site, further mixing the cement and water along the way. There are instances, usually at large construction sites, where the concrete is mixed on site in a central mix drum and then transferred to a transport truck.

Concrete Batch Plant



Source: EPA, AP-42, Figure 11.12-1 (June 2006)

The cement silos are generally the most noticeable part of a concrete batch plant. They will typically be very tall, maybe three stories or 40 feet. There will be several of them. At some concrete batch plants, there will be a silo that stores a supplemental mixture that is added to the concrete truck at the cement drop point. The drop occurs into a large funnel-shaped structure that is on stilts, so the concrete trucks can be driven beneath it for loading.

A concrete batch plant site will generally be at least an acre, and much larger sites are not uncommon. The site will have stockpiles of sand and gravel, and there will be conveyor belts that move these materials into position to be mixed with the cement. There will also be a driveway, often, a circular one, for the concrete trucks, and there will be some internal material haul roads.

There may be a railroad spur that brings in the raw materials, i.e., the sand, gravel, cement, and cement supplements. There will be a small building or two on the site for such things as office space and the storage of repair parts and cleaning materials. Owners and operators of large concrete batch plants sometimes also operate other facilities, such as asphalt plants or rock crushers, at the same site.[2]

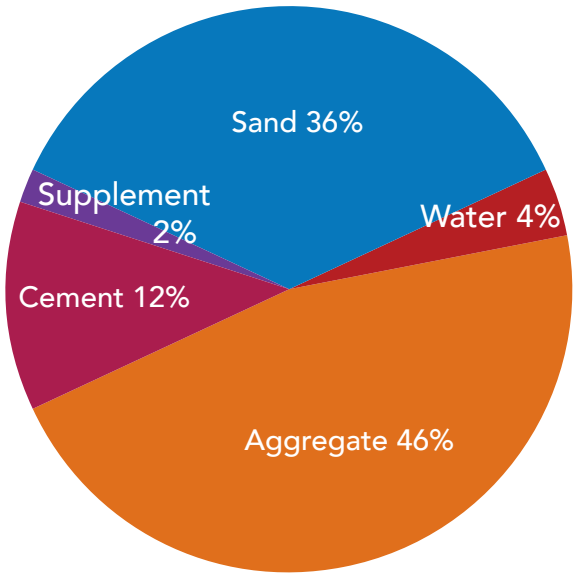
> Additives to the cement mixture may include materials such as fly ash, granulated blast-furnace slag, and silica fume, which are intended to make the concrete more economical, reduce permeability, or increase strength. They may also include chemical additives, which are usually liquid ingredients intended to entrain air, reduce the water required, retard or accelerate the setting rate, make the concrete more fluid, etc. The Texas Commission on Environmental Quality's (TCEQ's) standard permit prohibits the use of additives that release volatile organic compounds.

This is not an industry that has changed greatly in recent decades. The TCEQ's predecessor agency, the Texas Natural Resource Conservation Commission ("TNRCC"), determined in the late 1990s that most concrete batch plants produced between 100 and 300 yd^3/hr of concrete.[3] Various sources indicated to the agency staff that average production rates were in the lower half of that range, between 157 yd^3/hr to 176 yd^3/hr. Industry representatives participating in focus group meetings hosted by the agency indicated that a 200 yd^3/hr production rate was a reasonable worst-case assumption for most plants in Texas, with the exception of a central-mix style plant, which could approach 300 yd^3/hr. (Central-mix plants mix the cement and the water at the plant site in a fixed mixing machine; central-mix plants usually make large volumes of concrete for use very nearby.)

Batch plants are generally broken into two categories: permanent concrete batch plants and temporary concrete batch plants. TCEQ defines "temporary plants" as those that occupy a particular location for no more than 180 days or until a single construction project is completed. There are a few plants, usually permanent ones, that are treated as a third separate category. These are "specialty" concrete plants. Specialty concrete plants might make such things as precast concrete products, prefabricated building and road materials, cement blocks, concrete pipes, septic tanks, or statuary. The output of specialty plants is generally small, when compared to the output of permanent and temporary plants that mix concrete for off-site construction projects.

Composition of Concrete by Weight

A cubic yard of wet concrete weighs about 4,024 pounds



Source: EPA, AP-42, ch. 11.12, Table 11.12-2, note "a" (2011).

About Portland Cement

Portland cement is the binding ingredient in concrete. It was patented in England in 1824. The name suggested the strength of construction stone from the Isle of Portland.

Portland cement is a mixture of limestone, clay, iron ore, and small amounts of other minerals. These materials are ground into a slurry and heated to very high temperatures in a nearly horizontal rotary kiln, which might be very large (e.g., 12 feet in diameter and 500 feet long). The slurry is fed into the high end of the kiln. At the lower end is a roaring flame, perhaps 2700 degrees Fahrenheit. A number of gases are driven off by this firing process. The remaining material, called clinker, emerges at the low end as gray marble-sized balls. These are, themselves, ground to a fine dust with a small amount gypsum and limestone.

Hazardous wastes are often used as fuel for the flame, and the overall process can create a number of pollutants, including mercury and toxic acid gases. The exhaust dusts from cement kilns were defined by Congress in 1980, pending further study, not to be hazardous wastes. 42 U.S.C. §6921(b)(3)(A)(iii), the "Bevill Amendment." Over the last 40 years, however, there has been continuing controversy as to the risk that these toxic pollutants adhere to and within the clinker. See, for example, Kleppinger, "Cement Clinker: An Environmental Sink for Residues from Hazardous Waste Treatment in Cement Kilns," 13 Waste Management 553-572 (1993).

"Basic Information: Air Emissions from the Portland Cement Industry," EPA, www3.epa.gov/airquality/cement/basic.html, and "How Cement is Made," Portland Cement Association, www.cement.org.

WHAT PROBLEMS DO CONCRETE BATCH PLANTS CREATE FOR NEIGHBORS?

Air Pollution Issues:

Neighbors most commonly complain about dust and particulate matter (PM) emissions from concrete batch plants.

PM emissions come primarily from the transfer of cement and additive materials to the silos, the transfer of sand and aggregate, truck loading, mixer loading, and sand and aggregate blowing from the piles.[4] Roadways internal to the plant site are also big contributors to the overall level of dust associated with a plant. The PM is comprised mainly of cement and dust from the additives; there are metals associated with the PM.[5] The impact of dust on neighbors is usually controlled by the continuous watering, i.e., misting, of plant roadways and other sources of dust. Dust may also be somewhat controlled by establishing a buffer zone between roadways and neighbors. Another protective measure is to erect a barrier between the roadways and the neighbors.

> Based on observations and experience, the TNRCC found that the height of a dust plume will be about twice the height of the vehicle generating the road dust. To achieve approximately 50% control of the dust plume, the height of a barrier was thought to be at the height of the plume center line. Based on the modeling, the agency found this height to be about 12 feet.
>
> (TCEQ Regulatory Guidance RG-056, December 2000, p. 9 of 49)

Air pollutants - including carbon monoxide, nitrogen oxides, volatile organic compounds, particulate matter, nickel and formaldehyde - can also be generated by on-site internal combustion engines.[6] Most concrete batch plants that have engines use diesel compression ignition internal combustion engines up to 1,000 horsepower.[7]

Finally, while not part of the concrete plant itself, the trucks that access the facility are often diesel-fueled and frequently idle outside the facility waiting to load for long stretches of time. Emissions from

idling concrete haul trucks are not included in the TCEQ's potential to emit calculations for concrete batch plants.

Particulate emissions are a complex mixture of extremely small particles and liquid droplets. Once inhaled, these particles can affect the heart and lungs and cause serious health effects, including increased risk of heart attacks, aggravation of asthma, and decreases in lung function.[8] The smaller particles, 2.5 micrometers and less in diameter, are the most harmful ones, since they are inhaled more deeply in the lungs than are larger particles.

Both EPA and TCEQ have Potential to Emit Calculators for Concrete Batch Plants that can be used to help estimate a facility's emissions.

https://www.epa.gov/sites/...06/concrete_batch_plants_pte_calculator070214_0.xlsx and https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/emiss-calc-cbp.xlsx.

TCEQ estimated that a 300 yd^3/hr plant that was limited to 6,000 yd^3/day and did not generate its own electricity (i.e., did not run a diesel generator) would emit an average of about 4 pounds of total particulate matter per hour during a 24-hour period. Please see the further explanation in the endnote [9] to understand that in any one hour that rate could be higher. If the plant does not generate its own power, TCEQ estimates about 0.24 pounds per hour (6% of total emissions) will be $PM_{2.5}$. If the plant does generate its own power, TCEQ assumes all the particulate emissions from the generator are $PM_{2.5}$. With on-site power production, $PM_{2.5}$ emissions rise to about 1.13 pounds/hour, 4.7 times as much as in the "no power generation" scenario.

Non-Air Pollutant Concerns:

TCEQ will likely state that the first two of these concerns are outside of its jurisdiction. They are, however, issues that can be addressed in a settlement.

Noise: Noise is sometimes a problem for concrete plant neighbors. Large concrete trucks, those with the roughly cone-shaped mixing barrels on their backs, often arrive before dawn to pick up loads of concrete to take to construction sites, and the idling of these early-morning arrivals and their reverse warning sounds can be noisy, in addition to spreading diesel fumes throughout the neighborhood.

Traffic: The traffic of the trucks, depending on the roadway layout near the plant, can be a problem for the neighborhood, particularly when the trucks travel through or idle near residential areas.

Polluted wastewater runoff: The site stockpiles and dusty roads can contribute sediment to rain that falls on them, causing muddy runoff to the nearby neighborhood, if the runoff is not well-controlled by the plant.

HOW ARE CONCRETE BATCH PLANTS REGULATED?

This guide addresses only air quality permitting in any detail. However, other permitting programs also affect the operation of a concrete batch plant and may provide avenues for the local citizens to lessen the impact of a plant.

Storm water and waste water

A concrete batch plant that discharges storm water associated with the plants' operation, rather than retaining the water on-site, will need a storm water permit. A permit is needed if the storm water has come in contact with the stockpiles, infrastructure, or equipment at the plant.[10] In addition, if the plant discharges conventional waste water, for example, water that was used to wash down trucks or clean equipment, it will likely need a separate waste water discharge permit from TCEQ. If a plant's discharges are to a storm sewer, the terms of the city's municipal separate storm sewer system, i.e., "MS4," permit may also regulate the discharges.

There is a TCEQ general storm water permit that covers storm water discharges associated with a concrete batch plant. (A "general permit" is like a "standard permit" but is an authorization under the Clean Water Act rather than under the Clean Air Act.) The current general permit for concrete batch plants is Attachment E to this guide. As you will see from the coverage limitations on pages 6 and 7 of the permit, the general permit may be unavailable for operations near the Edwards Aquifer recharge zone or if the discharges might affect an endangered or threatened species. There are several other instances where storm water discharges may not be covered by the general permit. In the event a concrete batch plant does not qualify for or does not want to commit to the terms of coverage as described in the general permit, an individual Texas Pollution Discharge Elimination System ("TPDES") permit will usually be needed. A Storm Water Pollution Prevention Plan ("SWPPP") is required in order to secure coverage under the general permit and, as a practical matter, under an individual NPDES permit. These plans are not automatically submitted to the TCEQ for review, so they are often prepared poorly or not at all. A plan that conforms to the agency's SWPPP regulations can greatly improve the facility's storm water practices, if it is enforced.

Land use regulation

In addition to other pollution permitting requirements, a concrete batch plant may be subject to local zoning or land use requirements. While temporary batch plants may have fewer restrictions, permanent batch plants located in a city will generally be limited to certain areas, unless the plant obtains some sort of special use exception or change in zoning. The city land use proceedings may provide the best opportunity for neighbors to actually stop the siting of a new concrete batch plant in their area.

HOW ARE AIR EMISSIONS AUTHORIZED?

Concrete batch plants cannot begin construction of air pollution emitting facilities until the air pollution emissions are authorized by the TCEQ. There are two permitting vehicles for authorizing air pollution from a concrete batch plant: an individual New Source Review (NSR) permit and a Standard Permit. With a New Source Review Permit, the permit terms are written for the specific facility seeking authorization. A Standard Permit is a generic permit that applies to a certain type of industry or operation. Any facility that meets the terms of the standard permit can claim coverage and operate pursuant to its limits. There are two versions of the standard permit.

Neither the individual NSR permit nor either of the standard permits for concrete batch plants supersedes other TCEQ regulatory requirements or requirements of the Texas or federal Clean Air Act.[11] Therefore, theoretically, the holder of an authorization to operate under the TCEQ standard permit may not do so in such a manner as to cause a nuisance. Nuisance operations are prohibited by TCEQ regulation.[12]

Individual NSR Permit

Any size concrete batch plant may decide to seek to authorize its emissions pursuant to an individual NSR permit, but it is the only avenue for large-capacity plants, i.e., plants with greater than 300 yd^3/hr production or 6000 yd^3/day production at one site. In 2012, TCEQ reported that an average of three to four concrete batch plants apply for a conventional NSR permit in any one year.[13] TCEQ data indicate that, at the end of 2017, 249 of 796 permitted concrete batch plants held individual permits.[14]

To obtain an individual NSR permit, Texas statutes require that the facility demonstrate: (1) it will use at least the best available control technology, considering the technical practicability and economic reasonableness of reducing or eliminating the emissions resulting from the facility; and (2) there are no indications the emissions from the facility will contravene the intent of the Texas Clean Air Act, including protection of the public's health and physical property.[15]

In addition, TCEQ's regulations require that an individual NSR permit application:

- Demonstrate protection of public health and welfare, including compliance with all TCEQ regulations and the intent of the Texas Clean Air Act, including protection of the health and property of the public;
- For any facility within 3,000 feet of an elementary, junior high/middle, or senior high school, consider any possible adverse short-term or long-term side effects that an air contaminant or nuisance odor from the facility may have on the individuals attending the school(s);
- Include provisions for measuring the emission of significant air contaminants as determined by the executive director;
- Assure the facility will achieve Best Available Control Technology levels of emissions control;
- Demonstrate compliance with any additional, applicable federal requirements, including: New Source Performance Standards, National Emission Standard for Hazardous Air Pollutants, Hazardous Air Pollutant requirements, Prevention of Significant Deterioration or Nonattainment New Source Review requirements;
- Show that the proposed facility will achieve the performance specified in the permit application;
- Comply with any air dispersion modeling requirements imposed by the TCEQ executive director; and
- Obtain allowances to operate if the facility is subject to a Mass Emissions Cap and Trade Program.[16]

The terms of the individual NSR permit may be crafted to address the particular needs of and risks posed by the plant. Many terms in an individual NSR permit for a plant will mirror those in permits for other plants, but there is no real standardization of terms.

Standard Permits

The second and most-used permitting vehicle is a "standard permit," of which there are two types: (1) the Standard Permit for Concrete Batch Plants and (2) the Air Quality Standard Permit for Concrete Batch Plants with Enhanced Controls.[17]

Standard Permit for Concrete Batch Plants: Texas Health and Safety Code § 382.05195, allows TCEQ to promulgate permits for categories of facilities and to apply the same air emission controls to all plants that are within the defined category. TCEQ can only issue standard permits for "the types of facilities will not make a significant contribution of air contaminants to the atmosphere" and may not authorize "major" facilities through standard permits.[18] There are few legislative requirements for these standard permits, only that the permits be enforceable, be ones the Commission can adequately monitor for compliance, and that the permits require the permitted facilities to use Best Available Control Technology ("BACT").[19]

TCEQ's predecessor agency issued its first standard permit for concrete batch plants in 2000. That permit, now a TCEQ permit, is occasionally amended, most recently in 2012. As of 2012, TCEQ estimated that the average rate of application for coverage under its standard permit was 94 plants/year.[20] The Standard Permit for Concrete Batch Plants covers three types of facilities: (1) permanent concrete batch plants, (2) temporary concrete batch plants, and (3) specialty concrete batch plants. The standard permit is available for any concrete batch plant located at a site producing less than 300 yd^3/hr. The permit has separate requirements for permanent and temporary and specialty plants.

"Temporary" plants are defined to be plants that occupy a particular location for not more than 180 days or until a single project was completed.

The general test of the protectiveness of the standard permits

TCEQ performs "protectiveness reviews" that nominally test whether the terms of proposed and amended standard permits are, in fact, protective of human health and the environment. At its most basic, a protectiveness review models emissions from a plant operating with whatever pollution controls the standard permit requires and disburses the emissions to the property line or off-site sources using a computer-simulation of air flows. There are obviously a number of judgment calls to be made in the course of a protectiveness review: What are the uncontrolled emission rates, how efficient are the pollution control technologies, what are the background meteorological conditions at the "universal" site, etc.?

The 2000 standard permit for concrete batch plants was evaluated using the then-preferred EPA air dispersion model (ISCST3) to estimate the off-site air quality impacts. The restrictions of that permit were applied to hypothetical plants, and the agency modeled five years of atmospheric conditions it felt would be representative of atmospheric conditions anywhere in the state. The agency made a number of what it considered to be conservative or worst-case assumptions for model variables and concrete plant layouts. These are described in some detail in a regulatory guide published by the agency, RG-056, Air Quality Standard Permit for Concrete Batch Plants (December 2000), which is Attachment 1 to this guide.

The Texas-law "property line standard" for PM was the one by which the "protectiveness" of the 2000 standard permit had been measured. The property line standard, however, was considered by industry representatives to be more stringent than required by federal law, and before TCEQ conducted an additional protectiveness review in 2012, TCEQ repealed the property line standard. The 2012 amendments to the standard permit measured protectiveness against EPA's National Ambient Air Quality Standards.

The TCEQ standard permit is quite complicated. The following are only the highlights of the permit.[21]

- TCEQ's application notice requirements, found at 30 Tex. Admin. Code Chapter 39, generally apply to applications for standard permit coverage, but there is a very complicated exception for certain portable concrete batch plants associated with "public works projects."[22] Chapter 39 does not require mailed notice to neighbors of the to-be-permitted plant.
- A TCEQ approval of a registration under the standard permit is required before beginning construction or operation. There are some technical forms associated with applying for the registration, but air quality modeling is explicitly not required to support the application.
- The "site" of a plant includes contiguous or adjacent properties under common control, and a plant includes all the stockpiles and silos and conveyor belts, i.e., all the support equipment.
- Both the permanent and temporary plants are limited to 300 cubic yards of concrete production per hour at a site and to 6,000 cubic yards of production per day at a site. Specialty plants may not produce more than 30 cubic yards of concrete per hour at a site.
- The principal difference in the treatment of the permanent and temporary facilities is that temporary plants may only be on site for 180 days. A temporary plant serving only one construction project may remain on site longer than that. Roads at a permanent facility must be paved with "a cohesive hard surface" to control dust, whereas temporary and specialty plant roads may be watered or covered with such materials as roofing shingles or tire chips to suppress dust. The permit exempts temporary plants closely associated with public works projects from several of requirements that apply to other temporary plants.
- Operators are required to maintain their records on site for a rolling two-year period. Those records are, therefore, available to TCEQ and local government inspectors,[23] but most records are not filed with TCEQ (so, are not readily available to citizens).

- Silos and weigh hoppers (i.e., the hoppers where the concrete components are weighed) are required to have particulate-matter-control systems with fabric or cartridge filters or must be vented to a central baghouse. These filters are to be 99.5% efficient at removing $PM_{2.5}$. A filter that catches $PM_{2.5}$ will catch the larger particles, too.
- Materials conveyor belts have to be covered.
- Concrete haul trucks must be loaded within a 3-sided shroud or curtain.
- Stockpiles have to be sprayed with water or chemicals to suppress dust.
- Multiple standard-permit concrete batch plants may be operated at one site, but the limits on hourly and daily production apply to the entire site. This "at a site" limitation is important as it somewhat limits a proliferation of plants in one area. Similarly, if there are rock crushers, concrete crushers, or asphalt plants on site, there are some restrictions on batch plant operation and location.
- The default rule is that silos, stockpiles, equipment and vehicles (except entering and leaving the site) must be kept 50 feet from the property line. In the alternative, the operator may rely on 12-foot-high barriers and three-walled stockpile bunkers. The exhaust vent for the weigh hopper shroud has to be 100 feet from the property line.

