ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
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Janice K. Brewer
Governor

Henry R. Darwin
Director

DEC 30 2013

Mr. Jared Blumenfeld, Regional Administrator
U.S. Environmental Protection Agency, Region IX
Mail Code ORA-1
75 Hawthorne Street
San Francisco, CA 94105

RE: Arizona State Implementation Plan Revision for the West Pinal County PM_{10} Nonattainment Area

Dear Mr. ~~Blumenfeld~~ Jared:

Consistent with the provisions of Arizona Revised Statutes §§ 49-104, 49-106, 49-404, 49-406 and 49-425 (Enclosure1) and the Code of Federal Regulations (CFR) Title 40, §§ 51.102 through 51.104, the Arizona Department of Environmental Quality (ADEQ) hereby adopts and submits to the U.S. Environmental Protection Agency (EPA) the *Arizona State Implementation Plan Revision for the West Pinal County PM_{10} Nonattainment Area* as a revision to the Arizona State Implementation Plan (SIP).

ADEQ is submitting this State Implementation Plan for the West Pinal County PM_{10} Nonattainment Area that consists of five chapters to present background information, monitoring network, emissions inventory, base year modeling, and commitments to comply with additional Clean Air Act requirements.

This SIP revision is in support of the Clean Air Act requirements for the 1987 24-hour PM_{10} National Ambient Air Quality Standard for Pinal County. To comply with remaining requirements, ADEQ commits to submitting control measure selection and analysis, reasonable further progress, prevention of significant deterioration/new source review, transportation conformity, contingency measures, attainment demonstration, and commitments.

Enclosure 2 contains the SIP Completeness Checklist. Enclosure 3 contains the Final Arizona State Implementation Plan Revision for the West Pinal County PM_{10} Nonattainment Area. Enclosure 4 contains the public process documentation. Two additional paper copies are included as well as a CD with an electronic copy of the final submittal.

If you have any questions, please contact me at (602) 771-2288.

Sincerely,

Eric C. Massey, Director
Air Quality Division

Enclosures (4)

cc: Colleen McKaughan, EPA Region IX, w/o enclosures
Don Gabrielson, Director, Pinal County Air Quality Control District, w/o enclosures

Janice K. Brewer
Governor

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
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Henry R. Darwin
Director

February 25, 2011

TO: Eric Massey
Division Director
Air Quality Division

Under A.R.S. §49-104(D)(2), I authorize you, Eric Massey, Division Director, Air Quality Division, Arizona Department of Environmental Quality, to perform any act, including execution of any pertinent documents, which I as Director of the Arizona Department of Environmental Quality am authorized or required to do by law with respect to A.R.S. Title 49, chapters 1 and 3 and any other acts relating to air quality including personnel actions. This authority shall remain in effect until it is revoked or you resign. You may further delegate this authority in the best interest of the agency, however, those delegations must be in writing and you must forward a copy of any further delegations to me.

This delegation is effective February 25, 2011. I ratify all acts performed by you as Air Quality Division Director concerning the duties and functions in this delegation letter.

Henry R. Darwin
Director

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ENCLOSURE 1

Arizona Revised Statues §§ 49-104, 49-106, 49-404, 49-406, and 49-425

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49-104. Powers and duties of the department and director

A. The department shall:

1. Formulate policies, plans and programs to implement this title to protect the environment.

2. Stimulate and encourage all local, state, regional and federal governmental agencies and all private persons and enterprises that have similar and related objectives and purposes, cooperate with those agencies, persons and enterprises and correlate department plans, programs and operations with those of the agencies, persons and enterprises.

3. Conduct research on its own initiative or at the request of the governor, the legislature or state or local agencies pertaining to any department objectives.

4. Provide information and advice on request of any local, state or federal agencies and private persons and business enterprises on matters within the scope of the department.

5. Consult with and make recommendations to the governor and the legislature on all matters concerning department objectives.

6. Promote and coordinate the management of air resources to assure their protection, enhancement and balanced utilization consistent with the environmental policy of this state.

7. Promote and coordinate the protection and enhancement of the quality of water resources consistent with the environmental policy of this state.

8. Encourage industrial, commercial, residential and community development that maximizes environmental benefits and minimizes the effects of less desirable environmental conditions.

9. Assure the preservation and enhancement of natural beauty and man-made scenic qualities.

10. Provide for the prevention and abatement of all water and air pollution including that related to particulates, gases, dust, vapors, noise, radiation, odor, nutrients and heated liquids in accordance with article 3 of this chapter and chapters 2 and 3 of this title.

11. Promote and recommend methods for the recovery, recycling and reuse or, if recycling is not possible, the disposal of solid wastes consistent with sound health, scenic and environmental quality policies. Beginning in 2014, the department shall report annually on its revenues and expenditures relating to the solid and hazardous waste programs overseen or administered by the department.

12. Prevent pollution through the regulation of the storage, handling and transportation of solids, liquids and gases that may cause or contribute to pollution.

13. Promote the restoration and reclamation of degraded or despoiled areas and natural resources.

14. Assist the department of health services in recruiting and training state, local and district health department personnel.

15. Participate in the state civil defense program and develop the necessary organization and facilities to meet wartime or other disasters.

16. Cooperate with the Arizona-Mexico commission in the governor's office and with researchers at universities in this state to collect data and conduct projects in the United States and Mexico on issues that are within the scope of the department's duties and that relate to quality of life, trade and economic development in this state in a manner that will help the Arizona-Mexico commission to assess and enhance the economic competitiveness of this state and of the Arizona-Mexico region.

17. Unless specifically authorized by the legislature, ensure that state laws, rules, standards, permits, variances and orders are adopted and construed to be consistent with and no more stringent than the corresponding federal law that addresses the same subject matter. This provision shall not be construed to adversely affect standards adopted by an Indian tribe under federal law.

B. The department, through the director, shall:
1. Contract for the services of outside advisers, consultants and aides reasonably necessary or desirable to enable the department to adequately perform its duties.
2. Contract and incur obligations reasonably necessary or desirable within the general scope of department activities and operations to enable the department to adequately perform its duties.
3. Utilize any medium of communication, publication and exhibition when disseminating information, advertising and publicity in any field of its purposes, objectives or duties.
4. Adopt procedural rules that are necessary to implement the authority granted under this title, but that are not inconsistent with other provisions of this title.
5. Contract with other agencies, including laboratories, in furthering any department program.
6. Use monies, facilities or services to provide matching contributions under federal or other programs that further the objectives and programs of the department.
7. Accept gifts, grants, matching monies or direct payments from public or private agencies or private persons and enterprises for department services and publications and to conduct programs that are consistent with the general purposes and objectives of this chapter. Monies received pursuant to this paragraph shall be deposited in the department fund corresponding to the service, publication or program provided.
8. Provide for the examination of any premises if the director has reasonable cause to believe that a violation of any environmental law or rule exists or is being committed on the premises. The director shall give the owner or operator the opportunity for its representative to accompany the director on an examination of those premises. Within forty-five days after the date of the examination, the department shall provide to the owner or operator a copy of any report produced as a result of any examination of the premises.
9. Supervise sanitary engineering facilities and projects in this state, authority for which is vested in the department, and own or lease land on which sanitary engineering facilities are located, and operate the facilities, if the director determines that owning, leasing or operating is necessary for the public health, safety or welfare.
10. Adopt and enforce rules relating to approving design documents for constructing, improving and operating sanitary engineering and other facilities for disposing of solid, liquid or gaseous deleterious matter.
11. Define and prescribe reasonably necessary rules regarding the water supply, sewage disposal and garbage collection and disposal for subdivisions. The rules shall:
(a) Provide for minimum sanitary facilities to be installed in the subdivision and may require that water systems plan for future needs and be of adequate size and capacity to deliver specified minimum quantities of drinking water and to treat all sewage.
(b) Provide that the design documents showing or describing the water supply, sewage disposal and garbage collection facilities be submitted with a fee to the department for review and that no lots in any subdivision be offered for sale before compliance with the standards and rules has been demonstrated by approval of the design documents by the department.
12. Prescribe reasonably necessary measures to prevent pollution of water used in public or semipublic swimming pools and bathing places and to prevent deleterious conditions at such places. The rules shall prescribe minimum standards for the design of and for sanitary conditions at any public or semipublic swimming pool or bathing place and provide for abatement as public nuisances of premises and facilities that do not comply with the minimum standards. The rules shall be developed in cooperation with the director of the department of health services and shall be consistent with the rules adopted by the director of the department of health services pursuant to section 36-136, subsection H, paragraph 10.
13. Prescribe reasonable rules regarding sewage collection, treatment, disposal and reclamation systems to prevent the transmission of sewage borne or insect borne diseases. The rules shall:
(a) Prescribe minimum standards for the design of sewage collection systems and treatment, disposal and reclamation systems and for operating the systems.
(b) Provide for inspecting the premises, systems and installations and for abating as a public nuisance any collection system, process, treatment plant, disposal system or reclamation system that does not comply with the minimum standards.
(c) Require that design documents for all sewage collection systems, sewage collection system extensions, treatment plants, processes, devices, equipment, disposal systems, on-site wastewater treatment facilities and reclamation systems be submitted with a fee for review to the department and may require that the design documents anticipate and provide for future sewage treatment needs.
(d) Require that construction, reconstruction, installation or initiation of any sewage collection system, sewage collection system extension, treatment plant, process, device, equipment, disposal system, on-site wastewater treatment facility or reclamation system conform with applicable requirements.
14. Prescribe reasonably necessary rules regarding excreta storage, handling, treatment, transportation and disposal. The rules shall:
(a) Prescribe minimum standards for human excreta storage, handling, treatment, transportation and disposal and shall provide for inspection of premises, processes and vehicles and for abating as public nuisances any premises, processes or vehicles

that do not comply with the minimum standards.
(b) Provide that vehicles transporting human excreta from privies, septic tanks, cesspools and other treatment processes shall be licensed by the department subject to compliance with the rules. The department may require payment of a fee as a condition of licensure. After the effective date of this amendment to this section, the department shall establish by rule a fee as a condition of licensure, including a maximum fee. As part of the rule making process, there must be public notice and comment and a review of the rule by the joint legislative budget committee. After September 30, 2013, the department shall not increase that fee by rule without specific statutory authority for the increase. The fees shall be deposited, pursuant to sections 35-146 and 35-147, in the solid waste fee fund established by section 49-881.
15. Perform the responsibilities of implementing and maintaining a data automation management system to support the reporting requirements of title III of the superfund amendments and reauthorization act of 1986 (P.L. 99-499) and title 26, chapter 2, article 3.
16. Approve remediation levels pursuant to article 4 of this chapter.
17. Establish or revise fees by rule pursuant to the authority granted under title 44, chapter 9, article 8 and chapters 4 and 5 of this title for the department to adequately perform its duties. All fees shall be fairly assessed and impose the least burden and cost to the parties subject to the fees. In establishing or revising fees, the department shall base the fees on:
(a) The direct and indirect costs of the department's relevant duties, including employees salaries and benefits, professional and outside services, equipment, in-state travel and other necessary operational expenses directly related to issuing licenses as defined in title 41, chapter 6 and enforcing the requirements of the applicable regulatory program.
(b) The availability of other funds for the duties performed.
(c) The impact of the fees on the parties subject to the fees.
(d) The fees charged for similar duties performed by the department, other agencies and the private sector.
C. The department may:
1. Charge fees to cover the costs of all permits and inspections it performs to ensure compliance with rules adopted under section 49-203, except that state agencies are exempt from paying the fees. Monies collected pursuant to this subsection shall be deposited, pursuant to sections 35-146 and 35-147, in the water quality fee fund established by section 49-210.
2. Contract with private consultants for the purposes of assisting the department in reviewing applications for licenses, permits or other authorizations to determine whether an applicant meets the criteria for issuance of the license, permit or other authorization. If the department contracts with a consultant under this paragraph, an applicant may request that the department expedite the application review by requesting that the department use the services of the consultant and by agreeing to pay the department the costs of the consultant's services. Notwithstanding any other law, monies paid by applicants for expedited reviews pursuant to this paragraph are appropriated to the department for use in paying consultants for services.
D. The director may:
1. If the director has reasonable cause to believe that a violation of any environmental law or rule exists or is being committed, inspect any person or property in transit through this state and any vehicle in which the person or property is being transported and detain or disinfect the person, property or vehicle as reasonably necessary to protect the environment if a violation exists.
2. Authorize in writing any qualified officer or employee in the department to perform any act that the director is authorized or required to do by law.

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49-106. Statewide application of rules

The rules adopted by the department apply and shall be observed throughout this state, or as provided by their terms, and the appropriate local officer, council or board shall enforce them. This section does not limit the authority of local governing bodies to adopt ordinances and rules within their respective jurisdictions if those ordinances and rules do not conflict with state law and are equal to or more restrictive than the rules of the department, but this section does not grant local governing bodies any authority not otherwise provided by separate state law.

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49-404. State implementation plan

A. The director shall maintain a state implementation plan that provides for implementation, maintenance and enforcement of national ambient air quality standards and protection of visibility as required by the clean air act.

B. The director may adopt rules that describe procedures for adoption of revisions to the state implementation plan.

C. The state implementation plan and all revisions adopted before September 30, 1992 remain in effect according to their terms, except to the extent otherwise provided by the clean air act, inconsistent with any provision of the clean air act, or revised by the administrator. No control requirement in effect, or required to be adopted by an order, settlement agreement or plan in effect, before the enactment of the clean air act in any area which is a nonattainment or maintenance area for any air pollutant may be modified after enactment in any manner unless the modification insures equivalent or greater emission reductions of the air pollutant. The director shall evaluate and adopt revisions to the plan in conformity with federal regulations and guidelines promulgated by the administrator for those purposes until the rules required by subsection B are effective.

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49-406. Nonattainment area plan

A. For any ozone, carbon monoxide or particulate nonattainment or maintenance area the governor shall certify the metropolitan planning organization designated to conduct the continuing, cooperative and comprehensive transportation planning process for that area under 23 United States Code section 134 as the agency responsible for the development of a nonattainment or maintenance area plan for that area.

B. For any ozone, carbon monoxide or particulate nonattainment or maintenance area for which no metropolitan planning organization exists, the department shall be certified as the agency responsible for development of a nonattainment or maintenance area plan for that area.

C. For any ozone, carbon monoxide or particulate nonattainment or maintenance area, the department, the planning agency certified pursuant to subsection A of this section on behalf of elected officials of affected local government, the county air pollution control department or district, and the department of transportation shall, by November 15, 1992, and from time to time as necessary, jointly review and update planning procedures or develop new procedures.

D. In preparing the procedures described in subsection C of this section, the department, the planning agency certified pursuant to subsection A of this section on behalf of elected officials of affected local government, the county air pollution control department or district, and the department of transportation shall determine which elements of each revised implementation plan will be developed, adopted, and implemented, through means including enforcement, by the state and which by local governments or regional agencies, or any combination of local governments, regional agencies or the state.

E. The department, the planning agency certified pursuant to subsection A of this section on behalf of elected officials of affected local government, the county air pollution control department or district, and the department of transportation shall enter into a memorandum of agreement for the purpose of coordinating the implementation of the procedures described in subsection C and D of this section.

F. At a minimum, the memorandum of agreement shall contain:

1. The relevant responsibilities and authorities of each of the coordinating agencies.
2. As appropriate, procedures, schedules and responsibilities for development of nonattainment or maintenance area plans or plan revisions and for determining reasonable further progress.
3. Assurances for adequate plan implementation.
4. Procedures and responsibilities for tracking plan implementation.
5. Responsibilities for preparing demographic projections including land use, housing, and employment.
6. Coordination with transportation programs.
7. Procedures and responsibilities for adoption of control measures and emissions limitations.
8. Responsibilities for collecting air quality, transportation and emissions data.
9. Responsibility for conducting air quality modeling.
10. Responsibility for administering and enforcing stationary source controls.
11. Provisions for the timely and periodic sharing of all data and information among the signatories relating to:

(a) Demographics.
(b) Transportation.
(c) Emissions inventories.
(d) Assumptions used in developing the model.
(e) Results of modeling done in support of the plan.
(f) Monitoring data.

G. Each agency that commits to implement any emission limitation or other control

measure, means or technique contained in the implementation plan shall describe that commitment in a resolution adopted by the appropriate governing body of the agency. The resolution shall specify the following:
1. Its authority for implementing the limitation or measure as provided in statute, ordinance or rule.
2. A program for the enforcement of the limitation or measure.
3. The level of personnel and funding allocated to the implementation of the measure.
H. The state, in accordance with the rules adopted pursuant to section 49-404, and the governing body of the metropolitan planning organization shall adopt each nonattainment or maintenance area plan developed by a certified metropolitan planning organization. The adopted nonattainment or maintenance area plan shall be transmitted to the department for inclusion in the state implementation plan provided for under section 49-404.
I. After adoption of a nonattainment or maintenance area plan, if on the basis of the reasonable further progress determination described in subsection F of this section or other information, the control officer determines that any person has failed to implement an emission limitation or other control measure, means or technique as described in the resolution adopted pursuant to subsection G of this section, the control officer shall issue a written finding to the person, and shall provide an opportunity to confer. If the control officer subsequently determines that the failure has not been corrected, the county attorney, at the request of the control officer, shall file an action in superior court for a preliminary injunction, a permanent injunction, or any other relief provided by law.
J. After adoption of a nonattainment or maintenance area plan, if, on the basis of the reasonable further progress determination described in subsection F of this section or other information, the director determines that any person has failed to implement an emission limitation or other control measure, means or technique as described in the resolution adopted pursuant to subsection G of this section, and that the control officer has failed to act pursuant to subsection I of this section, the director shall issue a written finding to the person and shall provide an opportunity to confer. If the director subsequently determines that the failure has not been corrected, the attorney general, at the request of the director, shall file an action in superior court for a preliminary injunction, a permanent injunction, or any other relief provided by law.
K. Notwithstanding subsections A and B of this section, in any metropolitan area with a metropolitan statistical area population of less than two hundred fifty thousand persons, the governor shall designate an agency that meets the criteria of section 174 of the clean air act and that is recommended by the city that causes the metropolitan area to exist and the affected county. That agency shall prepare and adopt the nonattainment or maintenance area plan. If the governor does not designate an agency, the department shall be certified as the agency responsible for the development of a nonattainment or maintenance area plan for that area.

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49-425. Rules; hearing

A. The director shall adopt such rules as he determines are necessary and feasible to reduce the release into the atmosphere of air contaminants originating within the territorial limits of the state or any portion thereof and shall adopt, modify, and amend reasonable standards for the quality of, and emissions into, the ambient air of the state for the prevention, control and abatement of air pollution. Additional standards shall be established for particulate matter emissions, sulfur dioxide emissions, and other air contaminant emissions determined to be necessary and feasible for the prevention, control and abatement of air pollution. In fixing such ambient air quality standards, emission standards or standards of performance, the director shall give consideration but shall not be limited to the relevant factors prescribed by the clean air act.

B. No rule may be enacted or amended except after the director first holds a public hearing after twenty days' notice of such hearing. The proposed rule, or any proposed amendment of a rule, shall be made available to the public at the time of notice of such hearing.

C. The department shall enforce the rules adopted by the director.

D. All rules enacted pursuant to this section shall be made available to the public at a reasonable charge upon request.

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ENCLOSURE 2

SIP Completeness Checklist

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STATE IMPLEMENTATION PLAN COMPLETENESS CHECKLIST

Submittal of

Arizona State Implementation Plan Revision for the West Pinal County PM_{10} Nonattainment Area

40 CFR Part 51, Appendix V, *Criteria for Determining the Completeness of Plan Submissions*, contains the "minimum criteria for determining whether a State Implementation Plan submitted for consideration by EPA is an official submission for purposes of review under §51.103," *Submission of plans, preliminary review of plans*. Appendix V requires the following to be included in plan submissions for review by EPA:

1. **"A formal letter of submittal from the Governor or his designee, requesting EPA acceptance of the plan or revision thereof (hereafter ''the plan'')."** [Appendix V, 2.1(a)]

   See cover letter.

2. **"Evidence that the State has adopted the plan in the State code or body of regulations; or issued the permit, order, consent agreement (hereafter ''document'') in final form. That evidence shall include the date of adoption or final issuance as well as the effective date of the plan, if different from the adoption/issuance date."** [Appendix V, 2.1(b)]

   See cover letter.

3. **"Evidence that the State has the necessary legal authority under State law to adopt and implement the plan."** [Appendix V, 2.1(c)]

   See Enclosure 1, ARS 49-104, 49-106, 49-406, and 49-425.

4. **"A copy of the actual regulation, or document submitted for approval and incorporation by reference into the plan, including indication of the changes made (such as, redline/strikethrough) to the existing approved plan, where applicable ..."** [Appendix V, 2.1(d)]

   See Enclosure 3, Chapters 1- 5.

5. **"Evidence that the State followed all of the procedural requirements of the State's laws and constitution in conducting and completing the adoption/issuance of the plan."** [Appendix V, 2.1(e)]

   See Enclosure 4, Public Comment and Hearing Documentation.

6. **"Evidence that public notice was given of the proposed change consistent with procedures approved by EPA, including the date of publication of such notice."** [Appendix V, 2.1(f)]

   See Enclosure 4.

7. **"Certification that public hearing(s) were held in accordance with the information provided in the public notice and the State's laws and constitution, if applicable and consistent with the public hearing requirements in 40 CFR 51.102."** [Appendix V, 2.1(g)]

   See Enclosure 4.

8. **"Compilation of public comments and the State's response thereto."** [Appendix V, 2.1(h)]

   See Enclosure 4.

9. **"Identification of all regulated pollutants affected by the plan."** [Appendix V, 2.2(a)]

   PM_{10}.

10. **"Identification of the locations of affected sources including the EPA attainment/nonattainment designation of the locations and the status of the attainment plan for the affected areas(s)."** [Appendix V, 2.2 (b)]

    See Enclosure 3, Chapter 3.

11. **"Quantification of the changes in plan allowable emissions from the affected sources; estimates of changes in current actual emissions from affected sources or, where appropriate, quantification of changes in actual emissions from affected sources through calculations of the differences between certain baseline levels and allowable emissions anticipated as a result of the revision."** [Appendix V, 2.2(c)]

    ADEQ commits to submit a full plan to comply with the remaining Clean Air Act requirements – See Chapter 5 of the SIP.

12. **"The State's demonstration that the national ambient air quality standards, prevention of significant deterioration increments, reasonable further progress demonstration, and visibility, as applicable, are protected if the plan is approved and implemented. For all requests to redesignate an area to attainment for a national primary ambient air quality standard, under section 107 of the Act, a revision must be submitted to provide for the maintenance of the national primary ambient air quality standards for at least 10 years as required by section 175A of the Act."** [Appendix V, 2.2(d)]

    ADEQ commits to submit a full plan to comply with the remaining Clean Air Act requirements – See Chapter 5 of the SIP.

13. **"Modeling information required to support the proposed revision, including input data, output data, models used, justification of model selections, ambient monitoring data used, meteorological data used, justification for use of offsite data (where used), modes of models used, assumptions, and other information relevant to the determination of adequacy of the modeling analysis."** [Appendix V, 2.2(e)]

    ADEQ commits to submit a full plan to comply with the remaining Clean Air Act requirements – See Chapter 5 of the SIP.