Compliance monitoring is a weakness of the concrete batch plant standard permit. The standard for dust emissions is "no visible emissions." That standard applies at the property line, and it applies to the fabric or cartridge filter systems on site. But, the determination that the standard is met is made using EPA method 22,[24] which is basically that no more than 30 seconds of dusty air are observed in any 6-minute period (for the legislative "enhanced controls" permit, 5-minute period). The operator is required to perform this test only once a quarter, under what are supposed to be normal operating conditions.

The "reportable quantity" for PM, the air contaminant that is most commonly of interest at a concrete batch plant, is 100 pounds per 24 hours.[25] If an accident, such as a ripped baghouse or shroud at the truck-loading drop, results in PM emissions that are less than the reportable quantity, those emissions do not have to be reported at all.[26] The permittee simply has to create a report within two weeks of the emissions event, which is then kept on site.[27]

Air Quality Standard Permit for Concrete Batch Plants with Enhanced Controls

There is a second type of concrete batch plant standard permit that was created by the legislature in 2003.[28] More precisely, the legislature told TCEQ to issue a standard permit for concrete batch plants with "enhanced" pollution controls defined by the legislature.

The terms of the two standard permits are similar, but there are differences. The enhanced controls standard permit is only available for permanent concrete batch plants that produce 300 or fewer cubic yards of concrete per hour at a site.[29] Unlike the other standard permit, the enhanced controls permit allows more than 6,000 cubic yards of production per day at a site. While both standard permits include a "no visible emissions" standard, the enhanced controls standard is measured over a 5-minute, as opposed to a 6-minute, period. The enhanced controls standard permit does not include restrictions related to the co-location of rock crushers, concrete crushers, or asphalt plants on site. The enhanced control permit's record-keeping requirements are much-reduced, as compared to those of operators under the other standard permit. The enhanced controls standard permit also has its own public notice requirements, which include newspaper notice but do not require mailed notice or any posted (sign) notice. On the other hand and unlike the situation with the other standard permit, the enhanced controls standard permit requires a mandatory non-evidentiary public meeting before a registration for the permit may be authorized.

WHAT ARE THE OPPORTUNITIES FOR COMMUNITY INVOLVEMENT?

At the outset, there are two types of non-legislative opportunities for citizens to participate in the air permitting for concrete batch plants.

At the time a registration is sought: First, if a plant operator is seeking an individual permit, members of the public may participate in the permitting proceedings by filing comments, requesting a public meeting, and requesting a contested case hearing. Similarly, when an operator comes forward to seek coverage under the TCEQ-drafted standard permit, anyone may comment as to whether the operator qualifies for coverage under the standard permit, and an "affected person" may pursue a contested case hearing on that point and on the protectiveness of the standard permit, given the facts of the particular situation at hand. The "affected person" definition is limited, as discussed below. If the operator is seeking coverage under the enhanced controls standard permit, the rights of public participation are more limited. There is only a comment opportunity with no right to a hearing.

At the time the standard permit is being amended: Second, members of the public may participate in the periodic amendment of the TCEQ's standard permit. Historically, the interests of neighbors of concrete batch plants have not been well-represented in the various proceedings to draft or amend the TCEQ standard permit. During the 2012 amendment cycle, six representatives of the concrete and aggregates industries filed written comments on the proposed permit. No non-industry representative filed a comment.[30] In early 2003, when the permit was previously amended, one industry representative filed a written comment, and Harris County commented that a concrete batch plant being relocated to support a public works project should give notice to any local pollution control agency that had jurisdiction of the site.[31] In 2000, when the permit was initially drafted, eight industry representatives filed written comments, whereas only one non-industry representative filed comments.[32]

Public Notice of an application

There is no written notice of air quality permit proceedings to neighbors of a proposed concrete batch plant, regardless of air quality permit the operator seeks. Of course, if a neighbor happens to be on a mailing list for all permit applications in a county, that neighbor should receive notice of a concrete batch plant proceeding. If an operator is seeking coverage under an individual NSR permit or under the Standard Permit for Concrete Batch Plants, there is both newspaper and sign-posting notice. The sign-posting notice is not required for the Air Quality Standard Permit for Concrete Batch Plants with Enhanced Controls.

Comments and hearing requests

For an application for an individual NSR concrete batch plant permit, the comment and hearing request rights are the same as they are for any other individual air quality permit. (Note: S.B. 1045 from 2017 created a single-notice system for any individual air permit application for which a draft permit is prepared within 15 days of the initial filing of the application.) The public-notice (i.e., publication and sign posting) and hearing-request requirements for a registration under the non-enhanced controls standard permit are a bit different from the usual requirements.

Because of 2016 rule amendments to these requirements, initiated by the Texas Aggregates and Concrete Association, there is only one notice to the public and, hence, one comment period associated with applications to register a facility under the TCEQ standard permit. This notice is a consolidated notice of both (1) the receipt of application and intent to receive coverage under the permit and (2) the notice of application and preliminary decision by the agency. The consolidated notice is posted at the site and published after the administrative and technical reviews of the registration application

have been completed and the draft permit issued. The consolidated notice establishes a single, 30-day notice period during which comments and requests for a public meeting or contested case hearing can be submitted.[33] (So, note that public meetings, which are not mandatory in order to secure coverage under the TCEQ standard permit, nonetheless may be requested.)

Prior to the amendments, the comment period during which a person had to raise any issue that might be tried in a contested case hearing was only 15 days following the application filing, so the post-amendment rule, which lengthens the comment period to at least 30 days and arises after the application is technically complete and the draft permit issued, can be characterized as an improvement in public participation. The 30-day period begins on the last date of newspaper publication, and the comment period is automatically extended to the close of any public meeting. As required by 30 Tex. Admin. Code § 55.201, issues that might be tried in a contested hearing must be raised in a requestor's timely submitted comments.

For the Enhanced Controls standard permit, there is no contested-case hearing opportunity for anyone opposing an application. There is a required public meeting. The TCEQ has a 35-day time period, following the public meeting, in which to grant or deny the application.

Limitation on "affected person"

While the legislature generally provided limited direction to TCEQ regarding the terms of a standard permit that TCEQ issues, it did limit the opportunities for public participation by limiting the universe of potential "affected persons." In 1985, the legislature provided for a "standard exemption" from permitting for facilities that TCEQ "found upon investigation … will not make a significant contribution of air contaminants to the atmosphere."[34] (Authorization by standard exemption is no longer allowed.) Then, in the same bill, the legislature imposed a limit on the range of people who might be considered "affected persons" and, thus, potential contested case opponents for a standard-exemption concrete batch plant. The limitation stated that the person must reside in a permanent residence within ¼ mile of the proposed plant.[35] In 1999, the legislature added "standard permits" to the set of TCEQ authorizations for which only persons residing within 440 yards (i.e., a quarter mile) might be found to be affected.[36] So, the universe of persons potentially affected by a TCEQ standard permit concrete batch plant is, by law, a limited one.

Limitation on evidence that is admissible

TCEQ's first standard permit for concrete batch plants was issued in September 2000[37] in response to the legislature's 1999 grant to the agency of authority to develop standard permits.[38] TCEQ's action was preceded by a set of studies that attempted to determine the protectiveness of three "standard exemptions" that, prior to 2000, largely provided the regulatory mechanisms for obtaining authorization to operate a concrete batch plant.

The 1999 legislature also passed a second bill, SB 1298,[39] that directly affected concrete batch plant authorizations. Prior to 2000, citizens had started using air dispersion modeling to challenge the granting of concrete batch plant standard exemptions (rule-like authorizations that were then available for certain polluting activities but were less formally developed than is a rule). Would-be operators of concrete batch plants complained that they were being pulled into contested case hearings by affected persons who claimed atmospheric dispersion modeling of plant air emissions showed harmful off-site impacts.

The second 1999 legislative act prohibited the use of atmospheric dispersion modeling in contested case hearings arising from applications for concrete batch plant approval under a standard exemption if atmospheric dispersion modeling had been employed in developing the exemption. TCEQ, "in order to give full effect to the intent of SB 1298," has also barred atmospheric dispersion modeling in contested cases arising from applications for coverage under the newly-created concrete batch plant standard permit.[40] TCEQ took the legislative act applicable to standard exemptions and applied it to the roughly corresponding and newly-created standard permit.

WHAT POSSIBLE BENEFITS MIGHT BE SECURED FOR CLIENTS BY CHALLENGING A CONCRETE BATCH PLANT AIR PERMIT?

Most would-be operators of concrete batch plants opt to get authorization under the non-enhanced controls standard permit. If the operator has chosen an appropriately zoned location, citizens living or working nearby do not have strong leverage by which to protect their neighborhoods. Obviously, neighbors should check the operator's application to TCEQ to confirm that the proposed operation, as described, qualifies for the permit. If the application for a storm water permit has been filed, it is a good idea to check that (particularly the SWPPP) too.

If talking to a would-be operator in order to secure concessions in exchange for withdrawing or refraining from a protest of the facility, below are some "asks" one might consider. Keep in mind that the would-be operator is likely to be more receptive to incurring expenses that do not "front load" the project (i.e., expenses that may be incurred over time as production at the site generates cash flow). Any commitments agreed to by the would-be operator need to be memorialized in special conditions of an individual permit or in a side agreement in the event the permit is a standard permit. One must pay attention to the enforceability of a side agreement; consider how it will be enforced three or six years from now, should today's involved citizens move, for example.

1. Contact Person. Get the name and phone number of a contact person or persons to whom to raise complaints, should any arise. Get a commitment that the phone will be answered by a person during plant operating hours or that the call will relay to a staff person who will find an appropriate person.

2. Dust control. The general permit requires dust control, but it is vague about the details. Get details tied down. For example, the permit does not require any particular schedule of water sprays to control dust or of the particular circumstances that trigger the need to spray; it requires recordkeeping of water spraying, but it does not specify what the records have to contain. It does not require the records be made available to anyone other than state and local government inspectors. Some of these short-comings might be negotiated away by neighbors.

   There may be instances where paved internal haul roads and staging areas are not required by the permit but where the benefits to the local residents sufficiently outweigh the costs to the operator, so pavement is worth negotiating for. It is also possible that a wider buffer zone around stockpiles, hoppers, and staging areas would make a difference. Either the height or construction of barrier perimeter fencing could also be negotiated.

3. Dust measurement. This is difficult. The permit standards for measurement of particulate emissions are not strong. In a perfect world, there would be periodic upwind and down-wind (of the plant) measurements of dust during normal operating conditions, so that the fact of dust emissions and the amount of dust emissions could be quantified. That is a heavy ask. However, it might be possible to negotiate one or two continuous emissions monitoring systems (CEMS) at selected sites in or near the facility that, if nothing else, would alert the operator of the need to spray that area. (CEMS are basically light sources, like lasers, that measure the attenuation of light in a volume of air through which a beam is directed. They can be calibrated to a "visible emissions" or other opacity standard, but the size of the particles and the presence of water vapor makes a difference. So, calibrating a CEMS is not simple.) Most would-be operators will strongly resist any automated dust measurement efforts; there is little or no industry history of this, and there would be both initial and operating expenses associated with automated measurement.

4. Get copies of upset reports. Get copies of reports submitted to TCEQ regarding pollution events at the facility. Get the reports contemporaneously with their submission to TCEQ. Possibly, one could get notice of un-permitted emissions that do not rise to the level of a "reportable quantity" release.

5. $PM_{2.5}$. Diesel engine emissions are the overwhelming source of these emissions from a concrete batch plant site. $PM_{2.5}$ emissions are more dangerous, if less near-term bothersome, than are visible dust emissions. (2.5 microns is about $1/30^{th}$ the width of a typical human hair or about 1/10,000 of an inch.) So, try to get the would-be operator to use electric-drive equipment powered from the utility grid or some non-hydrocarbon source.

6. Hours of operation. Ask for known and more limited than 24x7 hours of operation. Also, define what "operation" means. Perhaps, plant maintenance, for example, could occur outside of "operational" hours. If haul truck idling or even arrival at the site at 5 a.m. is likely, negotiate to forbid that.

7. Lighting. Find out what the plan is for lighting the site and see if you can secure guaranties of down-cast lighting and/or a time of night when almost all lights are dimmed or turned off.

8. Truck traffic. The would-be operator has little control over the routes a concrete truck driver uses to reach and depart from the site. However, signs on site reminding the drivers that people live nearby and urging drivers to avoid shortcuts through the neighborhood may do some good, as may admonitions about speed and not stacking trucks outside the site gates on neighborhood roads.

9. Dispersion modeling. Air dispersion modeling is not legally required in order for the would-be operator to get coverage under the standard permit. Air dispersion modeling can be expensive, because if done well, data has to be collected concerning sources of emissions in addition to the sources on the would-be operator's site. Unfortunately, and in addition to any other criticisms one might have of TCEQ's assumptions when it developed its standard permit, the standard permit does not address the scenario in which there are multiple nearby concrete batch plants that are not owned or controlled by the same operator. Cumulative impacts are not effectively address by the standard permit.

   So, if the site is in a heavily industrial area or is among other nearby concrete batch plants, one could cause the would-be operator to undertake some air dispersion modeling, possibly providing arguments for altering hours of operation or to support enhanced dust (or NOx) controls. If nothing else, such modeling might provide evidence to take to TCEQ to convince the agency its standard permit needs adjustment in some scenarios. (If the applicant is seeking an individual permit, rather than coverage under a standard permit, air dispersion modeling that considers off-site sources will not be required by the agency in most cases; agency-approved screening techniques that are based on the size of the plant seeking the permit will usually mean that off-site pollution sources need not be considered.)

CONCLUSION

Concrete batch plants create environmental hazards and nuisance conditions in many low-income communities. Participating in the permitting or siting processes for these plants can halt construction of a plant or lead to better pollution limits and other community benefits. While the air permitting process for concrete batch plants is complicated, this guide can assist communities in navigating that process to improve conditions in their neighborhoods.

Endnotes

1 The additional chemicals are used to control properties like setting time and plasticity.

2 Amendments to the Concrete Batch Plants Air Quality Standard Permit, TCEQ (2012), p. 3 (Attachment C).

3 TCEQ, Air Quality Standard Permit for Concrete Batch Plants, RG-056 (December 2000), p. 31 of 49 (Attachment A).

4 U.S. EPA, Background Document: General Air Quality Permit for New or Modified True Minor Source Concrete Batch Plants at p. 2.

5 U.S. EPA, Background Document: General Air Quality Permit for New or Modified True Minor Source Concrete Batch Plants (July 2, 2014), p.1.

6 U.S. EPA, AP-42, Sec. 3.4, Tables 34.-1 through 3.4-4 (October 1996).

7 TCEQ, Amendments to the Concrete Batch Plants Air Quality Standard Permit: Summary Document, p. 7, available at https://www.tceq.texas.gov/assets/public/permitting/air/NewSourceReview/Mechanical/cbpsp-finalpreamble.pdf.

8 https://www.epa.gov/pm-pollution.

9 TCEQ's most recent "protectiveness review" for the concrete batch plant standard permit is summarized in two documents. The first is a staff memo that sets out most of the details entitled Concrete Batch Plant Standard Permit Protectiveness Review, by Robert Opiela and dated September 24, 2012, which is Attachment B to this Guide. That memo provides the emission rates that were assumed for the various emission sources at a plant that were modeled. Maximum possible particulate emissions/hour were reduced by 17% (i.e., 4/24), because the averaging time for emissions was calculated based on a 24-hour day, while a maximum rate of 300 cubic yards/hour assumes a plant will operate only 20 hours/day, so that it may remain within the 6,000 cubic yards/day limit. The Opiela memo is summarized in more polished form at pages 8-11 of 29 in TCEQ's Amendments to the Concrete Batch Plants Air Quality Standard Permit (2012), which is Attachment C to this guide. The latter indicates that, using the Opiela memo's emissions rates, total particulate emissions from the plant are either 4.07 pounds/hour or 3.84 pounds/hour over a 24-hour period.

10 The technical test is whether the runoff has contacted industrial activities, and runoff from some structures on site, such as an office building, are not "associated" with the plant, unless they become commingled with runoff that is associated with the plant.

11 30 Tex. Admin. Code § 116.615(1).

12 30 Tex. Admin. Code § 101.4. "A nuisance is a condition that substantially interferes with the use and enjoyment of land by causing unreasonable discomfort or annoyance to per- sons sonsof ordinary sensibilities. Barnes v. Mathis, 353 S.W.3d 760, 763 (Tex. 2011) (emphasis added). Nuisance actions have a two-year statute of limitations, measured from the time a person knew or should have known the condition would substantially interfere with the use of the land. But, the limitations period does not begin simultaneously with the construction of what turns out to be a nuisance-causing project. Schneider Nat. Carriers, Inc. v. Bates, 147 S.W.3d 264 (Tex. 2004)("a landowner has the right to wait and see what the result will be when the improvements are subjected to an actual test"). Gilbert Wheeler, Inc. v. Enbridge Pipelines (E. Texas), L.P., 449 S.W.3d 474 (Tex. 2014), is a more recent case that also discusses when the limitations period begins to run.

13 TCEQ, Amendments to the Concrete Batch Plants Air Quality Standard Permit (2012).

14 The 2017 data were produced as a spreadsheet by TCEQ in response to a Public Information Act Request. The data are doubtless generally accurate. However, interpretation of the spreadsheet entries required that some judgments be made regarding the permit applicable to any individual facility.

15 Tex. Health & Safety Code § 382.0518(b).

16 30 Tex. Admin. Code § 116.111.

17 Prior to 2012, there were concrete batch plants that could be authorized by rule, but new or modified plants may no longer receive authorizations under the permit-by-rule regimen.

18 Tex. Health & Safety Code § 382.05195(i)(2)(a).

19 Tex. Health & Safety Code § 382.05195(a). This section references § 382.0518(a) for the BACT requirement. BACT is not defined in state Statute, but it is defined in federal statute. The federal statutory definition, 42 U.S.C. § 7479(3), is that BACT is an emission limitation, e.g., "X ppm," achievable by various methods and control technologies. TCEQ, until 2010, defined the term in regulation at 30 TAC § 116.10(3) in a circular fashion, as "BACT with consideration given to the technical practicability and economic reasonableness of reducing or eliminating emission from the facility." In 2010, the regulation was changed to be "an air pollution control method" that is technically practical and economically reasonable. 30 TAC § 116.10(1). So, the State definition is of a control method, such as a scrubber, rather than of a level of emissions achieved by use of a scrubber.

20 "Amendments to the Concrete Batch Plants …"

21 Att. C, pp. 19-29, is the 2012 and currently-effective concrete batch plant standard permit, also available at: https://www.tceq.texas.gov/assets/public/permitting/air/NewSourceReview/Mechanical/cbpsp_only.pdf

22 See, 30 Tex. Admin. Code § 116.178.

23 Tex. Health & Safety Code § 382.111.

24 Method 22 is described in more detail in 40 CFR, Pt. 60, Appx. A-7.

25 30 Tex. Admin. Code §§ 101.1(88) and (89)(A)(ii).

26 30 Tex. Admin. Code § 101.201

27 30 Tex. Admin. Code §§ 101.210(b) and (b)(2).

28 Acts 2003, 78th Leg., ch. 361, § 3, codified at Tex. Health & Safety Code §§ 382.05198 and 382.05199. See, https://www.tceq.texas.gov/assets/public/permitting/air/NewSourceReview/Mechanical/cbp_ec_reqs.pdf.

29 The site-based limitation is one added by the agency. The legislature's statute included only a 300 yd^3 per hour per plant limitation.

30 Amendments to the Concrete Batch Plants Air Quality Standard Permit, TCEQ (2012), p. 12.

31 TCEQ RG-056 (July 2003), p. 2. This is Attachment 2 to this guide.

32 TCEQ RG-056 (2000), p. 21.

33 30 Tex. Admin. Code § 55.152.