14. **"Evidence, where necessary, that emission limitations are based on continuous emission reduction technology."** [Appendix V, 2.2(f)]

    ADEQ commits to submit a full plan to comply with the remaining Clean Air Act requirements – See Chapter 5 of the SIP.

15. **"Evidence that the plan contains emission limitations, work practice standards and recordkeeping/reporting requirements, where necessary, to ensure emission levels."** [Appendix V, 2.2(g)]

    ADEQ commits to submit a full plan to comply with the remaining Clean Air Act requirements – See Chapter 5 of the SIP.

16. **"Compliance/enforcement strategies, including how compliance will be determined in practice."** [Appendix V, 2.2(h)]

    ADEQ commits to submit a full plan to comply with the remaining Clean Air Act requirements – See Chapter 5 of the SIP.

17. **"Special economic and technological justifications required by any applicable EPA policies, or an explanation of why such justifications are not necessary."** [Appendix V, 2.2(i)]

    No known deviation from U.S. EPA policy.

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ENCLOSURE 3

Final Arizona State Implementation Plan Revision

West Pinal County PM_{10} Nonattainment Area
1987 Particulate Matter (PM_{10})
National Ambient Air Quality Standards (NAAQS)

December 2013

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FINAL

Arizona State Implementation Plan Revision

West Pinal County PM_{10} Nonattainment Area

Air Quality Division
December 2013

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EXECUTIVE SUMMARY

The West Pinal County PM_{10} Nonattainment Area is in Central Arizona, located within a basin between the Phoenix and Tucson metropolitan areas. The county encompasses 5,374 square miles and has two distinct regions: the eastern portion which is characterized by mountains with elevations up to 6,000 feet and the western region primarily comprised of low desert valleys and irrigated agriculture. Figure ES-1 illustrates the geographical location of Pinal County within the State of Arizona.

Figure ES-1: Pinal County at a Glance

Source: Pinal County Economic Development.[1]

Effective July 2, 2012, the U.S. Environmental Protection Agency redesignated a portion of western Pinal County from "unclassifiable" to "nonattainment" area for the 1987 24-hour PM_{10} National Ambient Air Quality Standards. The 24-hour PM_{10} standard was promulgated in 1987 to be 150 micrograms per cubic meter ($\mu g/m^3$).

The designation of the West Pinal County PM_{10} nonattainment area is based on recorded violations of the PM_{10} standard at various monitoring sites within the county. The boundaries of the nonattainment area encompass land that is located within Pinal County north of the east-west line defined by the southern line of Township 9 South, Gila and Salt River Baseline and Meridian, and west of the north-south line defined

[1] Pinal County Economic Development - *Pinal County at Glance*. Date Accessed: October 22, 2013. Retrieved from: http://www.pinalcountyaz.gov/ed/Pages/Home.aspx

by the eastern line of Range 8 East, except for Indian Country, certain federal land, and where the boundary extends farther east in the Florence and Picacho Peak areas.[2]

This State Implementation Plan for the West Pinal County PM_{10} Nonattainment Area consists of five chapters that present background information, monitoring network, emissions inventory, base year modeling, and commitments to comply with additional Clean Air Act requirements.

Chapter 1 – Provides an introduction to discuss the physical, demographic, economic description of the area, as well as the regulatory background of the PM_{10} National Ambient Air Quality Standard in Pinal County.

Chapter 2 - Describes how the Pinal County Ambient Monitoring Network meets the Clean Air Act and U.S. Environmental Protection Agency regulatory requirements.

Chapter 3 – Provides the base year emission inventory for the nonattainment area. It includes a summary of methodologies used to develop the inventory as required by the Clean Air Act Section 172(c)(3) and identifies significant sources of emissions within the West Pinal County Nonattainment Area.

Chapter 4 – Presents a summary of the 2008 base year modeling for selected design days and modeling domains. This analysis shows each source's contribution to PM_{10} emissions for 2008.

Chapter 5 – Describes the Arizona Department of Environmental Quality's commitment to complete all Clean Air Act requirements for the nonattainment area. A timeline is provided with tentative dates for the remaining tasks including: control measure selection and analysis, attainment demonstration, reasonable further progress, prevention of significant deterioration/new source review, transportation conformity, contingency measures, and additional commitments (if necessary).

Table ES-1 lists the rules that have been submitted to the U.S. Environmental Protection Agency and that have been approved into the Arizona State Implementation Plan to regulate emissions of PM_{10}.

Table ES-1: Arizona Administrative Code (AAC) and Pinal County Air Quality Control District (PCAQCD) Rules Approved into the Arizona SIP

Rule	Title	FR Date	FR Citation
R9-3-404	AAC - Open Areas, Dry Washes, or Riverbeds	4/23/1982	47 FR 17485
R9-3-405	Roadways and Streets	4/23/1982	47 FR 17485
R9-3-406	Material Handling	4/23/1982	47 FR 17485
R9-3-407	Storage Piles	4/23/1982	47 FR 17485
R9-3-4010	Evaluation of Nonpoint Source Emissions	4/23/1982	47 FR 17485
R9-3-502	Standards of Performance for Unclassified Sources	10/19/1984	49 FR 41026
R9-3-522	Standards of Performance for Existing Gravel and Stone Crushing Operations	9/28/1982	47 FR 42572
R18-2-702*	General Provisions	8/24/2004	69 FR 51952
Code 4-2-020	PCAQCD Fugitive Dust - General	4/6/2010	75FR 17307
Code 4-2-030	PCAQCD Fugitive Dust - Definitions	4/6/2010	75FR 17307

[2] 77 FR 32024; *Designation of Areas for Air Quality Planning Purposes; State of Arizona; Pinal County; PM_{10}.*

Table ES-1: Arizona Administrative Code (AAC) and Pinal County Air Quality Control District (PCAQCD) Rules Approved into the Arizona SIP			
Rule	**Title**	**FR Date**	**FR Citation**
Code 4-2-040	PCAQCD Fugitive Dust - Standards	8/1/2007	72 FR 41896
Code 4-2-050	PCAQCD Fugitive Dust – Monitoring and Records	8/1/2007	72 FR 41896

Source: Arizona Administrative Code and Pinal County Code

* R18-2-702, General Provision, reflect the current R18 Arizona Administrative Code numbering format. The R9 series of rules were subsequently renumbered, but have only been approved by EPA in the original numbering format.

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1.0 INTRODUCTION

Chapter 1 describes the purpose of the state implementation plan for the West Pinal County PM_{10} Nonattainment Area, summarizes the regulatory background of the area, including a description of the federal PM_{10} standard, and provides a general overview of the nonattainment area and county.

1.1 Statement of Introduction and Purpose

Pursuant to Section 107(d)(3) of the Clean Air Act (CAA), the U.S. Environmental Protection Agency (EPA) redesignated an area in western Pinal County from "unclassifiable" to "moderate nonattainment area" for the 1987 24-hour PM_{10} National Ambient Air Quality Standards (NAAQS). EPA based its redesignation on numerous recorded violations from various monitoring sites within the County. An area is considered in violation of the 24-hour PM_{10} NAAQS if it exceeds the standard more than once per year on average over three years.

Under the authority granted by the Governor and the State of Arizona, the Arizona Department of Environmental Quality (ADEQ) is responsible for the preparation and submittal of the State Implementation Plan (SIP). The purpose of the SIP is to demonstrate how the nonattainment area will attain the 1987 24-hour PM_{10} NAAQS.

1.2 National Ambient Air Quality Standards

Title I of the CAA requires EPA to set National Ambient Air Quality Standards (NAAQS) for those pollutants that are considered harmful to both the public health and the environment. EPA sets standards for six air pollutants: ground-level ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. There are two types of NAAQS: primary and secondary. Primary standards are set to protect human health and secondary standards are established to protect public welfare, such as decreased visibility and damage to animals, crops, vegetation, and buildings.[3]

The standard for each pollutant is set at a maximum concentration in either parts per million (ppm) by volume, parts per billion (ppb) by volume, or micrograms per cubic meter of air (μ/m^3). Each standard also has a distinct averaging time in order to provide the necessary level of protection.[4] These standards are reviewed every five years and are either retained or revised based on review of scientific literature and analyses.

1.3 U.S. EPA's Particulate Matter NAAQS

Particulate matter, or particle pollution, is a complex mixture of small particles and liquid droplets found in the air. Particulate matter (PM) can be directly emitted by a source such as smokestacks, fires, unpaved roads, or construction sites.[5] These particles can also be formed in the atmosphere when gaseous pollutants such as sulfur dioxides and nitrogen dioxides react to form fine particles.[6]

On July 1, 1987, EPA revised the NAAQS for PM, replacing Total Suspended Particulates as the indicator for particulate matter with new indicator, PM_{10} (52 FR 24634). This new indicator included particles with an aerodynamic diameter less than or equal to 10 micrometers. In order to attain the

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[3] U.S. Environmental Protection Agency, http://www.epa.gov/air/criteria.html. Date Accessed: October 29, 2013.
[4] Ibid.
[5] U.S. Environmental Protection Agency, http://www.epa.gov/airquality/particlepollution/basic.html. Date Accessed: October 29, 2013.
[6] Ibid

NAAQS for the 24-hour PM_{10} standard, an air quality monitor cannot measure levels of PM_{10} greater than 150 micrograms per cubic meter (µg/ m^3) more than once per year on average over a consecutive three-year period. Most of Pinal County was designated as "unclassifiable" for PM_{10} by operation of law upon enactment of the 1990 amendments of the CAA.

1.4 Regulatory Background

On October 14, 2009, EPA notified the Governor of Arizona and tribal leaders of four Indian Tribes (whose Indian Country is located entirely, or in part, within Pinal County) that air quality monitoring data for PM_{10} for the period 2006 to 2008, was violating the 24-hour PM_{10} NAAQS. EPA then began the process to redesignate the area as nonattainment for the 24-hour PM_{10} NAAQS.

Under Section 107(d) of the CAA, governors must submit boundary recommendations for violating areas. ADEQ conducted a nine factor analysis based on the analytical approach established in EPA's guidance for the 1997 8-hour ozone, the 1997 $PM_{2.5}$ NAAQS, and the 2006 $PM_{2.5}$ NAAQS.[7] ADEQ assessed the nine factors, the default under EPA guidance, with respect to Pinal County. ADEQ also evaluated neighboring counties with respect to their potential contribution to nonattainment. On March 23, 2010, the Governor of Arizona submitted to EPA a partial county boundary recommendation, excluding Indian Country.[8]

On May 31, 2012, EPA redesignated an area in western Pinal County, Arizona, from "unclassifiable" to "nonattainment" for the 1987 PM_{10} NAAQS (77 FR 32024; effective July 2, 2012). Establishment of the new PM_{10} nonattainment area, referred to as the "West Pinal County PM_{10} Nonattainment Area" was based on recorded violations of the PM_{10} standard at various monitoring sites within the county. EPA imposes certain planning requirements in order to reduce PM_{10} concentrations within this area.

1.5 Nonattainment Area Description

EPA's final designation of the West Pinal County PM_{10} nonattainment area defined the boundaries of the nonattainment area to encompass the land located within Pinal County north of the east-west line defined by the southern line of Township 9 South, Gila and Salt River Baseline and Meridian, and west of the north-south line defined by the eastern line of Range 8 East, except where the boundary extends farther east in the Florence and Picacho Peak areas.[9] Because the State of Arizona does not have jurisdiction on any of the Indian Country, it has not been included in the EPA's nonattainment area boundary re-designation. Figure 1.1 below shows the location of the West Pinal County PM_{10} nonattainment area.

This section discusses the geography, climate, population, and the economy of Pinal County and the nonattainment area. Figure 1.1 below shows the location of the West Pinal County PM_{10} nonattainment area.

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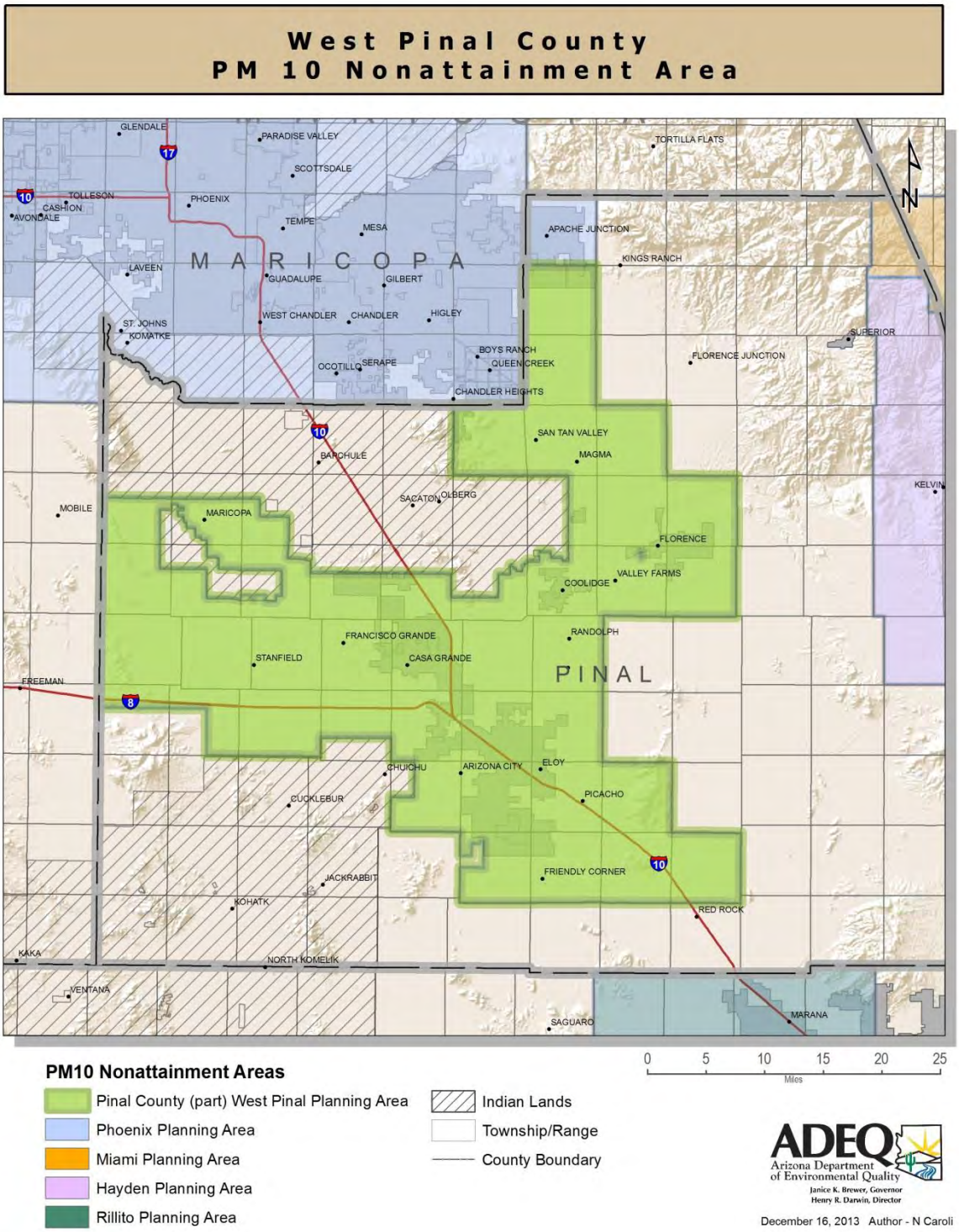
[7] Memorandum from Robert J. Meyers, Acting Assistant Administrator, "*Area Designations for the Revised 24-Hour Particle National Ambient Air Quality Standard*," June 8, 2007.
[8] Letter from Jan Brewer, Governor of Arizona, to Jared Blumenfeld, Regional Administrator, EPA Region IX. Dated March 23, 2010
[9] 77 FR 32024

Figure 1.1 – Map of West Pinal County PM_{10} Nonattainment Area



Source: Arizona Department of Environmental Quality

1.5.1 Geography and Climate

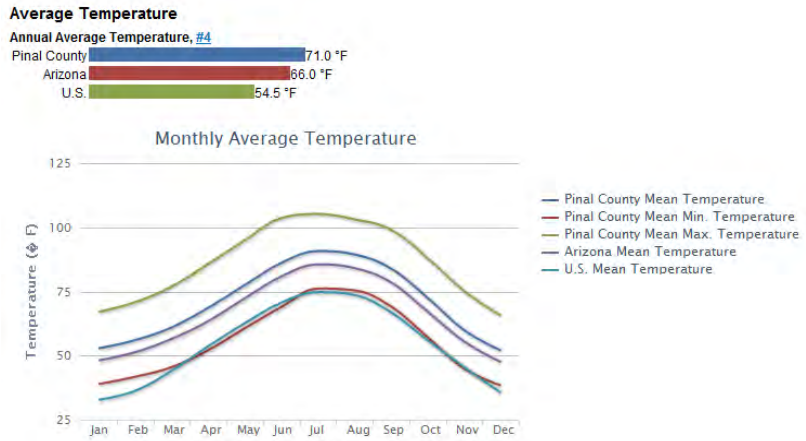
Pinal County is located in Central Arizona, lying within a basin between the Phoenix and Tucson metropolitan areas and encompasses approximately 5,374 square miles. The eastern portion of the county is mountainous with elevations up to 6,000 feet, whereas the western region primarily consists of low desert valleys. The county consists of several cities that sit on various elevations. Table 1.1 provides a list of incorporated cities and elevations that are located within the Pinal County jurisdiction.

Table 1.1 – Names and Elevations of Pinal County Cities

City Name	Elevation (ft.)	County Name
Apache Junction	1,754	Pinal
Casa Grande	1,403	Pinal
Coolidge	1,428	Pinal
Eloy	1,555	Pinal
Florence	1,473	Pinal
Maricopa	1,171	Pinal
Superior	2,842	Pinal
Source: How High is Greater Phoenix?[10]		

The climate is arid with an annual average temperature of 71°F, which is higher than the Arizona annual average temperature of 65.97°F, and is much higher than the annual national average temperature of 54.45°F. The mean maximum temperature reaches to 105°F in July and the mean minimum temperature drops to 38.5 °F in December.[11] Figure 1.2 compares Pinal County's monthly average temperatures with Arizona and national mean temperatures.[12]

Figure 1.2 – Pinal County, Arizona, and U.S. Monthly Average Temperatures

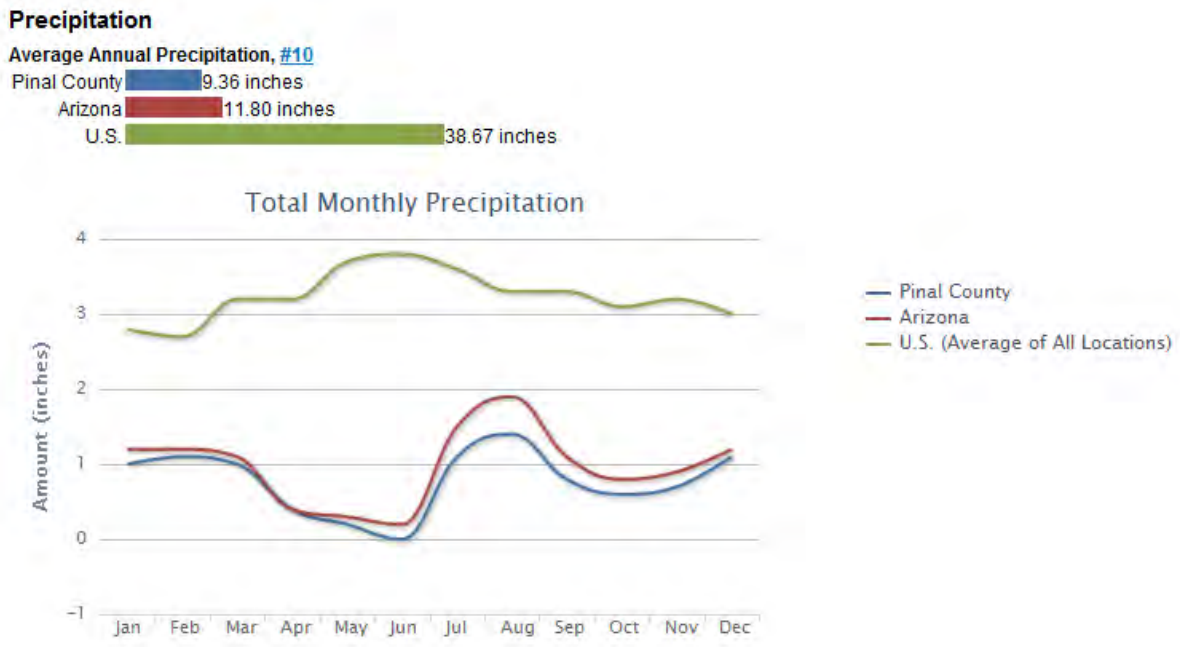


Source: USA.COM-Local Data Power Search.[13]

[10] About.Com – *How High is Greater Phoenix?*, http://phoenix.about.com/od/natureandenvironment/a/elevation_4.htm. Date Accessed: October 22, 2013.
[11] Ibid
[12] USA.Com – *Pinal County Weather*, http://www.usa.com/pinal-county-az-weather.htm#HistoricalPrecipitation. Date Accessed: October 22, 2013.
[13] Ibid

The driest time of the year for the County is typically April through June followed by September through November. Figure 1.3 shows the annual average precipitation for Pinal County, Arizona, and the U.S. Rainfall in Pinal County typically ranges between 5 to 10 inches annually. The county has two distinct rain seasons that occur during the winter (associated with low pressure systems and cold fronts) and summer (due to monsoon wind shift with increase moisture from Mexico).

Figure 1.3 – Total Monthly Precipitation for Pinal County, Arizona, and U.S.



Source: USA.COM-Local Data Power Search.[14]

1.5.2 Population

According to the Arizona Department of Administration (ADOA), the West Pinal PM_{10} Nonattainment Area has a total population of 259,141 for the emissions inventory base year 2008. Residence data shows that 136,790 of the population live in the incorporated areas, 34,937 people live in unincorporated (non-CDP) areas, and 87,414 live within the Census Designated Places (CDP).[15] Table 1.2 shows the population distribution for each area within the West Pinal County PM_{10} Nonattainment Area.

The general population of Pinal County is estimated at 389,192, which is approximately 109 percent higher than the population in the year 2000. The growth rate is much higher than the state average of 24.59 percent and is much higher than the national average rate of 9.71 percent. The population density is approximately 70 people per square mile, which is higher than the state average density of about 56 people per square mile and is lower than the national average density of 82 people per square mile. [16] Table 1.3 includes population estimate for each city, town, and other areas in Pinal County.

[14] Ibid
[15] Internal Report from the Arizona Department of Administration, October 31, 2013.
[16] USA.Com – *Pinal County Weather*, http://www.usa.com/pinal-county-az-weather.htm#HistoricalPrecipitation. Date Accessed: October 22, 2013.