34 Acts 1985, 69th Leg., Ch. 637, § 26. This was derived from SB 725. It amended § 3.27 of art. 4477-5, which was at the time the Texas Clean Air Act.

35 Acts 1985, 69th Leg., Ch. 637, § 26.

36 Acts 1999, 76th Leg., Ch. 406, § 7. This was derived from SB 766. The limitation is today at Tex. Health & Safety Code § 382.058(c).

37 TCEQ Regulatory Guidance RG-056, December 2000, p. 1 of 49. (In an apparent typographical error, the page is marked as 1 of 58, but subsequent pages are marked, 2, 3, 4, etc. of 49.)

38 Acts 1999, 76th Leg., Ch. 406, § 5, codified at Tex. Health & Safety Code § 382.05195.

39 Acts 1999, 76th Leg., Ch. 391, § 1, codified at Tex. Health & Safety Code § 382.058(d).

40 TCEQ, Air Quality Standard Permit for Concrete Batch Plants, RG-056, p. 1 of 49.

Exhibit 12



Exhibit 13



Exhibit 14



Exhibit 15



Exhibit 16



Exhibit 17



Exhibit 18


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April 15, 2020

American Fork City Planning Commission
c/o Adam Olsen, Senior Planner
via email:aolsen@afcity.net

RE: Roderick Enterprises opposition letter dated April 6th 2020 towards American Eagle ready mix site plan application.

Dear Members of the Planning Commission,

It is with heaviness that I am finding myself responding to such opposition that Mr. Roderick has expressed. I am going to be responding in line with each "complaint" as they are mentioned in Mr. Roderick's letter of opposition. It is with great desire that I may express in writing the facts and logic that need to be expressed at this time, as well as answer some unknowns or questions that have been asked.

Mr. Roderick first indicates that his 3 properties here in American Fork generated $315,000 in property tax for the citizens of American Fork in 2019. Ladies and Gentlemen this is not the case the city taxes that were kicked back were $66,003.47. I took those amounts directly from the Utah County Land Records tax notices. All of us are aware that our property taxes are distributed to many entities. American Fork City only receives 20.31% of our property taxes that we pay. This sheds light to the claims of that Mr. Roderick's Catalyst Business Park will generate 1.2 million in property tax is inaccurate.

It is mentioned that the Park will eventually employ 3000 people. I don't feel that Mr. Roderick can possibly gauge how many jobs will be provided as it is unknown as to what kind of companies will lease or buy office/warehouse space within the Catalyst Business Park nor is it possible to say that the buildings will always be occupied. It goes without saying that American Eagle as well as all the other surrounding businesses in the existing Lakeside Industrial Park also provide employment, a steady employment.

City requirements are indeed set to make improvements in the area. Roderick Enterprises is not bearing those improvements solely. We here at ESP Excavation are too making

improvements in fact nearly all improvements that Roderick's have indicated they are doing are in conjunction with the improvements that we have already made or will be making to improve our subdivision Phelon Lakeland that sits south of Catalyst Business Park as well as our current location that we have run our Excavation business out of for 21 years that sits East of said Roderick property. For example, when Lakeside Industrial Park was built 21 years ago, we burdened the cost of the sewer and road improvements on 500 East and the intersection of 1500 South and 500 East. The widening of 500 East that is mentioned is very minimal as it is to simply tie in the west curb gutter and sidewalk because 500 East is already at current width standards. ESP Excavation has made many attempts to work in conjunction with Mr. Roderick regarding all the improvements that surround the group of us. It is also known to all as it is public record found in the minutes of the February 21, 2020 City Council Meeting that the City is set to reimburse Roderick Enterprises for substantial portions of the said improvements to the tune of $1,094,870.29.

The accusations that American Eagle blatantly disregarded city requirements is preposterous. American Eagle is buying the piece of property that their machine currently sits on. This is not a building it is a piece of machinery. The land that they are on does have a land disturbance permit intact under our name, ESP Excavation as is it necessary to stabilize the property before any buildings can be built. The crusher and pile of concrete that Mr. Roderick has referenced in his letter of opposition is in conjunction with that stabilization as we are recycling the concrete waste to stabilize the ground. That stabilization process is not American Eagles doing nor are they tied to it in any way. Nor is there a truck repair facility anywhere on the radar for any piece of property owned by Phelon Lakeland or ESP Excavation. Furthermore, ESP Excavation does indeed have a SWPPP in place and are under inspections from the city. All the studies that Mr. Roderick claims to not have been done have indeed been done by proper professionals hired by ESP Excavation as the landowner.

Mr. Roderick is making accusations that American Eagle will pollute the air, Utah Lake, and irrigation water. This is a very bold accusation as well. Especially that of him encouraging to visit a batch plant at 5-6am. Never are there 50-100 concrete trucks lined up. Businesses such as ready mix and aggregate companies stagger trucks because if trucks are lined up in such a manner, they are wasting money, it is not economical to pay fuel for trucks or wages for drivers to wait to be loaded. What is more baffling than anything as to the accusations and opposition which Mr. Roderick is making is that he himself is a huge consumer of concrete products and building materials. In fact, on Tuesday, April 14, 2020 Mr. Roderick himself had ready-mix trucks, equipment, and pump trucks lined up idling to provide ready-mix for his project. I have attached pictures of this, so you don't have to go visit the plant or projects. This is just one of hundreds of concrete pours that will take place for not just this project of Roderick Enterprises but for his future projects as his buildings are full concrete shells as well. It is mentioned that the traveling of ready-mix trucks will have a negative affect on our city streets. The area in which this I-1 zoning is placed in American Fork could not be more ideal as it is less than a mile to the interchange. Mr. Roderick expresses that the trucks will damage already poor roads. My question is this, "If Mr. Roderick is genuinely concerned for the citizens, roads, etc. of American Fork why is it that Mr. Roderick's project is having concrete supplied out of Salt Lake County traveling many miles damaging the roads between the

suppliers and his project when Alta View Concrete batch plant is ½ a block from his project and would not have to drive on any asphalt streets to access his project?" Not to mention if he is again concerned about giving American Fork City tax revenue why is he not buying his concrete right here locally so that the sales tax is actual beneficial to American Fork City? To take the concerns for the roads further, Alpine School District has 300 buses that travel in and out of this same area 180 days a year. The surrounding warehouses and businesses including the existing properties of Mr. Roderick's and the current project that is being built does and will continue to have hundreds of 18-wheel semi's in and out of each warehouse every day.

Mr. Roderick has brought up that the concrete recycling is a trash dumping receptacle. Recycling is an essential to all our future in every sense. In fact, American Fork City had approached ESP Excavation with the option to have a transfer station brought in from a neighboring city as well as an irrigation holding pond just south of the very property that American Eagle is proposing as their batch plant property. Every city must have some maybe not so desirable companies or facilities. Without facilities such as Tri State Tires, Rock Canyon Oil, Southam and Associates, Alta View Concrete, ESP Excavation, Inc., and R & D Excavation, all of which were in place and surrounded Roderick Enterprises property prior to him purchasing it and now the possibility of American Eagle Ready Mix what Mr. Roderick does for a living would not be possible, building for anyone would not be possible. There is a reason companies such as American Eagle and the others I've included are considered essential businesses at this time of uncertainty in the world. We are essential because our homes and businesses need excavation for utilities and such, concrete, siding and roofing, our roads need excavation, oil, and concrete, our vehicles need tires and oil. These businesses and facilities are crucial even to Mr. Rodericks future.

Ladies and Gentlemen, I encourage you to truly look and see that preventing companies and facilities such as American Eagle from moving forward and growing a business that there is such a huge shortage in, would cause delays of not just your own personal necessities but our communities. The availability of ready-mix products in our industry is currently back logged often 2 days or more at a time holding up projects such as schools, churches, homes, utility installation, and city buildings from moving forward to meet deadlines. American Eagle is needed just as much as the next mans business such as perhaps a Roderick warehouse that ships paper products. There is truly a difference between being genuinely concerned for our community and being concerned for ones own personal gains. If I may, the definition of Community is a group of people living in the same place or having a particular characteristic in common. A feeling of fellowship with others as a result of sharing common attitudes, interests, and goals. Now is the time to see the existing community of the I-1 zoning here in the location that is in question has worked together without conflict or complaint in harmony with one another in order to actually benefit the city of American Fork by generating tax revenue and providing essential supplies and building materials to its residents since 1999 when Lakeside Industrial Park was built. ESP Excavation as well as R & D Excavation have felt pressure as Roderick Enterprises has tried to push out and bully them rather than work in harmony with them. Today is the day we stand as a community and continue to be long time hometown businesses.

It is my hope that I have not only given you some insight as to what I feel voids the complaints Mr. Roderick has voiced but has also brought to light some factual truths that has been twisted and falsified. The property Mr. Roderick purchased was already surrounded by I-1 zoning with commercial and aggregate materials companies occupying the properties around him. Even as much that R & D Excavation who also screens soil, repurposes haul back concrete by manufacturing blocks, as well as running an excavation company sits directly in the middle of the Catalyst Business Park. Lastly I would like to point out that American Fork city is an area of 6,880 acres, of that area there is only 75 acres zoned I-1 that is less than 1/10th of 1% of area that is zoned I-1 meaning that 99.99% of American Fork City is zoned anything other than I-1. American Eagle is a perfect fit for this very minimal section of I-1 zoning of American Fork City and will truly bring benefits to our community through sales tax revenue. There is no better place in American Fork for the essential construction companies of our future. We are tucked away from housing, close to the interchange and grouped together with like minded businesses to provide to all.

I appreciate your time and consideration regarding my concerns and views and look forward to continuing our working relationship with the city of American Fork and its residents.

Sincerely,

Elizabeth Phelon
General Manager
ESP Excavation, Inc.

Attachment; 4

April 16, 2020

American Fork City Senior Planner, Adam Olsen
American Fork City Planning Commission

email; solsen@afcity.net

Re: McDonald Fielding letter dated April 6, 2020
Roderick Enterprise letter dated April 6, 2020

Dear Mr. Olsen and the American Fork City Planning Commission,

American Eagle Ready Mix (AERM) was made aware and given copies of the documents from Roderick Enterprises (RE) and McDonald Fielding (McF) the day after the planning meeting on April 8, 2020.

AERM does not have an issue with others having their own opinion. However, we believe the information is misleading and inaccurate with many their facts and feel it necessary to give the actual facts and defend all the businesses in the I-1 zone.

The American Fork City Master Plan intended and planned this general area as I-1. The existing business within the I-1 zone comply and meet the intended use of this land. All business that currently exist, ready-mix producer, topsoil screening, recycle crushers, landscapers, oil and fuel distribution were planned that way due to the location. The transportation is close to and from the interstate. It is not near residential subdivisions, schools or churches. The business operates in much the same way. It is a great location for the intended use. See AERM Exhibit - 3

The Lakeland Business Park was developed originally work with American Fork City. The city wanted to move a business not located in the city into this park to set up and operate a transfer station for waist products and build an additional pond for storm water retention. In the beginning of this process the city manager was introduced to AERM. He was aware that we wanted to put a ready-mix plant in the Lakeland development. His words, “That is a perfect place and use of this land”. It is my understanding from city and the landowner that the best way to handle the development was to annex it from Utah County into American Fork City. My understanding again, that is would be zoned I-1 zone to ensure it was suitable for its intended use as a waist transfer station, topsoil screening, recycle concrete and put the ready-mix plant there. The I-1 zone is the same as the adjoining properties. This would allow other like existing business (ready-mix, concrete recycling, topsoil screening) into the park. From the beginning the city was aware the intent of this property was to install a ready-mix plant.

The property RE is developing for warehouse and office space was I-1. RE chose to change the zoning with the intent to change all the other companies around him. Business in the general area, in the American Fork I-1 zone and operational at the time of the change were the sewer plant, landscape and landscape materials, several concrete recycling, precast, topsoil screening. RE made several attempts last year to shut down other business in this area without success. I believe I was at

a Planning Commission meeting, that the members of the commission told Mr. Roderick, in my words, “stop trying to bully others to get your way”.

If these so-called construction experts were genuinely concerned with anyone but themselves, they would be buying local concrete from the existing ready-mix supplier, Altaview Concrete, which is in the I-1 zone, 600 feet from the entrance of the RE property? Additionally, they would be strategically working with the recycle and topsoil companies (ESP and D&R) next door to them for their engineered fill materials, road base and landscaping products. All are examples that would economically benefit RE as an owner, the local companies and American Fork City in keeping tax revenue local and improving the economic wellbeing of the city.
All the products that are local (concrete, engineered fill, road base, topsoil) are needed in most if not all construction projects. Ready-mix is the #1 building material in the world. The largest and most used material in RE products is concrete. See AERM Exhibit - 1

The remainder of my response will attempt to address page by page responses for the two documents. I believe it will explain the intent and use of the property and answer or dispute most in not all the misleading, malicious, factually inaccurate and attempt to bully others by RE.

Specifically, with regards to the RE document – Letter to Planning Commission April 6, 2020:

RE – P.1

1. RE boasts of his success. That does not excuse him of bullying and his attempt to mislead? The fact that there are several companies in the I-1 zone today and currently operating within the RE projects boundaries - 30’, across the street and 600 feet from and existing ready-mix company, Altaview.

RE – P.2

1. The neighbors RE fails to mention are the existing neighbors, (in the middle of his project, west side and east side) within the same zone, who are currently adding to the economic good of American Fork. Companies such as the oil refinery, fuel / oil distribution facility, outdoor landscape, outdoor hardscape material supply, Concrete / ready mix production facility, several topsoil screening facilities, several concrete crushing and recycling facilities and precast concrete manufacturing. See AERM Exhibit - 3
2. AERM is has been working and will continuing with the city to get our site plan approved.
3. AERM does not have 100’s of trucks. Nor do they intend to at this location.
4. RE fails to mention that his project will have 28 bay doors and 38 parking stalls for semi-trailers along with 28-+ forklifts for each warehouse? How do they move in and out daily without the same concerns, vibration, dust, noise, vapors, noxious odors, smoke, glair?
1. All cities across the Wasatch Front uses concrete. There are an estimated 37 ready mix plants in this region. 70% of them are in a city and not in a pit. See AERM Exhibit – 2. This is for several obvious reasons. First being safety. There would be several hundred more ready-mix trucks on the road. In turn it would drive the cost of the product up to so customers like RE could not afford to build. However, this does not address the fact that the concrete

quality, specification put out by engineers and overall shelf life of concrete. No one could build unless they were close to the pits. Which in turn would create this whole process over again.
2. We must all work together to co-exist. I will do my part, if you do yours. It's hard to imagine the money being thrown away and tax dollars lost because of the RE arrogance?

RE – P.3

1. The landowner owns a piece of property in the I-1 zone. Currently there are other concrete recycling facilities in operation. The neighbor RE continues and fails to mention is R&D. Who sits directly center of the RE project? R&D and Altaview Concrete have a working together to take all the Altaview comeback concrete and spoils generated at their plant to be recycled. See AERM Exhibit – 5. This is a great partnership which is good for both companies, intended for companies to work together in the I-1 zone and good for the economic wellbeing and broadens the tax base for American Fork. It was intended to work that way.
2. AERM is not going against the city's master plan. We fit in it and its intended use. Just as similar other companies do.
3. It is funny that RE brings up trash. In the very beginning of this venture, early 2019, American Fork City was approached to provide a great location to move an existing waist transfer station from a neighboring city to American Fork. The city approached Lakeland development to provide this site. Along with the transfer station there was to be a storm water pond. At this point the city manager knew we were also going to put the ready- mix plant in. There was never a question as the city was aware and there is an existing ready-mix producer next door in the same I-1 zone. See AERM Exhibit - 3
4. The rezoning of the shoreline was done for the intent of American Fork City to broaden their tax base by adding more I-1 zone land in the intended area to do so.
5. AERM is operating and intends to operate within the guidelines of its industry and American Fork City.

Specifically, with regards to the McF document – Letter to Planning Commission, April 6, 2020

Exhibit 19 - P. 1

1. AERM does not own a crusher, nor did they contract anyone to crush concrete, nor did we contract anyone to construct a truck repair facility, nor were the same parcel of land a AERM, nor would anyone McF talk to know anything about AERM or its plans.
2. All plant footings installed were in place prior to the annexation into American Fork City. All plant footings were built to specification using the Geotech report stamped by an engineer, stamped engineered drawings for footings, third party inspection agreement, third-party inspections with complete reports of all process from excavation, fabric, backfill material, compaction, rebar inspection and concrete inspection. Bolting together our machinery is not a permitted construction process.

Exhibit 19 – P.2

1. It would be very hard to argue that the existing sewer plant, oil refinery, fuel / oil distribution facility, outdoor landscape, outdoor hardscape material supply, Concrete / ready mix production facility , several topsoil screening facilities, several concrete crushing and recycling facilities and precast concrete manufacturing are not similar / like in nature. These all are current and operating companies in the I-1 zone. They all meet the intended use as per American Fork City. See AERM Exhibit – 3
2. AERM does agree when possible, ready mix can be more profitable when located at the source. Not just in ready-mix, transportation cost is a significant factor to the profitability of any company. Additionally, companies that have production within their sources, are also faces with importing products because not all sources create all the correct materials. Across the Wasatch Front, from Brigham City to Santiquin, and Park City to Tooele, there are approximately 6 ready-mix producers. With an estimated 37 ready mix plants; 70% of them are in the city vs pits. See AERM Exhibit - 2

Exhibit 19 – P.3

1. AERM does not own a crusher, nor did they contract anyone to crush concrete, nor did we contract anyone to construct a truck repair facility, nor were the same parcel of land a AERM, nor would anyone McF talk to know anything about AERM or its plans.
2. All plant footings installed were in place prior to the annexation into American Fork City. All plant footings were built to specification using the Geotech report stamped by an engineer, stamped engineered drawings for footings, third party inspection agreement, third-party inspections with complete reports of all process from excavation, fabric, backfill material, compaction, rebar inspection and concrete inspection. Bolting together our machinery is not a permitted construction process.
3. The south west quadrant of the site is not owned by AERM. It has an approved land disturbance permit to allow ESP who will recycle the material into topsoil and engineered fill.
4. The shroud the McF expert talks about is for a dry process plant. While they are good plants, they are not the wet / premixed plant AREM has. Additionally, the AERM plant has over 6 filter systems along with a central dust collector. All are sized sufficiently for the production the plant was designed for. They are appropriate for our use. They are an industry standard. They are the same as other ready-mix producers as well as the ready-mix producer located within this same I-1 zone. Most so called experts would know this simple process?
5. This zone was intended for the use as indicated by its current business.
6. AERM is working with American Fork City and its planning and building departments.

Exhibit 19 – P.4

1. AERM works with an independent air quality consultant and directly with the Division of Environmental Quality (DEQ). In all cases we have provided the requested information in spread sheets provided to them. In the estimate by our consultant and DEQ came up with

the same answer. I had a phone call meeting directly with them to go over the calculation and site plan. In the fact that we do qualify for the small source and meet all regulations and requirements and conditions. AERM did not fill in the DEQ form report in McF exhibit. In the AERM spread sheet, 30 cyph indicates the average amount of sand alone, or the average amount of aggregate alone delivered / hr. Once again, most so called experts would know and could read this simple process? I am guessing the experts are calling AERM, our consultant and DEQ liars? In the AERM spread sheet it qualifies that the calculation presented are accurate and we comply per DEQ. Additionally, See AERM Exhibit – 10, It clearly state that we have an air quality permit and it is ultimately upon AERM, the user, to comply as is with any operation and air quality permit.