Table 1.2: West Pinal County PM_{10} Nonattainment Area Population Distribution – 2008 Emissions Inventory Base Year		
Place	**Type**	**Population**
Apache Junction City	Incorporated	4
Casa Grande City	Incorporated	48,096
Coolidge City	Incorporated	12,236
Eloy City	Incorporated	14,620
Florence Town	Incorporated	22,574
City of Maricopa	Incorporated	38,794
Queen Creek Town	Incorporated	467
	Total Incorporated (Cities/Towns):	**136,790**
	Total Unincorporated (non-CDP area):	**34,937**
Ak-Chin Village CDP	CDP	5
Arizona City CDP	CDP	9,781
Blackwater CDP	CDP	0
Cactus Forest CDP	CDP	555
Chuichu CDP	CDP	0
Gold Canyon CDP	CDP	11
Picacho CDP	CDP	440
Red Rock CDP	CDP	0
San Tan Valley CDP	CDP	75,932
Stanfield CDP	CDP	691
	Total SDP:	**87,414**
	Total Population within the Nonattainment Area:	**259,141**
Source: Arizona Department of Administration - October, 2013, Internal Report		

Table 1.3: General Population of Pinal County and Cities		
City/Town/Area	**County Name**	**Population**
Apache Junction*	Pinal	36,632
Casa Grande	Pinal	50,296
Coolidge	Pinal	12,039
Eloy	Pinal	17,433
Florence	Pinal	26,773
Kearny	Pinal	1,979
Mammoth	Pinal	1,452
Maricopa	Pinal	44,946

Table 1.3: General Population of Pinal County and Cities		
City/Town/Area	**County Name**	**Population**
Queen Creek*	Pinal	459
Superior	Pinal	2,880
Winkelman*	Pinal	0
Unincorporated	Pinal	194,303
	Total:	**389,192**
* Population for Places in Two Counties: Apache Junction (Pinal & Maricopa) - 35,828; Winkelman (Gila + Pinal) – 350; Queen Creek (Pinal + Maricopa) - 26,448		
Source: Arizona Department of Administration (ADOA), Office of Employment and Population Statistics – July 1, 2012 Population Estimates.[17]		

1.5.3 County Economy

The eastern portion of Pinal County is characterized as a copper mining community. The communities of Mammoth, Oracle, San Manuel, and Kearny have traditionally been active in copper mining, smelting, milling and refining. The towns of Apache Junction, Arizona City, Coolidge, Eloy, and particularly Casa Grande have expanded and diversified their economic base to include manufacturing, trade, and services.[18] This expansion of the economy has been facilitated by the location of the area in the major growth corridor between Phoenix and Tucson.

Most of southern Pinal County, and a small portion of Apache Junction, are designated as Enterprise Zones. [19] Enterprise Zones are areas are designed to encourage growth and development. Businesses located in a state Enterprise Zone may receive tax credits on its Arizona corporate income tax by creating net new quality jobs. A total of 22.2% of the employed population is engaged in educational services, healthcare, and social services. Table 1.4 provides a percentage distribution of the total employed population by various sectors.

Table 1.4: Pinal County Civilian Employed Population 16 Years and Over – 2010 U.S. Census Bureau		
Industry	**Population**	**Percentage**
Agriculture, forestry, fishing and hunting, and mining	5,620	4.7%
Construction	7,051	5.9%
Manufacturing	9,493	7.9%
Wholesale trade	2,455	2.0%
Retail trade	11,528	9.6%
Transportation and warehousing, and utilities	7,710	6.4%
Information	2,533	2.1%
Finance and insurance, and real estate and rental and leasing	9,409	7.8%

[17] Arizona Department of Administration – *The Source of Labor Market and Demographic Information*, http://www.azstats.gov/population-estimates.aspx. Date Accessed: October 22, 2013.
[18] Business Connections – *Pinal County Statistics*, http://www.pinalcountyaz.gov/ed/businessconnections/Pages/PinalCountyStatistics.aspx. Date Accessed: October 22, 2013.
[19] Ibid

Table 1.4: Pinal County Civilian Employed Population 16 Years and Over – 2010 U.S. Census Bureau		
Industry	**Population**	**Percentage**
Professional, scientific, and management, and administrative and waste management services	9,801	8.1%
Educational services, and health care and social assistance	26,757	22.2%
Arts, entertainment, and recreation, and accommodation and food services	10,381	8.6%
Other services, except public administration	6,288	5.2%
Public administration	11,413	9.5%
Total	120,439	100.0%
Source: U.S. Census Bureau, 2011. American Community Survey[20]		

The median household income in Pinal County was $51,310 from 2006 to 2010 and has grown by 43.10 percent since 2000. The income growth rate is much higher than the state average rate of 15.36 percent and is much higher than the national average rate of 19.17 percent. On the other hand, from 2006 to 2010, the median house value in Pinal County was $164,000. Pinal County has shown much higher house value growth rate of 74.65 percent increase since 2000 compare to the state average rate of 39.16 percent and national average rate of 50 percent.[21]

In 2011, the number of permits issued for buildings and units issued were 975 and 978, respectively. By 2012, the number of permits issued for buildings and units increased to 1,776 and 1,823, respectively.[22] Table 1.5 provides a four-year annual summary of the issued building permits in Pinal County.

Table 1.5: Annual New Privately-Owned Residential Building Permits Pinal County (Reported Only)			
Year	**Buildings**	**Units**	**Cost**
2012	1,776	1,823	$244,641,995
2011	975	978	$126,271,132
2010	1,597	1,597	$206,850,342
2009	2,182	2,182	$284,576,575
Source: Building Permits - U.S. Census Bureau[23]			

[20] 2012 American Community Survey 1-Year Estimates - *Selected Economic Characteristics*, http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_1YR_DP03&prodType=table. . Date Accessed: October 22, 2013.
[21] Business Connection – *Pinal County Statistics*, http://www.pinalcountyaz.gov/ed/businessconnections/Pages/PinalCountyStatistics.aspx, Date Accessed: October 22, 2013.
[22] U.S. Census of Bureau – *Building Permits*, http://censtats.census.gov/bldg/bldgprmt.shtml?. Date Accessed: October 22, 2013.
[23] Ibid

1.6 General SIP Approach - Regulatory Requirements and Guidance

The 1990 CAA amendments were enacted by Congress to improve air quality across the nation. One of the primary goals of this comprehensive revision to the CAA was to expand and clarify the planning provisions for those areas not currently meeting the NAAQS. The amendments identify specific emission reduction goals, require both a demonstration of Reasonable Further Progress (RFP) and attainment, and incorporate more stringent sanctions for failure to attain or to meet interim milestones. Title I Part A, and Title I Part D, Subparts 1 and 4 of the CAA are applicable to this SIP. Table 1.6 includes the SIP requirements and explains how this document meets them. Pollutant specific requirements for moderate PM_{10} nonattainment areas are found in section 189 of the CAA, and the general planning and control requirements for nonattainment area plans are found in CAA sections 110 and 172.

Table 1.6: Clean Air Act (CAA) Regulatory Requirements

CAA Citation	Action to Meet Requirement	Location in Document
CAA Section 172Nonattainment Plan Provisions		
172(c)(1) – General	"...Such plan provisions shall provide for the implementation of all reasonably available control measures (RACM) as expeditiously as practicable (including such reductions in emissions from existing sources in the area as may be obtained through the adoption, at a minimum, of reasonably available control technology (RACT)) and shall provide for attainment of the national primary ambient air quality standards." RACT is defined for PM_{10} as that technology which is necessary to achieve the NAAQS (40 CFR 51.100(o)).	See Chapter 5 for a timeline to complete these requirements.
172(c)(2) – Reasonable Further Progress (RFP)	Plan provisions shall demonstrate reasonable further progress or "annual incremental reductions in emissions … for the purpose of ensuring attainment of the applicable national ambient air quality standards by the applicable date."	See Chapter 5 for a timeline to complete these requirements.
172(c)(3) – Emissions Inventory	The plan provisions "… shall include a comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutant(s)..." ADEQ maintains a historical and current database of actual emissions from State permitted point and area sources. The Pinal County Air Quality Control District and Pima County Department of Environmental Quality maintain a similar database of actual emissions from County permitted sources. All non permitted source emissions data (i.e.: mobile sources) are obtained from EPA's national emissions inventory.	Chapter 3
172(c)(4) – Identification and Quantification	Plan provisions "… shall expressly identify and quantify the emissions, if any, of any such pollutant or pollutants which will be allowed, in accordance with Section 173(a)(1)(B), from the construction and operation of major new or modified stationary sources in each such area. The plan shall demonstrate to the satisfaction of the Administrator that the emissions quantified for this purpose will be consistent with the achievement of reasonable further progress and will not interfere with	

Table 1.6: Clean Air Act (CAA) Regulatory Requirements		
CAA Citation	**Action to Meet Requirement**	**Location in Document**
	attainment of the applicable national ambient air quality standard …" The permit requirements of CAA Section 173(a)(1)(B) are applicable to sources located in a targeted economic development zone as determined by the Administrator under consultation with the Secretary of Housing and Urban Development. Within the West Pinal County Nonattainment Area, no such zones have been designated by EPA and there is no anticipation of major sources.	
172(c)(5) – Permits for New and Modified Major Stationary Sources	The plan provisions"…shall require permits for the construction and operation of new or modified major stationary sources anywhere in the nonattainment area…" All new sources and modifications to existing sources in Arizona are subject to state requirements for preconstruction review and permitting pursuant to AAC, Title 18, Chapter 2, Articles 3 and 4. All new major sources and major modifications to existing major sources in Arizona are subject to the nonattainment New Source Review (NSR) provisions of these rules or Prevention of Significant Deterioration (PSD) for maintenance areas. On October 29, 2012 ADEQ submitted a SIP revision to update its program to comply with all current federal major NSR requirements, including NSR reform. ADEQ submitted certified clean copies of the relevant statutes and rules as an update to this revision on September 6, 2013. ADEQ currently has full approval of its Title V permit program. Sources under Pinal County jurisdiction are subject to the Pinal County Air Quality Control District, NSR program in Code of Regulations, Chapter 3.	
172(c)(6) – Other Measures	The plan "... shall include enforceable emissions limitations, and such other control measures, means or techniques …, as well as schedules and timetables for compliance, as may be necessary or appropriate to provide for attainment of such standard in such area by the applicable attainment date...".	See Chapter 5 for a timeline to complete these requirements.
172(c)(7) – Compliance with Section 110(a)(2), Implementation Plans	The plan provisions "... shall also meet the applicable provisions of Section 110(a)(2)." The requirements of Section 110(a)(2) are detailed elsewhere in this Table.	
172(c)(8) – Equivalent Techniques	The plan may include upon application by the state "... the use of equivalent modeling, emission inventory, and planning procedures …" as allowed by the administrator. Equivalent techniques utilized in the preparation of the emission inventory in this SIP were approved by EPA through ADEQ's IPP submission.	See Appendix A

Table 1.6: Clean Air Act (CAA) Regulatory Requirements		
CAA Citation	**Action to Meet Requirement**	**Location in Document**
172(c)(9) – Contingency Measures	The plan "... shall provide for the implementation of specific measures to be undertaken if the area fails to make reasonable further progress, or to attain the national primary ambient air quality standard … Such measures shall be included in the plan revision as contingency measures to take effect in any such case without further action by the State or the Administrator."	See Chapter 5 for a timeline to complete these requirements.
CAA Sections 176 – Transportation Conformity and General Conformity Regulations		
176(c) Transportation Conformity	"Transportation conformity is required by the Clean Air Act section 176(c) (42 U.S.C. 7506(c)) to ensure that federal funding and approval are given to highway and transit projects that are consistent with ("conform to") the air quality goals established by a state air quality implementation plan (SIP). Conformity, to the purpose of the SIP, means that transportation activities will not cause new air quality violations, worsen existing violations, or delay timely attainment of the national ambient air quality standards."[24]	See Chapter 5 for a timeline to complete these requirements.
176(c) - General Conformity Regulations	"Section 176(c) of the Clean Air Act prohibits Federal entities from taking actions in nonattainment or maintenance areas which do not conform to the State implementation plan (SIP) for the attainment and maintenance of the national ambient air quality standards (NAAQS). Therefore, the purpose of conformity is to (1) ensure Federal activities do not interfere with the budgets in the SIPs; (2) ensure actions do not cause or contribute to new violations, and (3) ensure attainment and maintenance of the NAAQS."[25] General Conformity for the West Pinal County Nonattainment Area must be addressed to assure PM_{10} emissions from any federal actions or plans do not exceed the rates outlined in 40 CFR 93.153(b)(See 58 FR 63253; November 30, 1993). Criteria for making determinations and provisions for general conformity are located in R18-2-1438 of the Arizona Administrative Code. ADEQ and Pinal County commits to review and command as appropriate, on any federal agency draft general conformity determination it receives pursuant to 40 CFR 93.155 for activities planned for this air quality planning area.	See Chapter 5 for a timeline to complete these requirements.

[24] US EPA - *State and Local Transportation Resources*. http://www.epa.gov/OMS/stateresources/transconf/generalinfo.htm. Date Accessed: October 22, 2013.
[25] US EPA – *General Conformity Regulations*: http://www.epa.gov/ttn/caaa/genconformity.html. Date Accessed: November 1, 2013.

Table 1.6: Clean Air Act (CAA) Regulatory Requirements		
CAA Citation	**Action to Meet Requirement**	**Location in Document**
CAA Sections 188, 189, and 190 – Additional Provisions for Particulate Matter Nonattainment		
188(c)(1) - Attainment Dates	"Except as provided under subsection (d) of this section, the attainment dates for PM_{10} nonattainment areas shall be as follows: (1) Moderate Areas For a Moderate Area, the attainment date shall be as expeditiously as practicable but no later than the end of the sixth calendar year after the area's designation as nonattainment, except that, for areas designated nonattainment for PM_{10} under section 107(d)(4) of this title CAA, the attainment date shall not extend beyond December 31, 1994." On May 31, 2012, a portion of the West Pinal County was redesignated as a "moderate' nonattainment area. The area is required to demonstrate attainment no later than the end of December 2018.	See Chapter 5 for a timeline to complete these requirements.
188(d) - Extension of Attainment Date for Moderate Areas	Administrator may extend for 1 additional year if **"**(1)the State has complied with all requirements and commitments pertaining to the area in the applicable implementation plan; and (2)no more than one exceedance of the 24-hour national ambient air quality standard level for PM_{10} has occurred in the area in the year preceding the Extension Year, and the annual mean concentration of PM_{10} in the area for such year is less than or equal to the standard level." ADEQ is not requesting an extension at this time.	
189(a)(1) A) - Moderate Areas	Moderate Area plans shall include: "(A)For the purpose of meeting the requirements of section 7502(c)(5) of this title, a permit program providing that permits meeting the requirements of section 7503 of this title are required for the construction and operation of new and modified major stationary sources of PM_{10}. (B) Either (i) a demonstration (including air quality modeling) that the plan will provide for attainment by the applicable attainment date; or (ii) a demonstration that attainment by such date is impracticable. (C)Provisions to assure that reasonably available control measures for the control of PM_{10} shall be implemented no later than December 10, 1993, or 4 years after designation in the case of an area classified as moderate after November 15, 1990. "	See Chapter 5 for a timeline to complete these requirements.
189(a)(1)(B) – Moderate Areas	"(B)Either: (i) a demonstration (including air quality modeling) that the plan will provide for attainment by the applicable attainment date; or (ii) a demonstration that attainment by such date is impracticable."	See Chapter 5 for a timeline to complete these requirements.

Table 1.6: Clean Air Act (CAA) Regulatory Requirements		
CAA Citation	**Action to Meet Requirement**	**Location in Document**
189(a)(1)(C) – Moderate Areas	"C) Provisions to assure that reasonably available control measures for the control of PM–10 shall be implemented no later than December 10, 1993, or 4 years after designation in the case of an area classified as moderate after November 15, 1990."	See Chapter 5 for a timeline to complete these requirements.
189(c)(1) - Milestones	"(1) Plan revisions demonstrating attainment submitted to the Administrator for approval under this subpart shall contain quantitative milestones which are to be achieved every 3 years until the area is redesignated attainment and which demonstrate reasonable further progress, as defined in section 171(1) of this title, toward attainment by the applicable date."	See Chapter 5 for a timeline to complete these requirements.
189(c)(2) - Milestones	(2) Not later than 90 days after the date on which a milestone applicable to the area occurs, each State in which all or part of such area is located shall submit to the Administrator a demonstration that all measures in the plan approved under this section have been implemented and that the milestone has been met. A demonstration under this subsection shall be submitted in such form and manner, and shall contain such information and analysis, as the Administrator shall require. The Administrator shall determine whether or not a State's demonstration under this subsection is adequate within 90 days after the Administrator's receipt of a demonstration which contains the information and analysis required by the Administrator.	See Chapter 5 for a timeline to complete these requirements.
189(c)(3) - Milestones	**"**(3) If a State fails to submit a demonstration under paragraph (2) with respect to a milestone within the required period or if the Administrator determines that the area has not met any applicable milestone, the Administrator shall require the State, within 9 months after such failure or determination to submit a plan revision that assures that the State will achieve the next milestone (or attain the national ambient air quality standard for PM_{10}, if there is no next milestone) by the applicable date."	See Chapter 5 for a timeline to complete these requirements.
189(e) - Precursors	"The control requirements applicable under plans in effect under this part for major stationary sources of PM_{10} shall also apply to major stationary sources of PM_{10} precursors, except where the Administrator determines that such sources do not contribute significantly to PM_0 levels which exceed the standard in the area. The Administrator shall issue guidelines regarding the application of the preceding sentence."	See Chapter 5 for a timeline to complete these requirements.
190 – Issuance of RACM and BACM Guidance	"The Administrator shall issue, in the same manner and according to the same procedure as guidance is issued under section 108(c) of this title, technical guidance on reasonably available control measures and best available control measures for urban fugitive dust, and emissions from residential wood combustion…"	

Table 1.6: Clean Air Act (CAA) Regulatory Requirements		
CAA Citation	**Action to Meet Requirement**	**Location in Document**
CAA Section 110(a)(2) – Implementation Plans		
110(a)(2)(A) – Control Measures and Emission Limits	Section 110(a)(2)(A) requires that states provide for enforceable emission limitations and other control measures, means, or techniques, as well as schedules for compliance necessary to meet applicable requirements of the CAA.	

2.0 AIR QUALITY MONITORING

The primary goal of the PM_{10} monitoring network in Pinal County is to collect data necessary to determine compliance with the PM_{10} NAAQS and fulfill the regulatory requirements for PM_{10} monitoring in the nonattainment area.

This chapter provides a general description of the monitoring site, equipment, quality assurance procedures, data summary and 24-hour NAAQS compliance.

2.1 Monitoring Site, Equipment, and Quality Assurance Procedures

The monitors in Pinal County were installed and are maintained in accordance with federal siting and design criteria[26] and are consistent with *ADEQ's State of Arizona Air Monitoring Network Plan for the Year 2012,* approved by EPA on March 1, 2013.

EPA's comment on the 2012 network plan noted that Pinal's network lacked at least one collocated site with side-by-side monitors for every one of the several filter based monitoring methods. In response, Pinal County will standardize PM_{10} and $PM_{2.5}$ filer-based monitoring methods so that the existing sites will satisfy the requirement.[27]

Historically, a PM_{10} monitor was located at the Riverside site but was discontinued on May 15, 2011.[28] The Riverside monitoring site was outside the nonattainment area but the site was located within the Pinal County ambient monitoring network area. Within the same monitoring network area, there is a Queen Valley monitoring site (an ADEQ SLAMS site) which is part of the Photochemical Assessment Monitoring Station (PAM); a network that provides data regarding ozone transport from the Phoenix urban area. Due to budget cuts and personnel shortages, primary responsibility for operations was returned to ADEQ on June 1, 2011.[29] The data from Queen Valley monitoring site are not comparable to the NAAQS.

Pinal County Air Quality uses FRMs to collect filter based PM_{10} and automated FEMs for continuous PM_{10} and Ozone. There are three types of PM_{10} monitors that are used throughout the Pinal County monitoring network: (1) the filter-based, high-volume sampler, (2) filter based medium volume sampler, and (3) the Tapered Element Oscillating Microbalance (TEOM) which measures PM_{10} on a continuous basis.

The state and local air monitoring (SLAMS) network consists of monitoring stations that provide data to meet the requirements of an Ambient Air Quality Monitoring Network as listed in Appendix D of 40 CFR Part 58. The data obtained from these monitors are reported to EPA to be compared to the NAAQS.
In order to meet EPA requirements, monitored air data must be quality assured. Pinal County maintains authority under A.R.S 49-473 and PCAQCD Code 1-1-040 to conduct ambient surveillance. In February of 2013, ADEQ and PCAQCD entered a memorandum of agreement to clarify and define the responsibilities of a Primary Quality Assurance Organization (PQAO).[30]

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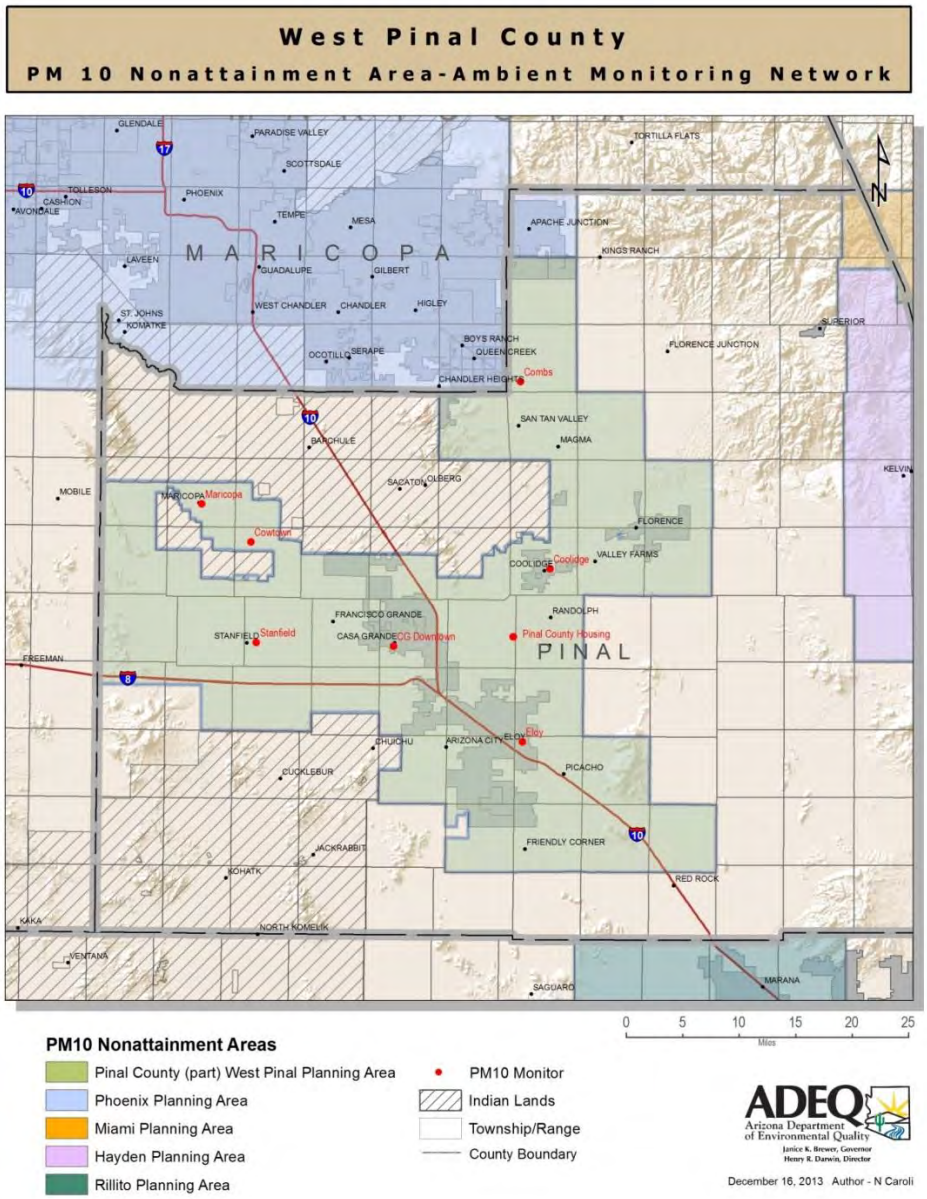
[26] Network Design Criteria for Ambient Air Quality Monitoring (40 CFR Part 58, Appendix D) and Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring (40 CFR Part 58, A (Appendix).
[27] 2013 Ambient Monitoring Network Plan and 2012 Data Summary - Pinal County Air Quality Control District Report.
[28] Ibid
[29] Ibid
[30] Memorandum of Agreement (MOA) between the ADEQ and Pinal County. Agreement # ADEQ 13-033141. The MOA was signed in February of 2013.