2. The MP 11 plant has been produced by Erie Strayer for years. The comments from McF are misleading. In fact the MP 11 can be built in many configurations. Like cars, many cars can be built for stock or built to be a race car. In the current configuration AERM should expect 180 cyph. Enough to get our trucks out in a timely manner and average 60 cyph for the remainder of the day.
3. Our trips per day in our ready-mix production will be estimated at 60+-. I am guessing much like the current existing ready-mix operation and like the recycle loads and similar to the topsoil loads. Probably like the semi load coming and going in the RE business park as well. Please also note, that the Alpine School District has their bus maintenance and parking facility just down the street from the RE project. There will be several hundred (300 busses parked at this facility) round trips, in and out, up to 2 times per day generated without students aboard. See AERM Exhibit - 6

Exhibit 19 – P.5

1. AERM does have a storm water and wastewater plan. It is in our agreement with Timpanogos Sewer District, provided to the American Fork City Engineer. We will not be tied into any storm drain system at all. We will contain all our water in water retention and recycle the water in our production process as well as recycling process we participate in.
1. Our operational does not generate any more or less air born contaminants than any of the existing business listed in item 1 above. In our industry we all must keep BMP in play and do our part. Just as all the other companies currently do. AERM has purchased the best equipment and implemented BMP's.
2. The McF experts did not disclose that it is building around 3 sides of an approved existing I-1 zone business who crushes concrete, screes topsoil and generates pieces of precast concrete? They accept 100% of the come-back concrete for to recycle generated by another existing I-1 zone business the ready-mix producer. See AERM Exhibit – 5, 3
3. It is the believe of AERM that all the business within the zone in this corridor of American Fork City are working very well together to maintain the I-1 zone requirement and to generate a positive impact for the city and their residents.

Exhibit 19 – P.6 - Summary

1. AERM is not any different than all the other approved and existing business with in the I-1 zone

2. The recycling mentioned is not AERM or hired by AERM. However, currently there is recycling going on in the center of the RE project that they failed to mention.
3. AERM has invested in all the BMP's available similar to all the other approved business in this zone. In fact, they did not look very hard. The dust collector and loading boot is on the ground in the southern portion of the parcel.
4. The report attempts to mislead. There has never been any communication by AERM to only load 30 cyph of ready-mix? This is MSFs words. We have been in full disclosure as to what our intent is. The plant is sufficiently to load the intended annual production.
5. With any DEQ permit, it is the requirement of the producer to properly maintain its facility properly, keep all working items in its proper working order and to have all the necessary report available to the DEQ anytime they request or come onto the property for inspection.
6. Wastewater has been addressed and will be recycled and used in several production items to manage and properly process.
7. If RE builds it project around a I-1 producer there is not much they can say? Stating the obvious that all I-1 producers are required to properly conduct business. Just as RE is required to do.
8. The approval needed after the annexation are in the process and AERM has been working diligently with American Fork to get approval so we can move forward.
9. Again, words from McF are inaccurate and misleading. AERM has never, nor can we physically produce 300 cyph. AERM has surrounded itself with existing like business; sewer plant, oil refinery, fuel / oil distribution facility, outdoor landscape, outdoor hardscape material supply, Concrete / ready mix production facility , several topsoil screening facilities, several concrete crushing and recycling facilities and precast concrete manufacturing are not similar / like in nature. These all are current and operating companies in the I-1 zone. They are all located in this location and are hereby the design of the city planners. Their business is intended to be here to positively impact promote the economic well-being of the people and broaden the tax base.

P.7 – Exhibit A – Keith Sorensen (KS)

1. AERM did not flagrantly and deliberately break American Fork City policies. As noted above; All plant footings installed were in place prior to the annexation into American Fork City. All plant footings were built to specification using the Geotech report stamped by an engineer, stamped engineered drawings for footings, third party inspection agreement, third-party inspections with complete reports of all process from excavation, fabric, backfill material, compaction, rebar inspection and concrete inspection. Bolting together our machinery is not a permitted construction process or breaking the law.
2. It cannot be against the law to have a ready-mix plant in the I-1 zone, as there is a current and already approved ready-mix business within the zone. See Exhibit – 3, 4
3. KS did not consider that his Everyone thinking of building around an I-1 zone business and not expecting the daily operations of I-1 approved business and expecting everyone else to change is being a bully. See AERM Exhibit - 3
4. The DEQ reports and all their approval were based on accurate numbers.
5. KS and RE are building their project in an I-1 zone. All businesses, existing and to come, will have to comply with the I-1 zone. The city meant to place them all here in this location.

6. KS continues to mislead and make untrue statements. The existing business with in the I-1 zone are not going to kill anyone per KS.

P.8 – Exhibit A – Keith Sorensen (KS)

1. It is hard to deny the intended use? There is another ready-mix operation and currently existing like business in the I-1 zone next to the RE project. See AERM Exhibit – 3,4,5,9
2. AERM has not placed any recycling facility on their property. However, the RE project is build around 3 sides of an existing and approved recycle crushing business.
3. It is a requirement of all ready-mix producers to operate cleanly. There are guidelines already put in place for by the DEQ for this. AERM is in compliance.
4. AERM will operate just as all the other existing and approved business in the I-1 zone. They are all placed here for a reason. We all comply with the noise, vibration, smoke, odor, dust or fumes. AERM currently operates, mitigates, has BMP's in place to mitigate and manage its operation in a professional manner.

P.9 – Exhibit A – Keith Sorensen (KS)

1. KS continues to mislead and misrepresent the facts. AERM will operate just as all the other existing and approved business in the I-1 zone.
2. The RE project surrounds an existing recycle crushing, topsoil screening and precast operation. In addition to that, the RE project will have the same standard semi-trucks bringing in and taking out products and forklifts generated by the warehouse businesses every day. The KS statement of "royalty" is once again the RE team being a bully to somehow get their way? See AERM Exhibit – 3,5,7,8,9

P.10 – Exhibit B – McDonald Fielding (McF)

1. It would be very hard to argue that a sewer plant, oil refinery, fuel / oil distribution facility, outdoor landscape, outdoor hardscape material supply, Concrete / ready mix production facility , several topsoil screening facilities, several concrete crushing and recycling facilities and precast concrete manufacturing are not similar / like in nature. These all are current and operating companies in the I-1 zone. They all meet the intended use as per American Fork City. They are not illegal?
2. The intent of the zone has already been established and defined by the existing business.

P.11 – Exhibit B – McDonald Fielding (McF)

1. The AERM ready-mix plant is planned in a zone that meets the intended I-1 uses. By definition and by similarities. There are other like companies and uses within the same zone in the same vicinity. The production of concrete is a manufacturing process of putting several raw materials together. Our process are the exact same as an adjacent operator who is currently operating.
   Specifically addressing:

a. Noxious odor - The manufacturing of concrete does not present or put off a noxious odor that is known or that in not typical by the existing sewer plant, mulch in landscape yards, ready mix plant, recycle crusher, topsoil screen or the trucks need for all these types of business to conduct business.
b. Smoke - The manufacturing of concrete does not present or put off any smoke that is known or that in not typical by the existing sewer plant, mulch in landscape yards, ready mix plant, recycle crusher, topsoil screen or the trucks need for all these types of business to conduct business.
c. Noise – The noise of manufacturing concrete are typical noises that already exist in this I-1 zone. Weather it by an existing ready-mix plant, recycle crusher, topsoil screen or the equipment and trucks need for all these types of business to conduct business. AERM has taken several precautions to mitigate noise by setting the plant back as far as possible from the frontage, 300'. The frontage perimeter wall / concrete fence will block noise. Currently it is planned to be 6', with the approval of the city we could increase that to 8'. Our shop and office building will be built between the plant and the frontage which will also act as a noise barrier.
d. Vapor - The manufacturing of concrete does not present or put off vapor. When we heat water, we emit steam from a 99% efficient natural gas burner. There is little to no emission and the steam evaporates. AERM has the same water heater as the existing ready-mix supplier in this I-1 zone.
e. Vibration - The vibration generated in the manufacturing process if any are not rhythmic or constant. If any vibrations that are created, they are typical vibrations that already exist in this I-1 zone. Weather it by an existing ready-mix plant, recycle crusher, topsoil screen or the equipment and trucks need for all these types of business to conduct business. AERM has taken several precautions to mitigate vibration by setting the plant back as far as possible from the frontage, 300'.
f. Glair - The manufacturing of concrete does not present or put off any glair that is known or that does not already existing from the ready mix plant, recycle crusher, topsoil screen or the trucks for all these types of business to conduct business.

Addressing all of these items above, AERM feels it has and will continue mitigated these situation just as the sewer plant, mulch in landscape yards, ready mix plant, recycle crusher, topsoil screen or the equipment and trucks need for all these types of business to conduct business and that these conditions do not create conditions which is harmful to the persons or which is readily discernable beyond the boundary of the zone or create an adverse visual impact readily discernable from the public roads

P.12 – 14 – Exhibit B – McDonald Fielding (McF)

1. Cement Manufacturing – This is that McF is ignorant and does not know the difference or they will say and try anything to maliciously hurt AERM. Most so-called experts would definitely know the simple distinction between cement and concrete or ready-mix? AERM does not manufacture cement and does not have a cement plant. AERM produces ready mix. There are 2 cement manufacture in Utah. Holcim Cement; located near Morgan Ut and Ashgrove Cement; located in Leamington UT.

2. Are we all to believe what McF has listed here? Concrete is the most widely uses construction material in the world. As a producer we must comply with the regulation set in place. Technology has significantly improved, and BMP's are in place for this reason. See AERM Exhibit – 1. RE uses quite a bit of it.
3. Are we also to believe that producing and pouring concrete if bad for everyone but RE? See AERM Exhibit – 1. Early morning pour on 4/14/2020. This is an example of talking out of both sides of their mouths. Additionally, if they would have used the local supplier, from American Fork, with in 600' of their entrance, they could have used 4 – 5 total trucks round trip into their project and generated several thousands in tax generating revenue.

P. 14 – Exhibit B – McDonald Fielding (McF)

1. Portable plants used for highway construction, in their FHWA example are not the same as a permanent plant.
2. Once again the noise RE keeps talking about is similar to all the current operation including the R&D Recycling operation that RE is building on 3 sides.
3. RE will generate noise with semi loads of production brought in and out of their project into its 28 bay doors and 38 trailer stalls.
4. RE has also failed to mention that most if not all warehouses will utilize a forklift. Forklifts in general generate noise, exhaust and vibrations with the walls of the office warehouse they are building?

P. 15 – Exhibit B – McDonald Fielding (McF)

1. As noted in previous responses, the I-1 zone allows for like companies. These companies produce products that all have outdoor storage. Topsoil, structural fill, recycled road base, washed rock and sand, bark, mulch and several other landscape products. Most if not all of these products RE project is building ar See AERM Exhibit – 3, 4 – Approved ready-mix producer currently operating in the S-1 zone.

P. 16 – Exhibit B – McDonald Fielding (McF)

1. The placement of the RE project is already impacted by its location to begin with. RE project is being built surrounded with like I-1 business. Including one that is withing his own project? See AERM Exhibit - 3

P. 17 – Exhibit B – McDonald Fielding (McF)

1. AERM operates it companies just as all the rest of the ready-mix companies in Utah. We all must comply with the regulations. We all meet them and work hard to do so. All construction projects from residential, subdivisions, commercial, city and DOT work uses concrete. It is the number one building material used in the world. It is not practical to have all the supply companies in aggregate pits for several reasons. First being safety. There would be several hundred more ready-mix trucks on the road. However, this does not address the fact that the quality, specification put out by engineers and overall shelf life of

concrete will not allow it. No one could build unless they were next to the pits. Which in turn would create this whole process over again.

In conclusion it is apparent that the RE team is only giving the Planning Commission false facts of the true reality. In most cases, their so-called experts do not know the ready-mix. The fact that if they did not want the neighbors they have currently, even without AERM, they building in the wrong piece of property. More so, RE changed the originally zoned I-1 to P-1. Knowing the property surrounding a I-1 zone manufacture. RE has tried his bullying tactic with several landowners surrounding him. The perfect analogy of this is: “The arrogant rich man who builds his mansion in a trailer park, bully’s its existing tenants and expects them to vacate”?

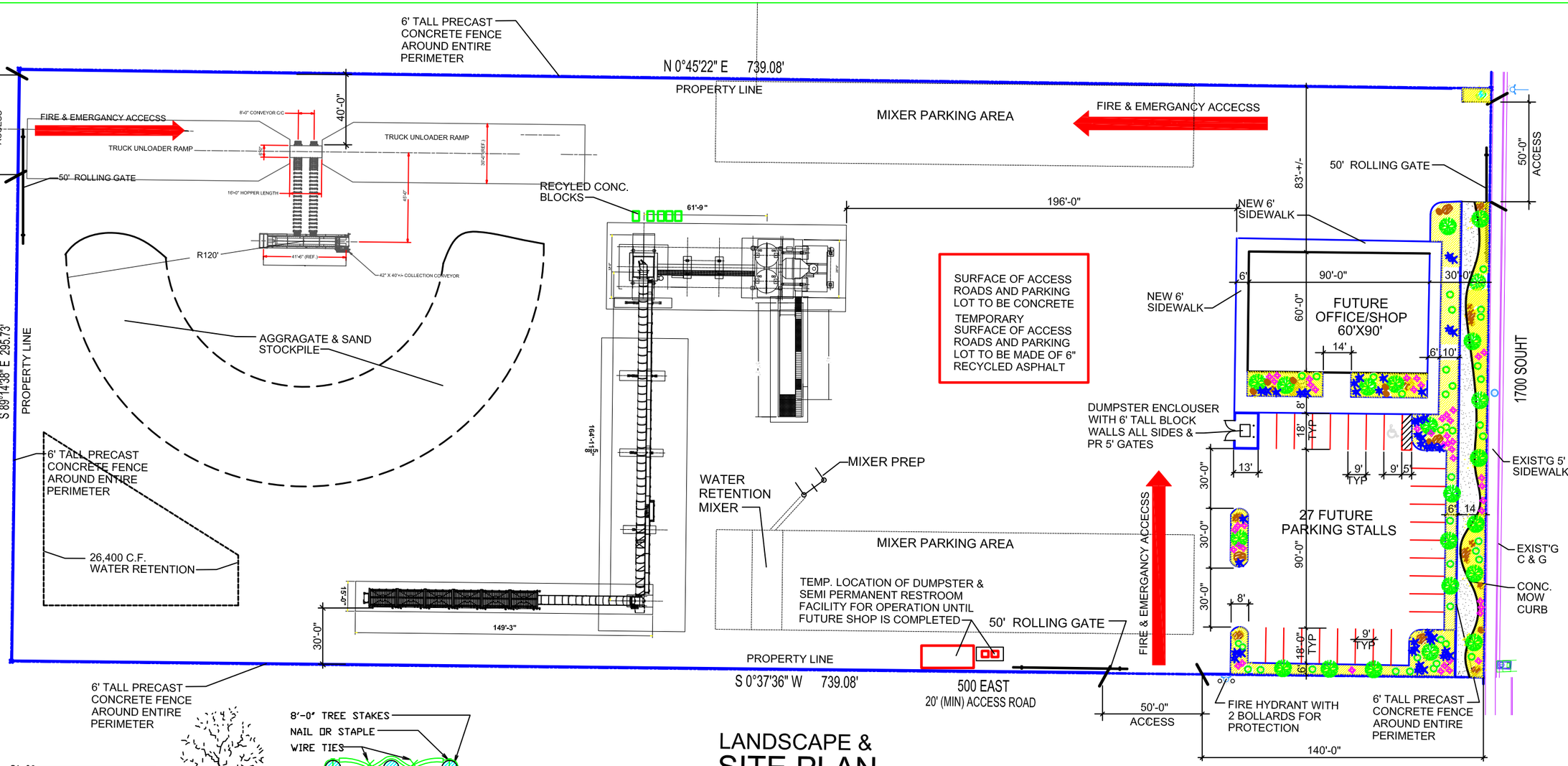
American Fork City is a great place to do business. It has developed its planning zones appropriately. AERM fits in the I-1 zone just as all the other existing companies do. The RE project uses all the products that surround them but has chosen not to do business with them and not help the overall good of American Fork? This leaves us all to believe that what is good for them is not good for the rest of us? Furthermore, RE should not be allowed to bully the existing companies that have been in American Fork providing economic opportunity for the city and its residents much longer than he has? If we do not squash this now, we can expect RE to continue to bully its neighbors, in the center, to the west and to the east. Additionally, the true frontage of the RE property is 1500 S, not 1700 S, are we to expect the all to be bullied? In the RE conclusion it appears as though they have threatened to bully American Fork City as well?

I apologize for the redundancy in my response. However, it seems as the two documents continually said the same thing over and over, to bully and possibly wear us out?

Respectfully,

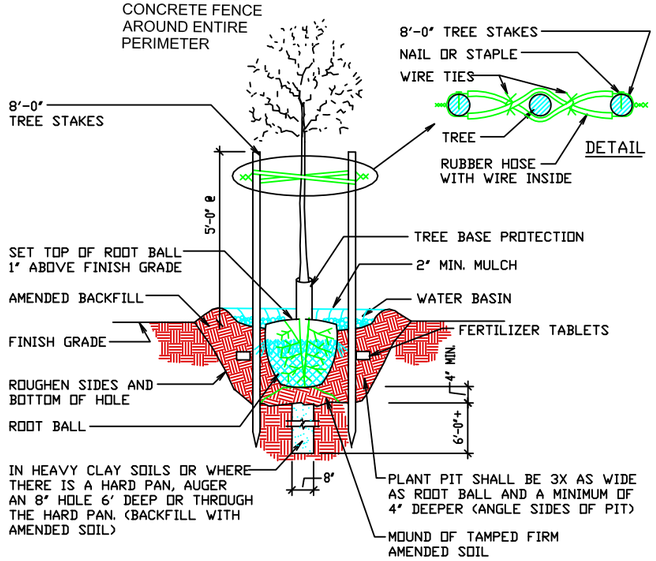
Doug Clements
American Eagle Ready Mix

Please see American Fork City_AERM Exhibits 1 - 10_04162020



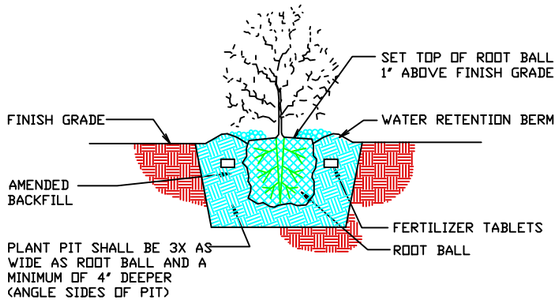
LANDSCAPE & SITE PLAN

N



TREE PLANTING AND STAKING (D)

SCALE: 1/2" = 1'-0"



SHRUB PLANTING DETAIL (B)

SCALE: 1/2" = 1'-0"

PLANTING & SPRINKLING IRRIGATION NOTES

1. THE IRRIGATION MATERIALS ARE TO BE FROM RAINBIRD OR TORO SUBMITTED EQUAL
2. IRRIGATION SYSTEM TO BE A FULLY AUTOMATIC SPRINKLER SYSTEM USING POP-UP HEADS AND PVC PIPING, WITH COMPLETE DRAINS AND STOPS
3. LANDSCAPE / IRRIGATION CONTRACTOR TO SUBMIT DESIGN/SCHEMATIC DRAWINGS SHOWING LOCATION AND COVERAGE OF IRRIGATION SYSTEMS, LOCATION OF VALVE BOXES AND TIME CLOCK LOCATION
4. TOP DRESS ALL PLANTING AREAS / MOUNDS WITH 3" DEEP SHREDDED BARK (MULCH).
5. ALTERNATE PLANT MATERIALS MAY BE SUBMITTED UPON THE APPROVAL OF THE DESIGNER
6. TOP SOIL TO SHALL CONTAIN AT LEAST 4% ORGANIC MATTER AND SHALL BE PLACES AT LEAST 12" DEEP IN ALL PLANTER BEDS

LEGEND

TREES

SYMBOL	COMMON NAME	QTY	BOTANICAL NAME	SIZE
	ASPEN TREE	20	ACER PLATANOIDES "SHADE MASTER"	2" CAL.