Figure 2.1 shows physical locations of the monitoring sites that are located within the nonattainment area and monitoring network. Table 2.1 provides the site descriptions for the Pinal County PM_{10} active monitoring sites located within the nonattainment area. The list excludes two PM_{10} Apache Junction Fire and Pinal Air Park active monitors that are located within the Pinal County monitoring network but are outside of the final boundaries for the PM_{10} nonattainment area.

Figure 2.1: West Pinal County PM_{10} Nonattainment Area



Source: Arizona Department of Environmental Quality

Table 2.1: Pinal County PM_{10} Active Monitors within EPA's Final Boundaries							
AQS ID	**Site Name**	**Latitude**	**Longitude**	**Classification**	**Monitor Type**	**Street Address**	**City**
04-021-0001	Casa Grande Downtown TEOM	+32.877583	111.752222	SLAMS	TEOM	401 N Marshall St.	Casa Grande
04-021-3009	Combs School TEOM	+33.219111	111.561111	SPM	TEOM	301 E Combs Rd	Queen Creek
04-021-3004	Coolidge Maintenance Yard[31]	+32.978556	111.514833	SLAMS	High Volume	212 E Broadway	Coolidge
04-021-3013	Cowtown Road TEOM	+33.010530	111.972050	SPM	TEOM	37580 W Maricopa	Maricopa
04-021-3014	Eloy County Complex[32]	+32.757639	111.554861	SLAMS	High Volume	801 N Main St	Eloy
04-021-3010	Maricopa County Complex (City of Maricopa)	+33.058500	112.047219	SPM	TEOM	44625 W Garvey Rd	Maricopa
04-021-3011	Pinal County Housing Complex	+32.891056	111.570500	SLAM	TEOM	970 N 11 Mile Rd	Casa Grande
04-021-3008	Stanfield County Complex	+32.881194	111.962000	SLAMS	TEOM	36697 W Papago Rd	Stanfield
Source: US EPA Site Description Report - May 7, 2013							

[31] The 2013 Pinal County Network Plan identifies collocated medium volume PM_{10} samplers at the Coolidge Maintenance Yard effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

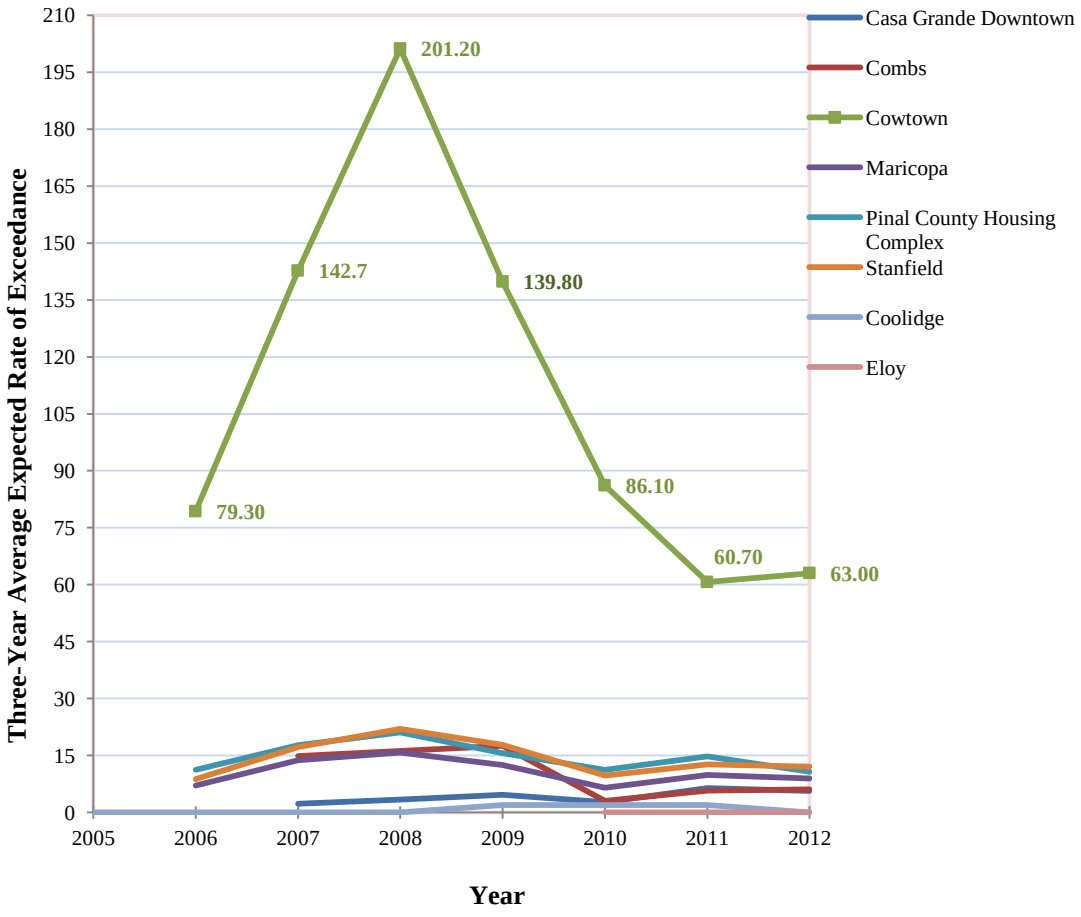
[32] The 2013 Pinal County Network Plan identifies a single medium volume PM_{10} sampler at the Eloy County Complex effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

2.2 PM_{10} Data Summary

The data summary presented in this section observes the three-year average expected rate of exceedances derived from the EPA Preliminary Design Value Report that includes measurements with exceptional event flags. In general, for the purposes of defining what constitutes a violation of several of the ambient air quality standards, EPA defines "exceedances" as discrete events, and that various standards define a violation as respectively occurring when either the actual or the expected number of exceedance is greater than one per year.

Figure 2.2 shows the historic trend to demonstrate the PM_{10} maximum 24-hour Average concentration for three-year average expected rate of exceedances between the year 2004 and 2012. The values presented from the Coolidge and Eloy monitoring sites are the results from the Medium-Volume PM_{10} samplers which collect samples on a one in six-day schedule. Six other monitoring sites from Casa Grande Downtown, Combs, Cowtown, Maricopa, Pinal County Housing, and Stanfield represent continuous air data that were processed by PM_{10} TEOM air monitoring instrumentation.

Figure 2.2: Three-Year Average Expected Rate of Exceedances



Source: U.S. EPA Air Quality System (AQS) Report[33]

[33] 2007 Preliminary Design Value – Report and data obtained on October 17, 2013, excluded regional events concurred by EPA. As of December 2013, no regional events have EPA concurrence.

2.3 24-Hours PM_{10} NAAQS Compliance

The primary (health) and secondary (welfare) 24-hour PM_{10} standards are met when the expected number of exceedances per year at each monitoring site is less than or equal to one. The expected number of exceedances per year is determined by recording the number of exceedances in each calendar year and averaging them over three years.

Based on complete quality-assured data for 2010-2012, the nonattainment area did not comply with the PM_{10} NAAQS. The findings indicate that all six monitoring stations that use continuous PM_{10} TEOM samplers yielded a three-year average expected rate of exceedance greater than one. The monitoring station at Cowtown recorded the highest three-year average expected rate of exceedances of 63 followed by the Stanfield monitor, which has a three-year average exceedance rate of 12.1. Because the annual expected exceedance rate is greater than one, the West Pinal County area is not currently meeting the PM_{10} National Ambient Air Quality Standards.

Table 2.2 below includes a summary of the three-year average expected rate of exceedances derived from six monitoring sites that utilized continuous PM_{10} TEOM samplers. Air data from the Coolidge and Eloy sites were processed by High-Volume PM_{10} samplers which collect samples on a one in six-day schedule.

Table 2.2: 2010 to 2012 Maximum 24-Hour Average PM_{10} Compliance – Continuous PM_{10} TEOM

AQS ID	Site Name	2010		2011		2012		Three-Year Avg Exp. Rate of Exc.
		Max-24-Hr Avg	Exp. Exc.	Max-24-Hr Avg	Exp. Exc.	Max-24-Hr Avg	Exp. Exc.	
04-021-0001	Casa Grande Downtown	569	1	479	14.1	235	2	5.7
04-021-3009	Combs	366	1	419	12.1	205	5.1	6.1
04-021-3004	Coolidge[34]	87	0	110	0	134	0	0
04-021-3013	Cowtown	497	29.4	2316	99	698	60.7	63
04-021-3014	Eloy[35]	87	0	154	0	120	0	0
04-021-3010	City of Maricopa Complex (City of Maricopa)	172	2	531	16.4	256	8.6	9
04-021-3011	Pinal County Housing	1,761	6	2,040	21.2	541	5	10.7
04-021-3008	Stanfield	205	1	586	23	339	12.1	12.1

Source: EPA AQS Report (Quick Look Criteria Parameters). Report Date: 10/17/2013
Key: Max –Maximum. Hr – Hour. Avg – Average. Exp – Expected. Exc - Exceedance

[34] The 2013 Pinal County Network Plan identifies collocated medium volume PM_{10} samplers at the Coolidge Maintenance Yard effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.
[35] The 2013 Pinal County Network Plan identifies a single medium volume PM_{10} sampler at the Eloy County Complex effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

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3.0 NONATTAINMENT AREA EMISSIONS INVENTORY

This chapter discusses the development of the emissions inventory as required by CAA Section 172(c)(3). ADEQ contracted with Sierra Research Inc. to develop the emissions inventory for the 2008 base year. To ensure compliance with EPA requirements for emissions inventories, Sierra Research developed an inventory preparation plan (IPP) outlining the planning procedures and quality assurance steps (see Appendix A, Inventory Preparation Plan). Sierra Research subsequently prepared the *Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains* (see Appendix B). Separate inventories were produced for individual design days and modeling domains ("modeling inventories") to assess each source's contribution to exceedances of the NAAQS (see Appendix C and Chapter 4). In addition to the design day inventories, a comprehensive annual inventory was developed for the West Pinal nonattainment area.

3.1 Summary of Emissions Inventory Methodologies

This section presents a summary of the methodologies used to calculate the emission inventories for the nonattainment area. Analysis shows that two discrete meteorological scenarios produce elevated levels of PM_{10} emissions and ambient concentrations: high wind conditions and stagnation/low wind conditions.