SHURBS/PLANTS

	COMMON NAME	QTY		SIZE
	CINQUEFOIL OR EQUAL	43	POTENTILLA FRUTICOSA "ABBOTTSWOOD"	1 GAL
	DAYLILLY	41	HEMERCALLIS HYBRIDS "STELLA D' ORO"	1 GAL
	LENA BROWN	45	CYTISUS X LENA	1 GAL

OTHER

		QTY		
	BOULDERS	25		2' – 4'
	3/4" COBBLE MULCH WITH WEED BARRIER		GRAY	
	GRASS FROM LOCAL SOURCE	1650 S.F.	T.B.D.	

revisions

WALLACE DRAFTING & BLUEPRINTING
Bryan, Ohio 43506
(001) 000-0000

project title
BATCH PLANT
FOR
AMERICAN EAGLE CONCRETE

date

drawn by
V.W.

checked by

cad title

sheet title
SITE AND LANDSCAPE PLAN

sheet no.
SD-1

Realize
2880 W 4700 S Suite A
West Valley City, UT 84129
tel: 808.930.9265
www.real-se.com

N 0°45'22" E 739.08'

TRUCK UNLOADER RAMP

TRUCK UNLOADER RAMP

50' Gate

R120'

739.08'

West Access road is minimum 20' wide

61'-9 7/8"

36'-8"

38'-7 1/8"

35'-9 5/8"

164'-11 5/8"

4'-0"

15'-0"

CONCRETE SLAB ON GRADE SEE 1/S101

THICKENED SLAB FOR 1ST CONVEYOR SUPPORT

149'-3"

S 0°37'36" W 739.00'

244.73'

Surface of access roads and parking lot is concrete

Future Shop
Estimated to be
60x90

North Access road is minimum 20' wide

N

50' Gate

HC

Employee Parking

TB 20 Stalls Min

Surface of access roads and parking lot is concrete

Fire Hydrant – located north of the east side (1700 So) gate.

MIXER PARKING

50' Gate

East Access road is minimum 20' wide

OWNER
American Eagle Ready Mix

Site Plan / Hydrant and Emergency Flow Diagram

PROJECT INFO
Concrete Batch Plant

Phelon Lakeland Property
1700 South 500 East
American Fork, Utah

① SITE PLAN
1" = 25'-0"

- Fire Hydrant

- Fire and Emergency Access

- 20 - Shrub
- 8 - Aspen Tree
- 5 – Pine Tree
- 10 – 12 1'- 1 ½' Boulder
- Precast Concrete Fence Entire Perimeter
- 3/4" Grey Rock
- Turf

Note:

All rock ground cover will have weed resistant barrier installed.

2330 W 4700 S Suite A
West Valley City, UT 84129
tel: 801.930.9263
www.real-se.com

OWNER
American Eagle Ready Mix

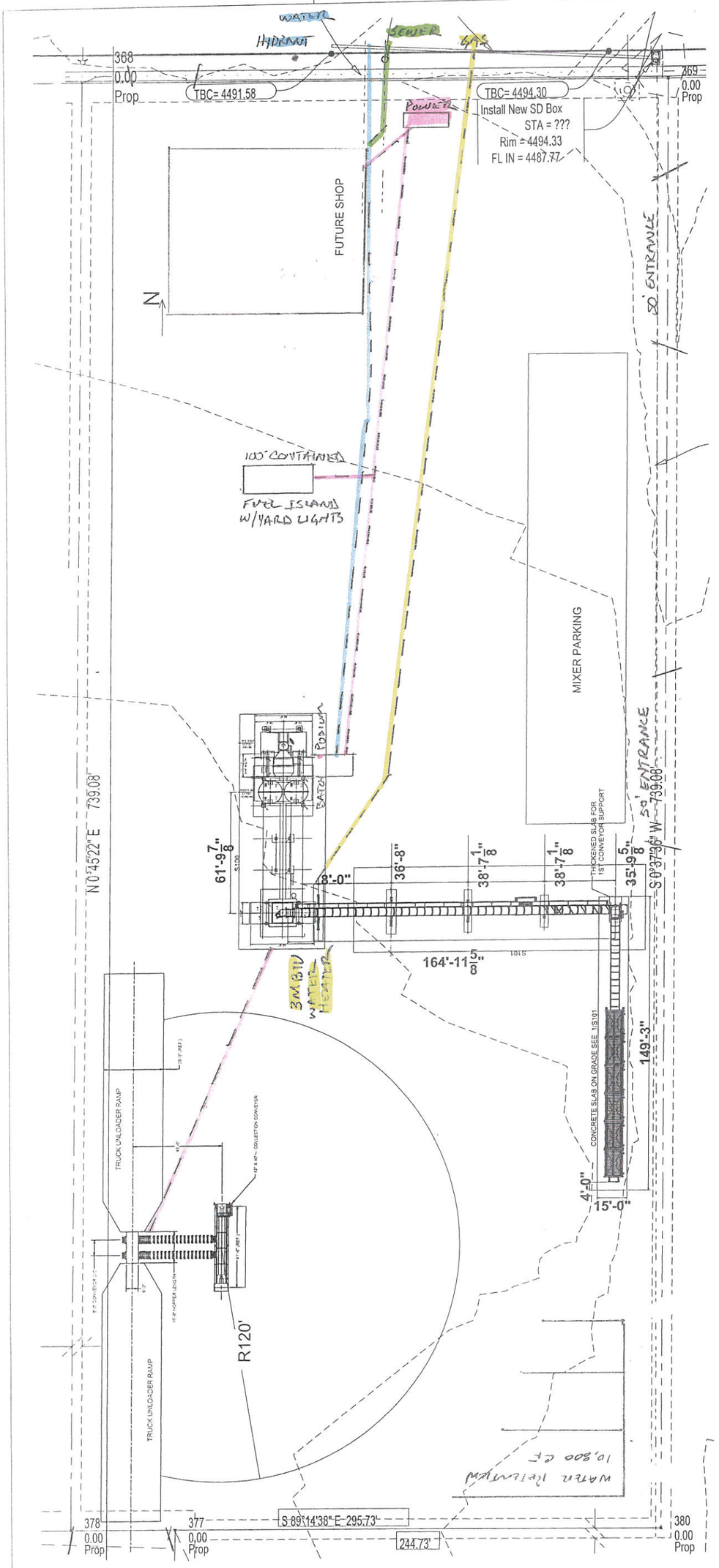
PROJECT INFO
Concrete Batch Plant
Phelon Lakeland Property
1700 South 500 East
American Fork, Utah

DRAWN BY: MNB
DESIGNED BY: Designer
CHECKED BY: Checker

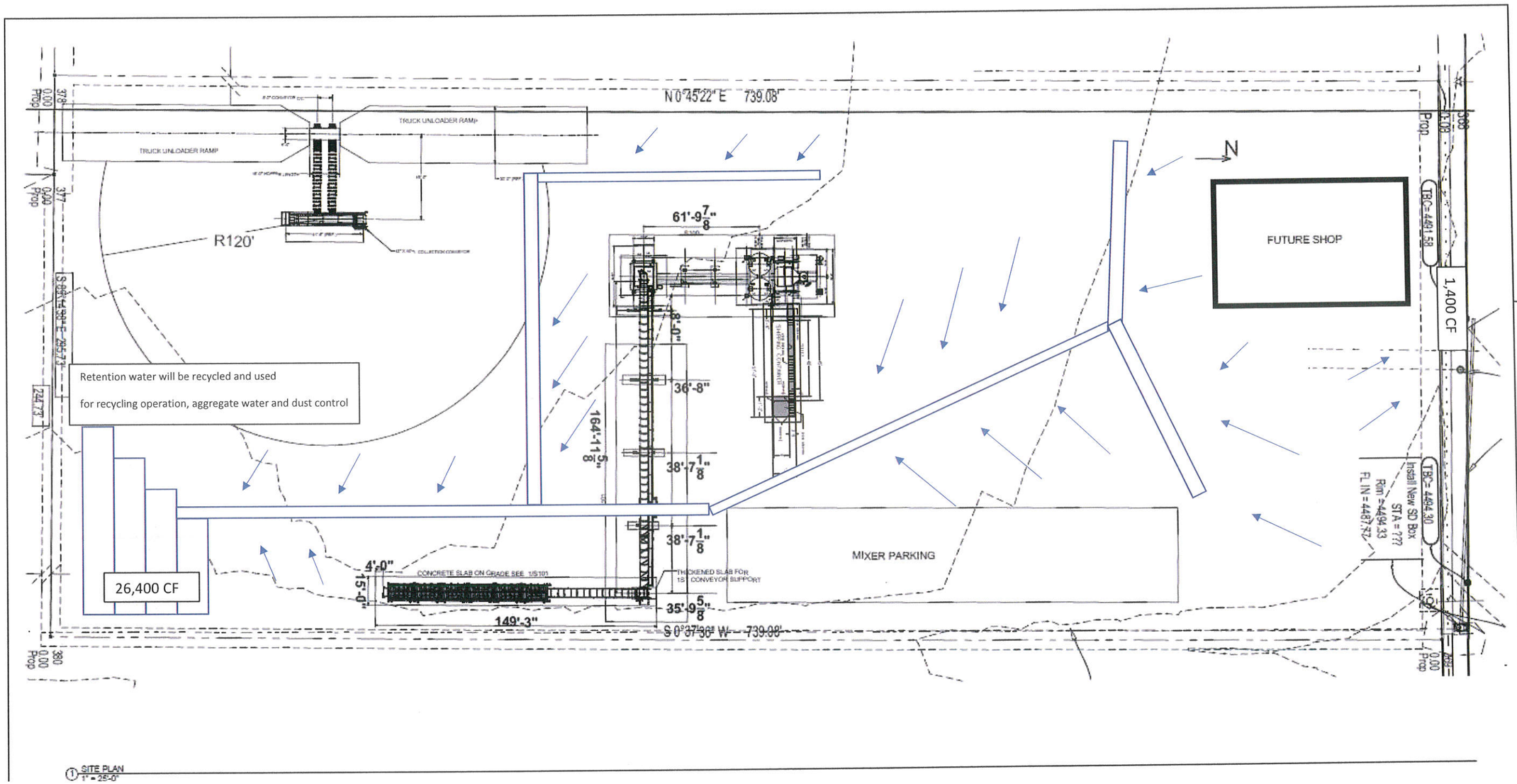
ISSUE DATE: Sep 10, 2019
ISSUE TYPE: Review Set
PROJECT NUMBER: 19039

SHEET NAME
SITE PLAN

SHEET NUMBER:
S000



1 SITE PLAN
1" = 25'-0"



① SITE PLAN
1" = 25'-0"

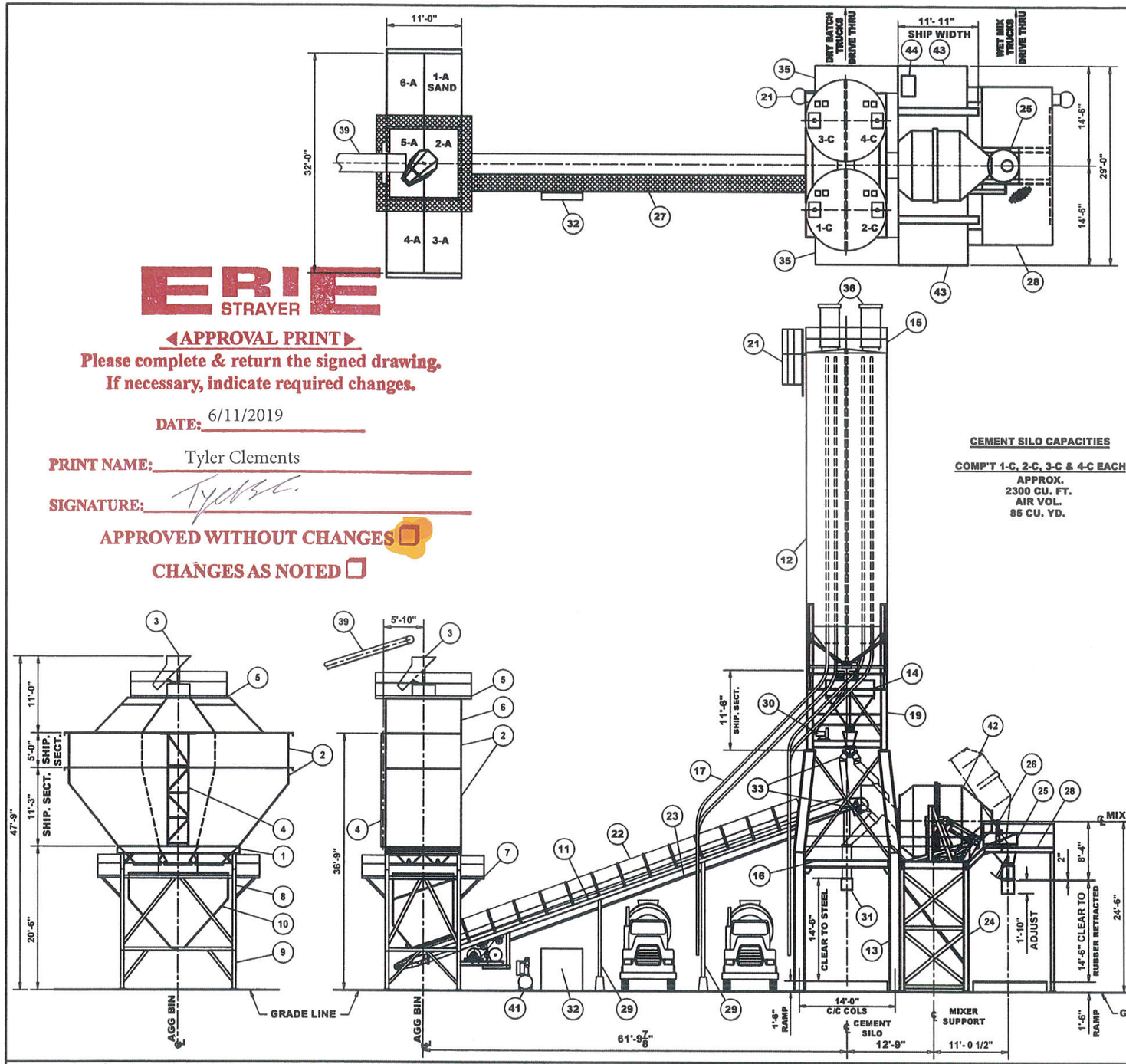
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OWNER
American Eagle Ready Mix

Drainage Plan

PROJECT INFO
Concrete Batch Plant

Phelon Lakeland Property
1700 South 500 East
American Fork, Utah



ERIE STRAYER

◀APPROVAL PRINT▶

Please complete & return the signed drawing.
If necessary, indicate required changes.

DATE: 6/11/2019

PRINT NAME: Tyler Clements

SIGNATURE: Tyler C.

APPROVED WITHOUT CHANGES ☐

CHANGES AS NOTED ☐

CEMENT SILO CAPACITIES

COMP'T 1-C, 2-C, 3-C & 4-C EACH
APPROX.
2300 CU. FT.
AIR VOL.
85 CU. YD.

BY ERIE STRAYER CO.

MP-11T & C

1. AGGREGATE BIN 6 COMPARTMENT (PATT. A-222) 215 CU. YD. HEAPED CAPACITY
2. REMOVABLE BIN EXTENSIONS
3. ROTARY DISTRIBUTOR
4. CONVEYOR HEAD END SUPPORT
5. ROTARY DISTRIBUTOR MAINTENANCE PLATFORM
6. PARTITION EXTENSIONS & HEAP PLATES
7. BIN HOPPER MAINTENANCE PLATFORM W/ HANDRAILS
8. AGG SUPPORT FRAME
9. LOWER COLUMNS & BRACING (AGG)
10. 12 CU. YD. AGG BATCHER
11. 48" INCLINED BATCH TRANSFER CONVEYOR 71'- 8" C. TO C. W/ 100 H.P. DRIVE
12. CS2-1150 CEMENT SILO SPLIT 1/2-1/2 W/ DOUBLE WALL DIVIDER 1150 BBL. MAX. CAPACITY (2 REQ'D)
13. LOWER COLUMNS & BRACING (CEMENT)
14. 12 CU. YD. CEM BATCHER (2 REQ'D)
15. SILO ROOF HANDRAILS (2 SETS REQ'D)
16. MIXER LEVEL SERVICE PLATFORM W/ HANDRAILS
17. AIR LOADING PIPING 5" - (6 REQ'D) (2 IN EA. COMP'T)
18. 4" WATER METER
19. CEMENT BATCHER UNITIZED SECTION W/ MAINTENANCE PLATFORM WITH HANDRAILS
20. WALKWAY BETWEEN SILOS @ ROOF
21. LADDER W/ SAFETY CAGE FROM GRADE TO MIXER LEVEL MAINTENANCE PLATFORM, BATCHER MAINTENANCE PLATFORM, & SILO ROOF
22. CONVEYOR BELT COVER
23. CONVEYOR DRIP PAN
24. MIXER COLUMNS & BRACING
25. CONCRETE DIRECTIONAL CHUTE W/ TELESCOPIC CHUTE & DRIP PAN
26. PIVOTING MIXER DUST PLUG
27. CONVEYOR WALKWAY
28. CONCRETE DIRECTIONAL CHUTE SERVICE PLATFORM
29. CONVEYOR SUPPORTS
30. 5 H.P. AERATION BLOWER
31. TRUCK CHARGING CHUTE W/ 1'- 8" EXTENSION
32. PLANT MOTOR CONTROL PANEL
33. CEMENT & AGGREGATE TWO-WAY CHUTING
34. LADDER W/ SAFETY CAGE FROM GRADE TO ROTARY DISTRIBUTOR MAINTENANCE PLATFORM W/ ACCESS TO BIN HOPPER MAINTENANCE PLATFORM
35. WALKWAY W/ HANDRAILS FROM MIXER PLATFORM TO MIXER LEVEL SERVICE PLATFORM (2 REQ'D)

BY CONAGGBIT

36. CEMENT SILO FILTER VENT (4 REQ'D)
37. CEMENT BATCHER FILTER VENT (2 REQ'D)
38. DUST COLLECTION SYSTEM FOR MIXER & DRY BATCH TRUCK CHARGING CHUTE
39. BIN CHARGING CONVEYOR

BY OTHERS

40. CONTROL SYSTEM
41. 25 H.P. AIR COMPRESSOR W/120 GAL. TANK

EXISTING EQUIPMENT

(FROM CONTRACT TM-9199)

42. 12 CU. YD. ERIE TILT MIXER
43. MIXER PLATFORM (2 REQ'D)
44. HYDRAULIC POWER UNIT

FOR ANCHOR BOLT PLAN SEE DWG. 4A-262987

GENERAL NOTES BELOW APPLY TO EQUIPMENT SHOWN ON THIS DRAWING.

- **AGGREGATE BINS AND BIN COMPARTMENTS**
  HEAPED CAPACITIES OF AGGREGATE BINS AND BIN COMPARTMENTS ARE AS SHOWN AND ARE BASED ON HEAPING TO AN ANGLE OF 45° FROM THE HORIZONTAL WITH MATERIAL WEIGHING 110# PER CU. FT. OR APPROXIMATELY ONE AND ONE HALF TONS PER CU. YD.
- **CEMENT BINS, BIN COMPARTMENTS AND SILOS**
  MINIMUM BARREL, BIN, BIN COMPARTMENT AND SILO CAPACITIES AS SHOWN ARE BASED ON BULKING OF 20% OR 0.8 CU. FT. PER BARREL.
- **ELECTRIC MOTORS**
  UNLESS INDICATED OTHERWISE, ALL ELECTRIC MOTORS ARE WIRED FOR 230/460 VOLT, 3 PHASE, 60 CYCLE CURRENT. STARTING EQUIPMENT WILL BE FURNISHED TO OPERATE ON 460 VOLTS UNLESS OTHERWISE STATED.
- **POWER REQUIREMENT FOR CONTROLS**
  VOLTAGE SHALL BE 120 VOLTS (+– 5%) 60 CYCLE PER SECOND.
- **MODIFICATIONS OR ADDITIONS**
  ALL FIELD CHANGES TO THE EQUIPMENT SHOWN HEREIN, OR ANY ENCLOSURE, WALKWAY, PLATFORM, HOUSING OR OTHER ADDITION TO THIS EQUIPMENT ARE THE RESPONSIBILITY OF THE BUYER, WHO AGREES TO HOLD ERIE STRAYER COMPANY HARMLESS AGAINST LIABILITY FOR THE SAME.
- **NOT FOR CONSTRUCTION**
  THE DIMENSIONS SHOWN HEREON ARE GENERAL AND OUTLINE DIMENSIONS ONLY AND ARE NOT INTENDED FOR USE AS DETAIL DIMENSIONS FOR MAKING MODIFICATIONS OR ADDITIONS, SUCH AS ENCLOSURES, WALKWAYS, PLATFORMS OR HOUSINGS TO THE EQUIPMENT SHOWN.

EQUIPMENT CONFORMS TO CPMB, PMMD, & CSMD STANDARDS

NO.	REVISION	BY	DATE
1	UPDATE SILO HEIGHT	DAP	3/7/2019

ERIE STRAYER CO.
1851 Rudolph Ave. Erie, PA 16502
Phone: (814) 456-7001 Fax: (814) 452-3422
Website: www.eriestrayer.com

DWG BY	DATE	CHK BY	DATE	APP BY	DATE
DAP	1/9/2019				

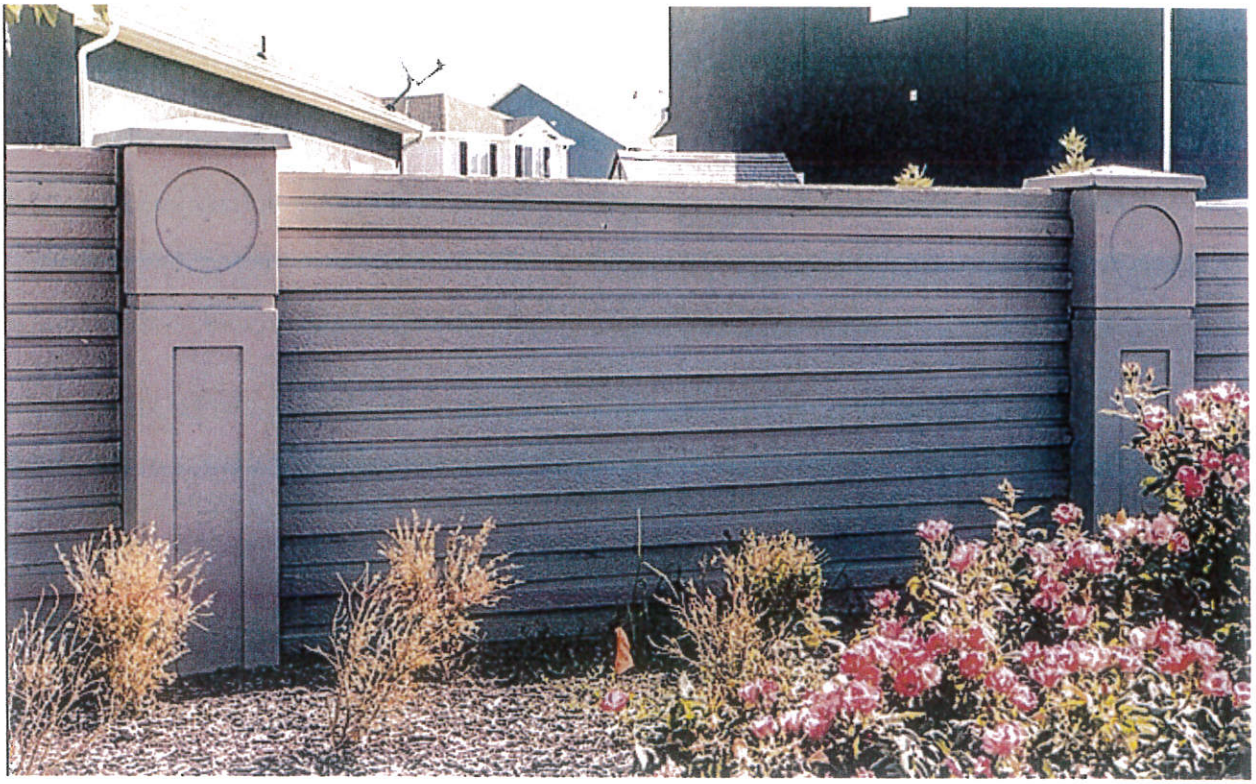
PLANT POWER 460V - 3PH - 60HZ
CONTROL POWER 120V - 1PH - 60HZ

ERIE STRAYER CO.
LOW PROFILE TRANSIT & CENTRAL MIX PLANT
GENERAL ARRANGEMENT
AMERICAN EAGLE

CONTRACT NO.	SCALE	DWG NO
MP-9214	1/8"=1'-0"	4A-262986-1

American Eagle - American Fork Ready Mix Plant-

Perimeter Fence







April 16, 2020

American Fork City Senior Planner, Adam Olsen
American Fork City Planning Commission

email; solsen@afcity.net

Re: American Eagle Ready Mix (AERM)

Dear Adam and the Members of the Planning Commission,

Thank you for your continued support and review of our project. We appreciate your time as well as the time and attention that Adam has given us. AERM was given the notes on items that needed to be addressed and revised from our initial submitted site plan.

The following items have been reviewed by AERM and updated for the City Planner and Planning Commission meeting.

1. The AERM ready-mix plant is planned in a zone that meets the intended I-1 uses. There are other like companies and uses within the same zone in the same vicinity. The production of concrete is a manufacturing process by putting several raw materials together. Our daily process is much like the ready-mix plant, mulch in landscape yards, recycle crusher, topsoil screen, sewer plant and other adjacent operators who are currently operating in the same I-1 zone.
   Specifically addressing:
   a. Noxious odor - The manufacturing of concrete does not present or put off a noxious odor. It would be similar to all other existing business that surround us such as the ready mix plant, mulch in landscape yards, recycle crusher, topsoil screen, sewer plant or the trucks needed for all these types of business to conduct business.
   b. Smoke - The manufacturing of concrete does not present or put off any smoke that is known or that in not typical of the existing ready mix plant, mulch in landscape yards, recycle crusher, topsoil screen, sewer plant or the trucks needed for all these types of business to conduct business.
   c. Noise – The noise of manufacturing concrete are typical noises that already exist in this I-1 zone. Weather it by an existing ready-mix plant, recycle crusher, topsoil screen or the equipment and trucks need for all these types of business to conduct business. AERM has taken several precautions to mitigate noise by setting the plant back as far as possible from the frontage, 300’. The frontage perimeter wall / concrete architectural fence will block noise. Currently it is planned to be 6’, with the approval of the city we could increase that to 8’? Our shop and office building will be built between the plant and the frontage which will also act as a noise barrier.
   d. Vapor - The manufacturing of concrete does not present or put off vapor. Please do not confuse Vapor with steam. When we heat water, we emit steam from a 99% efficient natural gas burner. There is little to no emission and the steam evaporates. AERM has the same water heater as the existing ready-mix supplier in this I-1 zone.

e. Vibration - The vibration generated in the manufacturing process are not rhythmic or constant. If any vibrations that are created, they are typical vibrations that already exist in this I-1 zone. Weather it by an existing ready-mix plant, recycle crusher, topsoil screen or the equipment and trucks needed for all these types of business to conduct business. AERM has taken several precautions to mitigate vibration by setting the plant back as far as possible from the frontage, 300'.
f. Glair - The manufacturing of concrete does not present or put off any glair that is known or that does not already existing from the ready mix plant, recycle crusher, topsoil screen or the trucks needed for all these types of business to conduct business.

Addressing all these items above, AERM feels it has and will continue to mitigated these situations just as the existing businesses do and that these conditions do not create conditions which is harmful to the persons or which is readily discernable beyond the boundary of the zone or create an adverse visual impact readily discernable from the public roads.

2. The location of all existing and proposed building and structures on the site, with full dimension showing the distance between buildings and distances from buildings to adjacent property lines.
    a. 30' setback for future shop and office
    b. This has been updated on the revised site plan dated April 16, 2020
3. A landscaping plan showing the location, types and initial sizes of all planting material to be used together with the location of fences, walls, hedges, and decorative materials.
    a. Landscape islands have revised and sized correctly with a minimum of 140 sf,
    b. There are at least 13 shade trees in the parking area for 27 stalls
    c. All landscape islands; there are not less than 1 shrub for every 25 sf of landscape
    d. There is a 6' wide landscape perimeter for the parking area
    e. There is a 14' wide landscape adjacent to the street frontage that include 8 trees for the 295'
    f. This has been updated on the revised site plan dated April 16, 2020
4. The location of all existing and proposed building and structure on the site with full dimensions showing the distance between buildings and distances from building to adjacent property lines
    a. This has been updated dated on the revised site plan dated April 16, 2020
5. Landscaping has been reviewed and updated. We believe our update addresses all the landscaping requirements. It is our intent to comply with the landscaping code. Any additions or changes can be addressed with final conditions.
6. The location of solid waste receptacles and trach pick-up areas.
    a. We have added a permanent dumpster enclosure and noted the temporary location for the dumpster during construction.
    b. This has been updated for temporary and permanent locations on the revised site plan dated April 16, 2020

AERM believes there may have been other items of concern from the commission that were raised during the meeting.

Please see the following to communicate answers to your questions.

1. Dust and dust mitigation
    a. Paving our yard – AERM intends to pave our yard to help mitigate and maintain dust, track out, water drainage and retention.
    b. Sweeper truck – Daily our sweeper truck will maintain the yard and main traffic patterns in our yard
    c. Covered conveyors - From the point the aggregates are loaded into the plant they are conveyed on covered belts. This will help prevent and mitigate dust coming off them in the event of windy conditions.
    d. Washed aggregates – All the aggregate and sand used to manufacture concrete is washed. Due to the moisture in this material after being washed, dust is mitigated, and the sand and aggregate are not typically dusty in nature.
    e. There are 6 Bag houses with filter - All silos and weigh hoppers are vented with their own bag house to vent and recycle the dust collected back into the raw product.
    f. There is a central Dust Collector used to pick up major transfer points where dust could be present and recycle it back into our raw materials.
    g. Wet batch processing plant – AERM manufactures concrete wet before it is loaded into our mixer trucks which prevents dust at that transfer point
2. Production
    a. The production rates of our plant were in question? The commission commented from 30 cyph to 300? Our plant configuration allows us to load 180 - 200 cyph. However, this is not achievable hour over hour as we cannot load the raw materials into the plant that fast. 4 min loads = 150 cyph. Which is very fast, and not achievable hour over hour for plant and raw material needs.
    b. We would like to average 500 - 550 cy per day. Which is 60 +- loads per day or about 60 cyph on the average
3. Trucks
    a. Specifically, the loading of trucks. AERM does not have 100's of trucks anywhere and never intends to have 100's of trucks at this location. This number is physically impossible with the size of our property and the size of our plant. It is our intention to keep and operate 20 mixer trucks.
    b. Initially in the morning the trucks are loaded, depending on the schedule, estimated to be 4 - 10 minutes apart. Once the initial loading takes place, we average about 6 loads an hour to achieve our average daily production.
4. Come back concrete
    a. Retaining wall blocks – Block forms will be utilized to pour come back concrete into retaining wall blocks
    b. Recycled into road base products – Concrete not used in blocks will be recycled into road base by our neighbor, Mike Dunn. Much like the relationship Altaview Concrete has with R&D Topsoil and Recycling on 1500 S.
    c. Water will be recycled and or used for dust control.

5. Visual site
    a. AERM is using a 6-foot architectural concrete fence. If warranted by the commission, AERM is willing to place 8' fence along the frontage.
    b. Landscape trees in along the frontage and in the parking lot islands will athletically provide and maintain pleasing visual for this zone and like properties.
    c. The addition of our shop and office will also be placed between the plant and road.
6. 1700 S.
    a. It should be mentioned that 1700 S along the frontage of AERM and its like manufactures in this zone have approximately ¾ of a mile of frontage. The traveling public and others coming to work in this industrial area, most likely never drive past our property as 1500 S is the main thoroughfare.
    b. Currently 500 E to the south is a dead end and 1700 S to the west is a dead end.
    c. AERM can / will post "No Through Street" signs on 500 E at 1500 S.

AERM believes this ready-mix plant complies and fits in the Master Plan of American Fork City. The location fits the definition and use (see below) of the city.
Specifically, for the following facts:

1. Bringing in raw materials in larger quantities and manufacture them into a smaller quantity for local distribution
2. AERM like other I-1 companies is strategically located close to the interstate (1 mile)
3. Location – AERM is in the intended location as we are next to and near like manufactures. We are not near residential, churches and commercial companies.
4. To improve the Economic Well Being for the people of American Fork. AERM will generate tax revenues of $14M +- and pay property taxes which will also benefit the city.

The Lakeland Business Park was developed originally work with American Fork City. The city wanted to move a business not located in the city into this park to set up and operate a transfer station for waist products and build an additional pond for storm water retention. In the beginning of this process the city manager was introduced to AERM. He was aware that we wanted to put a ready-mix plant in the Lakeland development. His words, "That is a perfect place and use of this land". It is my understanding from city and the landowner that the best way to handle the development was to annex it from Utah County into American Fork City. My understanding again, that is would be zoned I-1 zone to ensure it was suitable for its intended use as a waist transfer station, topsoil screening, recycle concrete and put the ready-mix plant there. The I-1 zone is the same as the adjoining properties. This would allow other like existing business (ready-mix, concrete recycling, topsoil screening) into the park. From the beginning the city was aware the intent of this property was to install a ready-mix plant.

In conclusion, not to sidestep, but to clear up and apologize; The current situation of the plant is all plant footings were installed prior to the annexation into American Fork City. All plant footings were built to specification using the Geotech used for the parcel / approved subdivision and stamped by an engineer, stamped engineered drawings for footings, third party inspection agreement, third-party inspections with complete reports of all process from excavation, fabric, backfill material, compaction, rebar inspection and concrete inspection. Bolting together our machinery is the work that has taken place since the annexation and we have not continued any process that would require our building permit from the city.

We are committed to be a great partner with the city and other like business in the I-1 zone. In these times of uncertainty, construction and construction related products will remain an essential business. Construction is the backbone of our infrastructure which include building homes, subdivision, restaurants, warehouses, utilities, roads and bridges. We all contribute in an economically positive way for the city and its residents.

We respectfully submit this updated information with the anticipation of approval from the Planning Commission.

Sincerely,

Doug Clements
American Eagle Ready Mix.

AMERICAN FORK CITY
PLANNING COMMISSION MINUTES
APRIL 8, 2020

The American Fork City Planning Commission met in a regular session on April 8, 2020 in an electronic meeting on the Zoom platform, viewable on the City's YouTube link, commencing at 7:00 p.m.

Present: John Woffinden
Chris Christiansen
Geoff Dupaix
Harold Dudley
Ryan Hunter
Christine Anderson
Rod Brocious

Absent:

Staff Present: Adam Olsen, City Planner
Wendelin Knobloch, Planner
Ben Hunter, Engineer
Lisa Halversen, Administrative Assistant
Scott Sensanbaugher, Public Works Director
Cherylyn Egner, City Attorney

Public Comments Received: Larry Olsen, Tyler Skidmore, Clint and Reva Cook, John Mulholland, Brandon Anderson, Dan Duncan, Micki Cottam, Kristie Jensen, Shane Armitage, Lacy Anderson, Karen Auman, Allison Duncan, Brittney Gonzalez, Nathan Price, Carolyn Lloyd, Tresa Chadwick, Luis Gonzalez, Lynlee Price, Roderick Legal Counsel, Doug Clements, Liz Phelon, Ken Berg, Robbie Thompson, Reid Swenson

1. Pledge of Allegiance

Chairman Woffinden welcomed everyone and those present recited the Pledge of Allegiance.

2. Review and action on a commercial site plan for American Eagle Ready Mix, located in the area of 1700 South 500 East in the I-1 Industrial zone

Mr. Olsen stated that the American Eagle Ready Mix proposes an operation at approximately 1700 S. 500 E. The site is within the proposed Lakeland Industrial Park subdivision. The property was recently annexed, and improvements initially constructed without formal site plan approval. The facility was required to shutter operations until such approval occurred. The applicant submitted a site plan, which is now before the Planning Commission for review.

Uses and site plan requirements within the I-1 zone are covered in Sections 17.4.503 and 17.6.101, respectively, of the City's Development Code. 17.4.503.B.1(a & b) states that "structures and areas used for the manufacturing, compounding, processing, fabrication and warehousing of goods and materials" are allowed within the zone, provided that "none of the activities carried out on the premises shall produce any noxious odor or any fumes, smoke, noise, vapor, vibration, glare or similar condition which is harmful to persons or which is readily discernable beyond the boundary of the zone or create an adverse visual impact readily discernable from the public roads". From the application materials, it is unclear how the above issues will be addressed. The Planning Commission may request the applicant address the items as outlined in the Code, mitigation efforts to take place and how they will apply to the site.

The site plan illustrates a proposed structure toward the north end of the property, south of 1700 South. The I-1 zone requires a 30' front setback for structures. Verification of front setback is required. Verification of adherence to landscape requirements is also unclear and should be addressed. Specifically, the following: (1) landscape islands adequately sized at the end of all parking rows, (2) shade trees provided at the ratio of 1 tree per 6 parking stalls and 1 shrub per 25 sq. ft. of landscape island, (3) 6' wide parking perimeter landscape area, and (4) a 14' wide landscape area adjacent to a street frontage with 1 tree provided for every 40' of street frontage.

Mr. Olsen notes for the record that he has received information and a letter of opposition from a neighboring property owner's legal counsel.

Mr. Dupaix said that the code seems to be pretty generic, and that with a concrete plant there is usually dust and noise. There are other concerns with a concrete crusher, he doesn't see how those things fit within the code for this zone.

Mr. Olsen replied that the code is broad, and in looking at the application for ready-mix, it could possibly fall within the allowed manufacturing and processing, but he doesn't know how they plan to address the issues. The planning commission can make the call if they think the operations are outside of the approved zone allowances.

Mr. Christiansen added that he thinks this is more of a heavy-industrial application than a light one which would be allowed. He is concerned that this project would generate a lot of dust, and their site plan doesn't seem to address on-site containment and processing in a satisfactory way.

Chairman Woffinden agreed, and stated that the applicant is asking for forgiveness instead of permission, and that they're still working on the site. There will be a lot of trucks hauling stuff to the site. He thinks the site plan seems to be kind of sketchy by not showing information regarding operations and containment.

Mr. Dupaix added that it's not only the hauling in and out that he's concerned about, but protection of their existing materials.

Chairman Woffinden stated that the site plan is lacking in every way.

Mr. Ben Hunter indicated that infrastructure improvements and rights-of-way are shown as Lakeland Industrial Park. Off-site infrastructure meets code, but applicant should address issues with their operations.

Mr. Brocious asked Mr. Ben Hunter about the ability of the water system to support this project. Would it be able to meet peak demand, etc?

Mr. Ben Hunter indicated that the utility plans show water lines being brought to the area.

Mr. Sensanbaugher added that this is similar to the TOD area in that there are major pipes that need to be built to feed the area. His recommendation is that if the city council is able to commit to build the water lines to the southern part of the city, we recommend approval. If not, we recommend denial.

Mr. Brocious asked if the water system would fail if it were to tie in today.

Mr. Sensanbaugher said not necessarily, but if all pending projects are built and occupied but water lines aren't built, we will have a problem. There's a time delay between approval and occupancy and operational water lines.

Mr. Brocious asked if commissioners should be looking at it as though the subdivisions that have been approved should be counted toward use.

Mr. Sensanbaugher replied that the need hasn't physically hit yet, but it's coming.

Mr. Brocious expressed concern about continuing to approve additional plats. He asked if the necessary infrastructure should be put in before they approve any more plats.

Mr. Sensanbaugher stated that he is comfortable continuing to approve plats knowing that additional capacity is coming, if the council approves.

Mr. Brocious questioned how they will know if the council is approving the infrastructure, is there a way that they make a more informed decision?

Mr. Sensanbaugher indicated that he is filling out a loan application with the state for the water lines, but the council has to approve borrowing the funds. He can't speak for the council, but they understand and seem to be on board with building the required water lines. They haven't yet taken the formal action to accept the loan.

Ms. Anderson expressed concern that so much of what they're doing tonight has the same requirement - they need to know what the city council is doing before they can move ahead. She asks if there is a timeline of when a decision can be expected.

Mr. Sensanbaugher replied that probably in the next 2-3 months a funding item will be taken to them for approval.

Mr. Olsen instructed commissioners that they are still free to make any decision with the caveat that places the burden on the council. Items move on to the council for final decision and they can

see what concerns were discussed. The Planning Commission recommendation could match the Engineering Division recommendation regarding council approval of infrastructure.

Mr. Christiansen agreed that they should make a similar recommendation, but Mr. Brocious felt that it is a disservice to a development to get approval from Planning Commission and then have to stop if conditions of infrastructure approval by council aren't met.

Mr. Sensanbaugher pointed out that many of tonight's agenda items are in the same situation.

Chairman Woffinden also instructed commissioners that they are simply a body that makes a recommendation, and the council has final authority.

Mr. Olsen added that this agenda item gets final approval or denial from this commission.

Mr. Brocious stated that he has read the legal letter of objection. It referred to a traffic study, has Engineering looked at the demands this item would place on current roads?

Mr. Ben Hunter replied that the Technical Review Committee review flags when a traffic study is required, this didn't meet that threshold. Maybe the applicant could give more information regarding traffic if that's a concern for commissioners.

Mr. Brocious said that due to the nature of vehicles coming in, the roads might not be adequate to support them.

Mr. Ben Hunter said that that's a good question, and the applicant should give more information if commissioners want it.

Chairman Woffinden stated that there will be a lot of materials both coming in and going out.

Ms. Anderson asked if the proposed uses are even allowed in this zone.

Mr. Olsen replied that prohibited uses are called out specifically, it's up to the Planning Commission to make the decision based on how applicant will address commission's concerns.

Ms. Anderson asked if there is a limit on noise level in this zone.

Mr. Olsen replied that there is not.

Chairman Woffinden stated that you can't contain noise and dust very well.

Mr. Doug Clements, applicant, stated that they won't be crushing and processing concrete, and an air quality survey has been secured. He believes that commissioners may not have latest site plan. On the newest plan, ponds for retention and recycling water are shown. He believes the current use meets city code, they also have an option of using well water to supplement culinary water. The developer did a traffic study and gave the engineer all the information, and he calculated that it's ready for a building permit. There's already a batch plant 300 ft to the east that is bigger than the one he's putting up. A typical early morning load will be around 100 yards an hour, but most times of the day will be on the order of 50-60 yards per hour. They're not asking for anything

that's not already in the neighborhood, they intend to be a good neighbor. They've been working on securing a few safety items and are ready for a building permit.

Chairman Woffinden reiterated that applicant is asking for forgiveness and not permission, and they should have done it the right way in the first place. They've been shut down by the city. If the city is not going to enforce its ordinances, why bother having them? He thinks they should be required to take it down.

Mr. Sensanbaugher added that they can't get a building permit until they have approval from the commission. He feels that the developer has given city staff everything they've asked for.

Mr. Ben Hunter said that there are two types of traffic studies. The Building Department was given numbers to generate impact fee estimates. This is a separate report from a full-blown traffic impact study.

Mr. Clements said that he understands the Chairman's concern, and he added that the batch plant itself is a machine. The only thing that needs inspection are the footings. He understands commissioners concerns but the only thing they've done is pour some footings. Everything else will come in with the full building permit. Their intention was not to be evasive. He sat in several council meetings a year ago with the intention of having it annexed and getting up and going. The annexation ended up taking a lot longer than anyone intended. They're just trying to get the business up and running. There are other businesses in the area that do similar things. They are one mile west of I 15, they bring in fully loaded aggregate trucks for that mile. Ninety percent of everything he produces will go on that same road up to I-15, then disperse along that road. No residences, churches or schools will be in the area.it is purely an industrial park . He apologizes and said that they've been trying for over a year, and he feels that this will be a good addition to American Fork.

Chairman Woffinden said that this is the first time he's heard of a batch plant in this zone, how can the developer be trusted?

Mr. Clements indicated that they've been working with city staff for quite a while.

Mr. Dupaix asked about the other batch plant. Is it in the same zone? Yes, so there's already established precedent.'

Ms. Anderson has concerns are about dust, and how will they verify adherence to landscape requirements?

Mr. Olsen replied that landscaping is a concern that hasn't been addressed, it's one of the loose ends.

Mr. Clements replied that they've talked extensively with staff about landscaping. They intend to put a precast wall around the plant,the yard will be fully covered in concrete to help in dust control, and they will also use water trucks with recycled water. He feels that they are doing more than is required.

Christine acknowledges that things weren't done the way they should have been. She feels comfortable recommending approval based on certain requirements being met.

Mr. Brocious doesn't think that the vibration that will be generated has been addressed. How will this be mitigated?

Mr. Clements isn't aware of any vibration that will be generated, the plant sits on a 3" foundation. Trucks that deliver concrete, sand and rocks don't usually generate any concern about vibration. The plant itself is called a wet batch plant. Concrete that goes into the truck is wet and premixed, minimal vibration is generated.

Mr. Christiansen said that if there was much vibration, it would tear the machine apart.

Mr. Olsen noted that legal counsel retained by Mr. Roderick sent a letter opposing this item earlier this week. He made sure that each commissioner has a copy.

Ms. Anderson stated that a lot of opposition is based on this activity not being allowed in this zone, but there seems to be another batch plant in the same area.

Mr. Christiansen said that the difference is that this is right next to other businesses, which is concerning. He feels that there are too many red flags to move forward. He felt like commission should table the item based on the existing issues.

Ms. Anderson said that the situation in the country right now is that everything is on hold. She would like to let something move forward with stipulations.

Ms. Cherylyn Egner, city legal counsel, stated that public comments can still be provided throughout the meeting. She reads into the record a comment from Roderick which indicates that they believe the batch plant is illegal use and will result in litigation to the city.

Ms. Anderson moved to approve the site plan for American Eagle Ready-Mix, with the findings listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report, and with the conditions that landscaping meets requirements and any effects of noise, dust, and visual impacts will be mitigated.

Mr. Dudley seconded the motion. Voting was as follows:

Chairman Woffinden	**Nay**
Chris Christiansen	**Nay**
Christine Anderson	**Aye**
Geoff Dupaix	**Nay**
Harold Dudley	**Aye**
Ryan Hunter	**Nay**
Rod Brocious	**Nay**

The motion failed.

Mr. Dupaix moves to table the site plan for American Eagle Ready-Mix until landscaping and other concerns have been resolved.

Mr. Christianson seconds. Voting was as follows:

Chairman Woffinden	**Nay**
Chris Christiansen	**Aye**
Christine Anderson	**Nay**
Geoff Dupaix	**Aye**
Harold Dudley	**Nay**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

3. Hearing, review and action on the preliminary and final plats for Lakeland Industrial Park, consisting of 4 lots, located in the area of 1700 South 500 East in the I-1 Industrial zone

Mr. Olsen stated that Lakeland Industrial Park Plat A is a 3-lot industrial subdivision, located south of 1700 South at approximately 500 East. Lots 1 and 2 are approximately 5.1 acres and Lot 3 is 10.5 acres. Access to the lots will be from 1700 South. An area of future development (labeled at "Future Plat B") is illustrated on the plat, immediately adjacent (west and south) of Plat A.

Mr. Ben Hunter said this item isn't specifically related to the previous item, but it creates the lot that the previous application would use. Master plan utilities are included in the subdivision, required improvements would be extending 500 East further to the south, and 1700 South would also be extended past Lot 1. The Engineering Division doesn't have any further issues or concerns.

Public Hearing Opened

Ms. Liz Phelon, representing ESP Excavation, brought to the commissioners' attention that Mr. Roderick re-zoned his property after purchasing it. He moved in knowing that it was I-1 zoned, and he chose to re-zone knowing that his zone was surrounded by industrial use.

Mr. Brocious asked who will be occupying the lots.

Ms. Phelon replied that American Eagle is a potential buyer, as well as landscapers and other buyers that would be interested in property in an industrial zone.

Chairman Woffinden then asked if American Eagle had built on the property before buying it.

Ms. Phelon indicated that American Eagle has a piece of equipment that is mobile on the lot, not a building. She instructed that a batch plant is a piece of machinery that can be moved wherever it is needed, like the screening machine that ESP uses for landscaping.

Public Hearing Closed

Mr. Christiansen moved to recommend approval of the preliminary plan and final plat for Lakeland Industrial Park Plat A, with the finding and condition listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report.

Mr. Ryan Hunter seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

4. Hearing, review and action on the amended preliminary and final plats for Dixie Farms Plats E-1, E-2, F-1 and F-2, located in the area of 900 West 900 South in the PR-3.0 Planned Residential zone

Mr. Olsen said that the property consisting of Dixie Farms was annexed in early 2018. Initial preliminary Plan approval was granted on May 2, 2018. Upon annexation, the property was zoned PR-3.0 (Planned Residential 3 du/ac), PF (Public Facilities), and SP (Shoreline Preservation). The PF zone designation lies within a power line corridor, slated as a linear park; additionally, the PF zone designation was given in an area for a potential alignment of the Vineyard Connector. Should the Vineyard Connector not locate within this corridor, a large park area, adjacent to the power line corridor park will be present. The Shoreline Preservation zone was designated for the area encompassing wetlands and floodplain adjacent to Utah Lake. Right-of-way was dedicated with the annexation for a Utah Lake Shoreline Trail, which will parallel a road (Lakeshore Drive) that will act as a defend/no defend line in the event of lake flooding. The elevation of the road will be one foot above the 100 yr. flood elevation of 4,495'.

Plats E-1 through F-2 constitute a redesign of previous plats. Units have been clustered in the area of 900 West in order to provide a more open corridor as one travels north/south toward Utah Lake

and the Frontrunner/TOD area. Single-family lots will be present to the east and west of the immediate 900 West corridor. Townhome units are proposed and meet the requirements of the underlying PR-3.0 zone. Trail corridors meander through the entire subdivision, providing access from the linear park and TOD area to the north, to the Utah Lake Shoreline Trail/open space area to the south.

Mr. Ben Hunter stated that roadways adjacent to this development are adequate for anticipated needs. As to liquefaction concerns, this developer did several geotech reports that were peer reviewed by a 3rd party. These reports identified clay layers above silty layers so the reviewer didn't feel that liquefaction was a concern. 900 West is the primary access that would be required to be constructed, along with connections to 620 South, 570 West and 200 South. He did receive from the developer plan sets for 200 South to be reviewed and comments provided. They are continuing on a path forward to finalize the reviews, he knows this is a major concern for residents.

Ms. Anderson asked when the roads will be completed, and how does that fit in with the timeline of Dixie Farms being completed.

Mr. Ben Hunter did not know what the Ardero (developer) timeline is. They are working on several plans and projects, 900 West will have to be built as part of those. He doesn't know the developer's timeline for the specific plats and when homes will actually be built. It will be months down the road, and building permits can't be issued until the infrastructure is in place. He wouldn't expect to see any occupancy for quite a while. Plans for 200 South should be ready to go to bid this summer, then the timeline depends on funding by council.

Ms. Anderson asked if the city's part of the roads will be fixed before occupancy or after.

Mr. Ben Hunter said that he's not sure, there are many variables. He is aware that there are delays and traffic concerns, but the road (200 South) hasn't actually failed at this point.

Mr. Brocious asked if all the approved subdivisions were built out, would this push 200 South into failure?

Mr. Ben Hunter replied that it all depends on timing and occupancy rates. That would be the worst-case scenario, it will be some time before homes are ready for occupancy.

Ms. Anderson asked if the current infrastructure is adequate for the added use of heavy vehicles and construction equipment.

Mr. Sensanbaugher replied that the road needs to be built, but it's hard to say when it will fail as this is subjective.

Mr. Brocious indicated that there are safety concerns as 200 South has no sidewalks and shoulders.

Mr. Ben Hunter added that 200 South was functioning at a level C in 2018, and traffic has increased since then.

Mr. Dupaix expressed concern that 900 West will take time to build. He is concerned about the additional wear and tear on existing roads in the area.

Ms. Anderson brought the issue up of at what point do we hold back on approving development until needed infrastructure is in place?

Mr. Sensanbaugher replied that there is a road that is failing and help is on the way. Approval of development depends on commissioners' level of comfort and what message they want to send to the council. He felt that water is an easier concern to quantify than roads.

Chairman Woffinden said that he doesn't agree with the liquefaction report, but it's been reviewed by a 3rd party. He just hopes there's not an earthquake.

Mr. Dudley asked if the engineer would be willing to put on F-2 "no building in power line corridor".

Chairman Woffinden added that "no basements" should also be noted on plats.

Public Hearing Opened

Mr. Ken Berg, civil engineer, is fine with adding a note about "no building in power line corridor." No homes can be there currently, but if commission wants to also prohibit accessory buildings he is fine with that.

Ms. Carolyn Lloyd and Ms. Tresa Chadwick submitted emails into the public comments, they are as follows:

Ms. Lloyd - I am concerned with the development on Dixie Farms, AF10 & AF PD South. Currently the only road access to these developments are on 570 West & 7300 North. I do understand that 900 West will need to be completed for these developments. So what that means is that the secondary access will be on a county road which is 570 West & 7300 North. These roads will not be able to handle the kind of traffic volume that 400 plus homes will bring. I know that there are plans for 700 West but that road access will not be required for these developments and it will not be completed in the near future. The only way that road will be built is if more developments come into the city in that area. Right now the owner of the land is not selling so that road will not be done for awhile. All of these roads connect to 200 South and that is still nowhere from being done. So you will be adding construction equipment and road construction equipment onto 200 South that cannot even handle the amount of traffic from Willow Glen Town homes and The Meadows apartments.

Another concern is having enough water for all of this development on the South side of the freeway. I wished we would slow down the development to allow the infrastructure to catch up to what is being built out there. Developments are being approved and the roads still haven't been fixed and having enough water access for emergencies is a huge concern of mine.

My last concern is the water table and liquefaction issues. I have brought up my concern on this issue many times, John and I have discussed my concerns regarding this as well. My main concern is adding multiple units on an area of ground that has a high water table. I am not okay with adding town homes in this area. It is going to cause water issues in the future. I currently run a sump pump in my crawl space

24x7 from January to June each year. I feel like a Geo-tech report needs to be acquired again since we just had a very wet year. The last soils report that was done was done in 2018 during one of the driest years that we have had in a very long time.

I have attached some photos that I have taken. Some are of the crazy traffic due to the trax station. I have also taken one of the view of Willow Glen and The Meadows from the back side. This is the view that I have right now. I understand change & development but I would like to leave the town homes/ condos up on the TOD. Most of us south of 200 south own over acre lots and would like to keep some of the character of our area intact.

17.02.104 (section 3) Says: Such regulations shall be made in accordance with a comprehensive zoning plan

schools, parks and other public requirements. Such regulations shall be made with reasonable consideration, among other things, to the character of the zone and its peculiar suitability for particular uses, and with a view to conserving the value of buildings and encouraging the most appropriate use of land throughout the city.

Please take all of these concerns into consideration.

Ms. Chadwick - I am concerned with all of the continued condensed housing that is being planned and implemented in our area. The proposed plan adds additional condensed housing. I would be more in favor for a balanced plan were the condensed housing is combined with single family homes. This would insure that we have a community with members that will be there long term and have a vested interest in what happens as well as those who will only be there a short time. If you push more short term housing in this area you will be opening the door for a more slum type atmosphere because people do not have ownership in what happens in the community because they will only be there a short time. Also with only two main access roads for all of the planned building down there you may see some seriously traffic problems. I know you may not be living in this area and I may not be living here in the future but I do think it is up to us to create a community that would make AF city proud rather than a place that AF city is ashamed of.
The future of generations is in your hands.
Thank you for your time

Public Hearing Closed

Mr. Dudley moved to recommend approval of the amended preliminary and final plats for Dixie Farms Plats E-1, E-2, F-1, and F-2, with the finding and condition listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report, and the condition of no buildings be allowed in the Rocky Mountain Power corridor

Mr. Christiansen seconded the motion. Voting was as follows:

Chairman Woffinden Aye

Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

5. Hearing, review and action on plats A, B and C of the AF 10 Project located in the area of 780 West 620 South in the PR-3.0 Residential zone

Mr. Olsen stated that AF 10 Preliminary was approved at the March 4, 2020 Planning Commission meeting. The final plat complies with the approved preliminary plan.

AF 10 Subdivision proposes a combination of both a Conservation Subdivision PUD and Low Density Attached Housing PUD. 30 lots/units are proposed, two lots having existing homes. Access is provided off 620 South. An open space area exists at the southern portion of the subdivision, to be dedicated to the City. Additional common area is proposed around the attached/townhome units, south of 700 South. Conservation subdivisions within the PR-3.0 zone require 25% open space. The subdivision meets this requirement.

Mr. Ben Hunter said that the Engineering Division has no concerns, and recommend approval.

Public Hearing Opened

Previously cited emails from Ms. Lloyd and Ms. Chadwick apply to this development as well.

Public Hearing Closed

Mr. Brocious moved to recommend approval of the preliminary plan and final plat for plats A, B and C of the AF 10 Project, with the finding and condition listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report.

Mr. Ryan Hunter seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**

Rod Brocious Aye

The motion carried.

Ms. Anderson wanted it noted that she votes aye because the requirements have been met, but she wants the council to understand that infrastructure is a paramount consideration of this commission. Mr. Brocious, Mr. Christiansen, Mr. Dupaix, Mr. Ryan Hunter and Chairman Woffinden all expressed agreement with her comments.

Mr. Sensanbaugher encouragesd the commissioners to feel free to communicate in any appropriate way their concerns to the council.

6. Hearing, review and action on the preliminary plan and final plat for AF PD South located in the area of 900 West 620 South in the PR-3.0 Planned Residential zone

Mr. Olsen said that the Planning Commission approved a preliminary plan for the AF PD South Subdivision at its December 4, 2019 meeting. The proposal consisted of 24 units with an overall density of 3.8 du/ac. Since the time of initial approval, the applicant has redesigned the layout; largely clustering the townhome units to the west of 900 West and increasing the open space area east of 900 West. The overall density has been reduced from 3.8 du/ac to 3.5 du/ac.

Within the AF PD South subdivision, 22 lots/units are proposed. Access is provided off 900 West, through 800 South and 650 South, both public streets. An open space area exists in the center of the subdivision, to be dedicated to the City. Additional common area is proposed around the attached/townhome units, west of 900 West. Conservation subdivisions within the PR-3.0 zone require 25% open space. The subdivision meets this requirement.

As with other development options in the PR-3.0 zone, the Code allows the Planning Commission flexibility to require changes in the plan. Changes may include, but are not limited to, "adjustments in the density or number of structures, relocation of project elements, redesign of the road system, increase in the amount of open space and provisions for the disposal of surface water drainage" (17.7.503.D.

Mr. Dupaix expressed concern about pedestrians crossing 900 West to get to the open space, young families will be affected.

Mr. Olsen said that there will be crossings at the roundabouts and to the south, but he does understand the concern.

Mr. Ben Hunter stated that improved pedestrian access is a good idea. Everything else that is required is in place. Roads that end in stubs will connect in the future.

Mr. Dupaix asked about the possibility of a mid-block crossing or possibly flashing beacons.

Mr. Ben Hunter said that they already had concerns about accessibility for emergency vehicles, and a mid-block crossing may create a traffic-calming device.

Mr. Ken Berg has no other concerns, he said that he has tried to get the best layout for the city with this parcel. He hopes people will follow the wide trails to get to the open space.

Public Hearing Opened

Previous emails from Ms. Lloyd and Ms. Chadwick apply to this development as well.

Public Hearing Closed

Mr. Ryan Hunter moved to recommend approval of the preliminary plan and final plat for AF PD South, with the finding and condition listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report, and subject to city council agreeing to improvements in the area.

Ms. Anderson has concerns that this means this specific development is on hold if council doesn't commit, but other developments can go forward because they don't have this condition.

Mr. Ryan Hunter said that he understands that this is just a recommendation, hinging on the city council committing to infrastructure improvements before they approve the developments.

Ms. Anderson thinks that we should be consistent with all the development in this area. This is a hard thing that they keep coming up against every meeting. They are having a hard time without further commitment from the council.

Chairman Woffinden thinks it is unfair to tie conditions to specifically one development, and he hopes that council should understand that it applies to all.

Mr. Brocious thinks that the motion should be amended.

Mr. Ryan Hunter amends the motion to recommend approval in the standard way.

Mr. Dupaix seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

7. Hearing, review and action on the preliminary plan and final plat for The Yard Plat A Subdivision located at 200 South 1100 West in the TOD-Transit Oriented Development zone

Mr. Olsen stated that this item and the following item will be discussed together, with the focus beginning on Edgewater North. He then moves to item 8.

The Yard is a subdivision located at approximately 1100 West 200 South. The property received approval of a district framework plan in 2019, followed by a block plan (staff level review). As part of the lot plan submittal and review (staff level review), a subdivision plat was necessary. The subdivision is intended for higher density, multi-family use. Adherence to the TOD Code as it relates to lot types has been met. Further review at staff level will ensure placement of structures, including setbacks, height, landscaping, parking, etc. to be compliance with the TOD Code. The subdivision plat acts as a formal instrument in proceeding toward placement of these structures and ultimate development of the site. Cross access and parking easements are noted on the plat.

Public Hearing Opened

Public Hearing Closed

Mr. Dupaix moved to recommend approval of the preliminary plan and final plat for The Yard, Plat A Subdivision, with the finding and condition listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report.

Ms. Anderson seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

8. Hearing, review and action on the preliminary and final plat for the Edgewater North Subdivision located at 200 South 1100 West in the TOD-Transit Oriented Development zone

Mr. Olsen said that Edgewater North is largely intended to provide rights-of-way for 1100 West, 300 South, 350 South and 1200 West. The subdivision proposes 4 lots; Lots 1 and 3 will be further

divided and developed into a higher density multi-family project (The Yard Subdivision). Lots 2 and 4 will be further divided and developed into medium density residential uses (townhomes). Edgewater North is located at approximately 1100 West 200 South, extending from 200 South to 350 South. The area received approval of a district framework plan in 2019, followed by a block plan (staff level review). As part of the lot plan submittal and review (staff level review), subdivision plats were necessary. Further review at staff level will ensure placement of structures, including setbacks, height, landscaping, parking, etc. to be compliance with the TOD Code. The subdivision plat acts as a formal instrument in proceeding toward placement of these structures and ultimate development of the site

Mr. Ben Hunter indicated that some of the improvements of 200 South are included in this project. This project's engineer is coordinating with staff for improvements on frontage on 200 South. They have been working with Ensign Engineering and a lot of coordination between developments is happening. Additional infrastructure meets the master plan requirements.

Mr. Brocious asked if the widening shown is for the right-turn lane.

Mr. Ben Hunter affirmed, the jog in the line is to mitigate consequences to TSSD and other utilities. Curb and gutter will extend along 1100 West and transition into 200 South.

Public Hearing Opened

Public Hearing Closed

Mr. Dupaix moved to recommend approval of the preliminary and final plat for the Edgewater North Subdivision, with the finding listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report.

Ms. Anderson seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

9. Hearing, review and action on the preliminary plan and final plat for Stonecreek Plat D Conservation PUD, consisting of 25 lots, located in the area of 700 South 330 West in the PR-3.0 Planned Residential zone

Mr. Olsen stated that Stonecreek Plat D is a 25-lot phase of an overall 143-acre development. The preliminary plan is being processed concurrently with the final plat. The final plat is consistent with terms of a preliminary plan approval. Plat D is located directly south of an open space area dedicated with a previous plat, and access is provided off 700 South.

Conservation Subdivision Projects within the PR-3.0 zone must adhere to certain parameters. Subdivisions must have a minimum project area of five (5) acres, and a maximum density of 3 units per acre. Plat D is the fourth phase in a 143-acre development, with an overall density of 3 units per acre; falling within the parameters of a Conservation Subdivision project in the PR-3.0 zone.

As with plats A, B and C, the applicants request Planning Commission consideration and allowance for modification of building site requirements, allowing the ability to average lot sizes in order for greater overall consistency. This modification is allowed pursuant to Sections 17.7.401, allowing the "harmonizing (of) development within a project". The Planning Commission may, but is not required, to make this finding. A finding allowing the modification is offered below.

Conservation Subdivisions within a PR-3.0 zone require 25% open space. The overall project area provides for 26% open space upon buildout. Plats A, B and C provided dedication of land. Plat D furthers this dedication with wetland areas dedicated along the northern boundary of the subdivision. These wetland areas serve and important habitat for a number of species, most notably the Monarch Butterfly. Studies are being conducted in the open space area, tracking these butterflies. Ultimately, the City will have area for a larger, regional type park upon completion of the Stonecreek development. While wetland areas are present, areas for traditional park development are also included in the overall area.

Mr. Ben Hunter told commissioners that improvements will be minimal along 700 South, he has no major concerns.

Mr. Robbie Thompson, developer, says that this is a continuation of other plats previously approved. The lots are a little bigger than the other plats, but there are no basements, high water table.

Public Hearing Opened

Public Hearing Closed

Mr. Christiansen moved to recommend approval of the preliminary plan and final plat for Stonecreek Plat D Conservation PUD, with the finding listed in the staff report and subject to any findings, conditions and modifications listed in the Engineering report.

Mr. Brocious seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

10. Hearing, review and action on the Loveridge zone map amendment from the RA-5 Residential Agricultural zone to the R-1-9,000 Residential zone located in the area of 508 South Storrs Avenue

Chairman Woffinden indicated that items 10 and 11 will be discussed together and voted on separately.

Mr. Olsen indicated that the applicant proposes a zone map amendment in order to subdivide property into additional lots (subdivision plat follows this item). The City's Land Use Plan designates the area as "Low Density Residential" and the change to the R1-9,000 zone supports the underlying Land Use Plan. This is a 2-lot plat. Current use of nearby properties is residential and residential/agriculture.

Public Hearing Opened

Public Hearing Closed

Mr. Dupaix moved to recommend approval of the Loveridge zone map amendment.

Mr. Ryan Hunter seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**

Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

11. Hearing, review and action on the preliminary plan and final plat for the Loveridge Subdivision Plat A, located in the area of 508 South Storrs Avenue

Mr. Olsen stated that the area of the proposed subdivision is also subject to a zone change (previous item on the March 18, 2020 Planning Commission agenda). Approval of the subdivision is dependent on the zone change. The applicant intends to subdivide the property into two lots, both lots exceeding the minimum requirements of the R1-9,000 zone. Lots will access 480 South, a newly constructed residential street within the Stonecreek subdivision. Lot 1 will consist of .85 acres and Lot 2 will consist of .30 acres. An area of delineated wetlands is illustrated on the plat.

Public Hearing Opened

Public Hearing Closed

Mr. Dupaix moved to recommend approval of the preliminary plan and recommend approval of the final plat of Loveridge Subdivision Plat A, with the finding and condition listed in the staff report and subject to any findings, conditions, and modifications listed in the engineering report.

Ms. Anderson seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

12. Hearing, review and action on a land use amendment located at 700 North 900 West from the residential low density to the professional office designation

Chairman Woffinden indicated that items 12 and 13 will be discussed together and voted on separately.

Mr. Olsen stated that the applicant proposes to amend the land use and zone map designations for an area at the northeast corner of 700 North 900 West from residential designations to a professional office designation. The area currently has an approved residential subdivision (Mitchell Farms). The applicant would like to construct an orthodontist office. A conceptual design is included in the submittal materials for reference.

In the past, both the Planning Commission and City Council have felt that commercial uses along 900 West should not extend north of 700 North. If the intent of the Commission and Council is to hold firm on that view, staff recommends denial of the amendments.

Chairman Woffinden thinks that 700 North is still intended to be the cutoff.

Mr. Reid Swenson, property owner, would like to build an orthodontist office on this corner lot. It's not an ideal residential lot with the traffic, he thinks it would be a good, quiet business to have there. They would be open from 8 am to 5 pm.

Chairman Woffinden asked if the entire building will be an orthodontist office.

Mr. Swenson said half would be orthodontist and half endodontist.

Ms. Anderson thinks that there should be a strong line to keep the residential area intact and protected from commercial encroachment.

Mr. Swenson said that when the 700 North line was drawn, there was a concern from big box stores like Costco encroaching over 900 West. Obviously this is different and would fit in better.

Chairman Woffinden indicated that the IFA and blood center were the motivators to draw a strong line.

Ms. Anderson said that this is a mild use, but if we say yes to commercial beyond the line then it opens the door to other businesses.

Mr. Swenson asked about the lot to the south, where a barn is, and if that could go commercial.

Mr. Olsen stated that it's still zoned residential, but it would be a more palatable choice as it's adjacent to other commercial. There already is an approved plan for a residential subdivision nearby.

Public Hearing Opened

There were several public comments from residents regarding the proposed land use and zone map change. They are as follows:

Mr. Larry Olsen - My family and I live in Cambridge Court. I saw the proposal to change the zoning of 700 N 900 W (northeast corner) from residential to commercial. In my opinion, that doesn't make sense as it is surrounded by residential property on all sides and would increase traffic and noise for those homes making it less safe for the residents of the area, including my family. We walk past that area often to walk to the nearest park. Please vote AGAINST rezoning. The area should be kept residential as originally planned.

Mr. Tyler Skidmore - What are your plans to access this development? Are you planning on using 6500 west? Are you planning on using 7300 north? Are these county roads? Who is going to replace the damaged road due to construction traffic? Are you going to have the same issue that you already have on 200south?

Ms. Reva Cook- I live across the street from this address and have for 7 1/2 years. I do not wish for there to be a business of any kind in this area. I wish for it to remain low density residential only. I don't want a business and the additional traffic and noise it would bring to the area.

Mr. John Mulholland- I became aware today that there is an effort to rezone a portion of the Mitchell Farms property to become professional offices. I oppose this rezoning. We already went through the IFA rezoning and development and were told that is where it would stop. Mr. Mitchell even reassured me that his property would stay residential. That corner seems like a great place as a barrier between residential and commercial properties.

Mr. Brandon Anderson - My family and I have lived in the Cambridge Court neighborhood just west of 900W for 7.5 years. We love our neighborhood and community.We support the current zone and land use maps and believe businesses should not be allowed north of 700N. Please vote against the request to amend the maps. I'm happy to share additional thoughts if desired.

Mr. Dan Duncan - I live in the Mitchell Farms subdivision and I support the current zone and land use maps and think businesses should not be allowed here. Please vote against the request to amend maps for commercial zoning in this area. Thanks.

Ms. Micki Cottam - I am a resident who lives directly on 700 N, only a few houses away from the intersection of 900 W and 700 N. I write to implore you not to change the zoning of this corner parcel from residential to commercial but to protect my neighborhood and community by maintaining the residential zoning.

I am a mother of four small children who, especially amidst the social restrictions, spend a lot of time playing outdoors including their front yard right on 700 N. As it is now, the speeding (it is a residential 25 mph speed limit) and distracted driving I witness constantly on 700 N is dangerous (and sometimes shocking) enough that I fear for my children and have strict rules on how they are allowed to play in their own front yard. Since the Patterson development has sprung up across the street from me in place

of the Mitchell's orchards, I have noticed some drivers are becoming more cautious and regard the area with the respect a residential area full of families with young children deserves. This would not be the case with a commercial property so close. Those driving and visiting around homes drive and behave much more respectfully than those rushing to an appointment or a business.

Being so close to commercial properties already, we have become accustomed to hearing sirens, disturbances, bright lights late at night, loud customers, and cars dangerously peeling out of parking lots. However, I am daily grateful that those occurrences are tucked around the corner and not directly on my street.

I sincerely ask you to please help maintain the integrity of my neighborhood and the growth of the community of families that surround my children on a daily basis by keeping the zoning as residential. I fear the corrosion and creep of commercial into my neighborhood and the naturally dangerous, or simply disrupting, disturbances it would bring to my daily life and how I raise my family.

Ms. Kristie Jensen - My family and I have lived in the area for just over 2 yrs (in the newer Woodside homes). We appreciate current zoning in our area. We support the current zone and land use maps and believe businesses **should not be allowed** north of 700N. Please vote against the request to amend the maps.

Mr. Shane Armitage - I am an A.F. City resident in the area of 900W 700N. I'd like to voice my opinion that the area in question (corner of 900W and 700N) remain zoned residential. Please retain a hard line of residential zoning north of 700N. Ideally, consider turning some of that into green space.

Ms. Lacy Anderson - I am a resident of American Fork just across 900 W from the parcel in question. I understand it is currently zoned for residential but you are considering re-zoning it for business. I am strongly against this re-zoning. I have lived in this neighborhood for about 8 years, and my family and I love it's neighborhood feel- even though we are close to Costco and other commercial buildings.

I think the commission was wise when they zoned this area as residential from 700 N continuing north. We want this area to remain residential. Thank you for your time.

Ms. Karen Auman - I read with interest the item on the agenda to rezone the property at the northeast corner of 900 West and 700 North, which is an area surrounded by family homes.

I live very near there and am adamantly opposed to the casual rezoning of residential land to commercial. When the city bows to the demands of developers, it irrevocably changes the nature and character of our neighborhoods.

My opposition stems from the City's decision to rezone land to build the very large IFA store. In that contentious process, IFA made several promises to the City in order to get the desired change. Predictably, IFA regularly breaks their promises, and we have struggled to get enforcement. The building is built, and our wonderful neighborhood is impacted by the consequences of the City rolling over for developers. Please consider the long-term of our city, and the residents of American Fork; stick to the master plan and master zoning designations.

Mr. Clint Cook - I live across the street from 900 W and 700 N. There is no need to change the zoning to allow business to build there. There are several reasons why this corner should remain zoned as residential.
900 W is already too busy, and with new housing development continuing to go in, the local residential traffic will increase on 900 W. Allowing offices to be built on this corner will only increase the traffic, and make the problem worse. There is a housing development currently be build on all sides of this lot. I makes no sense to carve out one corner so orthodontist can have an office there. Home owners do not want their properties to border businesses. Allowing this corner to become business offices will decrease the property value of the surrounding residential properties, and change the look and feel of the neighborhood.
There is still plenty of space in the Meadows Business Park (Walmart, Home Depot, Target area). This area has an incredible amount of consumer traffic, is less than 1/4 mile from the lot in question. There is no need for more office space, when there is plenty of commercial space available. The available space is in a prime location. The only reason I could see for the orthodontist to want this corner rezoned is to make money as a developer. Renting and leasing the remaining office space for profit, not because there is no other space available for his office. He is approaching this as a developer, under the guise of a friendly neighborhood doctor wanting to provide a valuable community service. 700 North makes a very logical boundary between commercial and residential zoning. Keeping commercial zoning limited to the south of 700 N would help maintain the quiet, family friendly feeling of the surrounding areas. Something that is becoming more rare, but highly sought.I struggle to understand the need, or see a logical reason why this property needs to be rezoned, other than a few private individuals are looking to make $$, with little thought or concern about the impact it would have on the surrounding neighborhoods. Please do not allow rezoning of the 900 W 700 N corner.

Ms. Allison Duncan - We just moved into the Mitchell farms and I would not have moved here if I would have known the zoning would be changed to businesses. We support the current zone and land use maps and think businesses should not be allowed here. Please vote against the request to amend maps.

Mr. Nathan Price - I am the head of household at the Price residence located at 799 N. 920 W. American Fork, UT, 84003. We have lived in the Cambridge Court neighborhood since March 2013.

We align with the thoughts of our neighbors and friends who support the CURRENT zone and land use maps designed for residential purposes. We believe businesses should NOT be allowed north of 700N. Please take into consideration the opinions of the vast majority of neighborhood residents in this area by VOTING AGAINST the request to amend or rezone the maps. If you are interested in hearing specific concerns, feel free to contact me.

Ms. Brittney Gonzalez - My family moved to the Woodside development adjacent to 900 West in 2017. We are strongly against changing the zoning to allow business development north of 700 North, and do NOT support a zoning amendment. Please consider the well-being of children who use that crosswalk to access other neighborhoods and church buildings, and increased traffic so close to

residential areas. A commercial building in that location would be a detriment to our community. Thank you for your time and consideration in this matter.

Mr. Luis Gonzalez – My family and I have lived in the Cambridge Court neighborhood just west of 900 W. for 7.5 years. We love our neighborhood and community. We support the current zone and land use maps and believe businesses should not be allowed north of 700 N. Please vote against the request to amend the maps. I'm happy to share additional thoughts if desired.

Ms. Lynlee Price - We moved to the Cambridge Court neighborhood (just west of 900 W.) seven years ago. We have loved our time here and plan on staying long-term. We have supported the current zoning, and believe businesses should not be allowed north of 700 N. The increase in traffic would be very unfortunate. Please vote against the request to amend the maps!

Public Hearing Closed

Mr. Christiansen moved to recommend denial of the land use amendment.

Mr. Dupaix seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

13. Hearing, review and action on a zone map amendment located at 700 North 900 West from the RA-5 and R-1-12,000 zones to the PO-1 Professional Office designation

Public Hearing Opened

Previous email comments apply to this agenda item as well.

Public Hearing Closed

Mr. Christiansen moved to recommend denial of the zone map amendment.
Mr. Dupaix seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

14. Hearing, review and action on amendments to the General Plan by providing a recommendation on the 2019 Storm Drain Master Plan and Impact Fee Facility Plan

Mr. Ben Hunter indicated that the Engineering Division recommends approval of the proposed general plan amendments for the public facilities and service elements of the storm water system master plan. These updates reflect current development needs related to public infrastructure. These updates are consistent with the long-term planning and engineering goals for the City and are not detrimental to the general health, safety and welfare of its citizens.

Public Hearing Opened

Public Hearing Closed

Mr. Ryan Hunter moved to recommend approval of the General Plan Amendments relating to the Storm Drain Master Plan and Impact Fee Facility Plan.

Mr. Brocious seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Aye**

The motion carried.

15. Other Business

Ms. Anderson suggested that with the new online meetings, it would be helpful and appropriate to thank developers when their item is finished with discussion so that they know when they can leave the meeting.

16. Site Plan Committee Report

Mr. Knobloch reviewed the upcoming Planning Commission items, these include quite a few developments moving through TRC. They are not quite ready, so the next meeting will be very short. The item that was tabled today will be back on the April 22 agenda.

17. Review and action on the minutes of the March 4, 2020 Planning Commission Regular Session

Ms. Anderson moved to recommend approval of the minutes of the March 4, 2020 Planning Commission Regular Session.

Mr. Dupaix seconded the motion. Voting was as follows:

Chairman Woffinden	**Aye**
Chris Christiansen	**Aye**
Christine Anderson	**Aye**
Geoff Dupaix	**Aye**
Harold Dudley	**Aye**
Ryan Hunter	**Aye**
Rod Brocious	**Abstain**

The motion carried.

18. Adjournment

Ms. Anderson moved to adjourn.
Mr. Dupaix seconded the motion. All concurred.

Meeting adjourned at 10:00 pm.

Lisa Halversen, Administrative Assistant