Stagnation/Low Wind

Sources of PM_{10} emissions during low wind/stagnation events are commonly from mechanical or combustion processes and other anthropogenic activities. As a result, the emissions inventory during these conditions focused on specific source categories such as: agriculture, concentrated animal feeding operations, paved roads, unpaved roads, nonroad, railroad, construction, permitted sources, dairies and other source categories emitting PM_{10} from the process listed above. Emissions calculations for point and mobile sources utilized standard methodologies and are discussed in Appendix B. The emissions calculations that were less straightforward and utilized research from previous studies, additional data from Pinal County, Arizona Department of Transportation, and individual sources.

High Wind

High wind emissions sources typically consist of disturbed soil surfaces that expose loose particles to wind entrainment and transport. In this analysis, high winds conditions are days with recorded high wind hours exceeding 12 miles per hour. Emissions are estimated as a function of wind speed, land use, and disturbance for each land parcel.

3.2 Stagnation/Low Wind Emissions Inventory for Selected Design Days

Because of the need to evaluate potential control measures under a range of meteorological conditions, baseline inventories were developed for selected design days during which exceedances of the NAAQS occurred. Section 3.3 of the IPP describes the selection process for the design days during stagnation/low wind conditions. October 29, 2008, was selected as representative of stagnant conditions. Three monitors exceeded the 24-hour PM_{10} NAAQS on this date: Cowtown, Pinal County Housing, and Stanfield. Separate modeling domains were defined and emission inventories developed for each of the three monitoring sites. These inventories were used in modeling analyses to quantify source contributions and impacts at the exceeding monitors. Evaluation of source contribution is needed to inform the development of control strategies designed to attain the air quality standards. The base year emission inventories for the three modeling domains are presented in Tables 3.1 through 3.3 below. CAFOS, other agricultural sources, and unpaved roads comprise more than 80 percent of emissions in all three domains. Construction sources are moderate contributors to the Cowtown inventory.

Table 3.1 - Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at Cowtown on 10/29/2008																
Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	RailRoad	Permitted Point Sources	Paved Road	Construction	CAFOs	Agriculture		Unpaved Road					Total(lbs/hr)
									County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribe road	
1	2.2	153	402.3	1.2	10.0	2.0	0.0	74.2	0.0	0.0	0.0	12.9	3.6	0.0	2.5	106.4
2	2.9	178	343.0	1.2	10.0	1.9	0.0	74.2	0.0	0.0	0.0	12.8	17.9	0.0	5.3	123.3
3	3.4	133	417.8	1.2	10.0	1.8	0.0	74.2	0.0	0.0	0.0	12.8	9.0	0.0	3.1	112.1
4	3.8	153	125.4	1.2	10.0	2.2	0.0	148.4	0.0	0.0	0.0	11.0	0.0	0.0	1.6	174.4
5	2.0	152	248.4	1.2	10.0	4.3	0.0	370.9	0.0	0.0	0.0	21.4	10.7	0.0	5.7	424.2
6	0.9	198	156.5	1.2	10.0	14.0	0.0	370.9	0.0	0.0	0.0	53.6	37.6	0.0	15.2	502.6
7	2.9	198	294.2	1.2	10.0	24.0	0.0	370.9	143.7	92.3	354.3	118.1	75.2	2.4	44.1	1236.3
8	2.9	182	171.8	1.2	10.0	21.2	211.3	370.9	143.7	92.3	354.3	169.2	46.6	2.4	46.6	1469.7
9	2.5	184	136.3	1.2	10.0	17.8	211.3	370.9	143.7	92.3	354.3	146.5	62.7	2.4	47.8	1460.9
10	0.9	252	219.5	1.2	10.0	13.6	211.3	370.9	143.7	92.3	354.3	168.7	118.2	2.4	59.0	1545.6
11	1.6	327	165.8	1.2	207.4	14.7	211.3	296.7	143.7	92.3	354.3	147.6	78.8	2.4	50.8	1601.2
12	2.5	348	103.2	1.2	207.4	15.4	211.3	296.7	143.7	92.3	354.3	177.9	121.8	2.4	61.9	1686.3
13	2.7	13	76.3	1.2	10.0	14.4	211.3	222.5	143.7	92.3	354.3	156.0	87.8	2.4	54.8	1350.7
14	4.0	326	61.7	1.2	63.4	15.1	211.3	222.5	143.7	92.3	354.3	178.1	139.7	2.4	65.5	1489.5
15	3.1	328	38.5	1.2	63.4	19.1	211.3	222.5	143.7	92.3	354.3	197.0	111.1	2.4	62.2	1480.5
16	2.5	336	41.5	1.2	10.0	32.3	211.3	296.7	143.7	92.3	354.3	209.7	118.2	2.4	64.5	1536.6
17	1.8	4	103.2	1.2	10.0	30.3	211.3	370.9	143.7	92.3	354.3	186.5	86.0	2.4	56.4	1545.4
18	3.4	327	60.6	1.2	10.0	16.5	0.0	519.2	143.7	92.3	354.3	168.2	71.7	2.4	50.3	1429.8
19	1.1	347	67.2	1.2	10.0	8.9	0.0	593.4	0.0	0.0	0.0	93.7	75.2	0.0	27.5	810.0
20	1.8	286	300.9	1.2	10.0	7.1	0.0	593.4	0.0	0.0	0.0	52.9	57.3	0.0	18.1	740.0
21	2.7	131	383.6	1.2	10.0	6.1	0.0	519.2	0.0	0.0	0.0	55.0	64.5	0.0	19.7	675.8
22	1.6	158	194.8	1.2	10.0	4.4	0.0	370.9	0.0	0.0	0.0	47.0	17.9	0.0	9.9	461.4
23	3.4	149	228.4	1.2	10.0	3.3	0.0	148.4	0.0	0.0	0.0	32.5	16.1	0.0	7.2	218.6
24	4.0	149	189.2	1.2	10.0	2.5	0.0	148.4	0.0	0.0	0.0	21.5	5.4	0.0	4.0	193.0
Average			188.7	1.2	30.9	12.2	88.0	309.1	71.9	46.2	177.2	102.1	59.7	1.2	32.7	932.3
Percentage Contribution				0.1%	3.3%	1.3%	9.4%	33.2%	7.7%	5.0%	19.0%	11.0%	6.4%	0.1%	3.5%	100.0%

Table 3.2 - Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at Stanfield on 10/29/2008														
Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	Paved Road	Neighborhood Paved Road	Neighborhood UnPaved Road	Construction	CAFOs	Agriculture	Unpaved Road				Total (lbs/hr.)
										AG Road	Public Dirt	Private Dirt	Trail	
1	2.1	251.9	46.0	0.3	0.0	0.01	0.0	42.8	0.0	0.0	13.3	2.2	0.0	58.5
2	2.3	159.9	79.0	0.2	0.0	0.05	0.0	42.8	0.0	0.0	19.7	10.8	0.0	73.5
3	3.5	139.5	76.8	0.2	0.0	0.02	0.0	42.8	0.0	0.0	12.1	5.4	0.0	60.5
4	2.8	155.2	63.0	0.3	0.0	0.00	0.0	85.5	0.0	0.0	12.7	0.0	0.0	98.5
5	2.8	99.4	144.0	0.5	0.0	0.03	0.0	213.8	0.0	0.0	25.5	6.5	0.0	246.4
6	1.9	108.0	183.5	1.8	0.0	0.10	0.0	213.8	0.0	0.0	51.5	22.6	0.0	289.9
7	1.8	179.6	187.7	3.1	0.1	0.21	0.0	213.8	206.1	650.6	129.2	45.2	2.6	1250.8
8	1.8	171.9	307.2	2.7	0.1	0.13	1.4	213.8	206.1	650.6	179.1	28.0	2.6	1284.5
9	1.5	183.8	226.0	2.3	0.1	0.17	1.4	213.8	206.1	650.6	168.0	37.6	2.6	1282.7
10	3.6	82.4	133.2	1.8	0.0	0.33	1.4	213.8	206.1	650.6	176.3	71.0	2.6	1324.0
11	3.2	121.4	126.2	1.9	0.0	0.22	1.4	171.1	206.1	650.6	162.8	47.3	2.6	1244.1
12	2.9	129.8	116.1	2.0	0.1	0.34	1.4	171.1	206.1	650.6	187.9	73.1	2.6	1295.2
13	3.0	165.8	101.7	1.9	0.0	0.24	1.4	128.3	206.1	650.6	168.5	52.7	2.6	1212.4
14	2.0	112.1	69.7	2.0	0.0	0.39	1.4	128.3	206.1	650.6	190.0	83.9	2.6	1265.2
15	2.2	67.2	65.5	2.5	0.1	0.31	1.4	128.3	206.1	650.6	210.8	66.7	2.6	1269.3
16	2.4	94.3	43.8	4.0	0.1	0.33	1.4	171.1	206.1	650.6	229.3	71.0	2.6	1336.5
17	2.8	59.4	43.8	3.8	0.1	0.24	1.4	213.8	206.1	650.6	226.6	51.6	2.6	1356.9
18	2.6	5.3	509.1	2.1	0.1	0.20	0.0	299.4	206.1	650.6	197.5	43.0	2.6	1401.5
19	2.5	297.8	341.7	1.1	0.0	0.21	0.0	342.1	0.0	0.0	114.2	45.2	0.0	502.9
20	1.8	296.4	628.5	0.9	0.0	0.16	0.0	342.1	0.0	0.0	70.3	34.4	0.0	447.9
21	2.9	260.5	124.8	0.8	0.0	0.18	0.0	299.4	0.0	0.0	76.0	38.7	0.0	415.0
22	2.2	253.8	72.7	0.6	0.0	0.05	0.0	213.8	0.0	0.0	60.2	10.8	0.0	285.4
23	2.9	169.3	93.1	0.4	0.0	0.04	0.0	85.5	0.0	0.0	38.9	9.7	0.0	134.6
24	3.5	163.9	106.6	0.3	0.0	0.01	0.0	85.5	0.0	0.0	25.9	3.2	0.0	115.0
Average			162.1	1.6	0.0	0.2	0.6	178.2	103.1	325.3	114.4	35.8	1.3	760.5
Percentage Contribution				0.2%	0.0%	0.0%	0.1%	23.4%	13.6%	42.8%	15.0%	4.7%	0.2%	100.0%

Table 3.3 - Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at Pinal County Housing on 10/29/2008															
Hour	WSPD (mph)	WD (degree)	PM10 Obs. (µg/m3)	Paved Rd	Neighbor-hood Paved Rd	Neighborhood UnPaved Rd	Permitted Point Sources	Construction	Dairies	Agriculture	Unpaved Road				Total(lbs/hr)
											AG Road	Public Dirt	Private Dirt	Trail	
1	2.1	100.2	91.4	0.2	0.0	0.0	33.0	0.0	0.0	0.0	0.0	10.0	1.7	0.0	44.8
2	1.3	122.1	86.1	0.2	0.0	0.0	33.0	0.0	0.0	0.0	0.0	10.9	8.3	0.0	52.4
3	1.1	73.5	72.5	0.2	0.0	0.0	33.0	0.0	0.0	0.0	0.0	9.0	4.1	0.0	46.4
4	1.1	144.0	67.8	0.2	0.0	0.0	33.0	0.0	0.0	0.0	0.0	9.6	0.0	0.0	42.9
5	1.1	246.0	76.6	0.5	0.0	0.0	33.0	0.0	0.0	0.0	0.0	22.4	5.0	0.0	60.9
6	1.1	142.8	60.1	1.5	0.0	0.0	33.0	0.0	0.0	0.0	0.0	45.4	17.4	0.0	97.4
7	1.1	189.5	145.8	2.4	0.0	0.0	33.0	0.0	0.0	89.7	137.1	96.1	34.8	0.7	393.9
8	1.1	276.0	287.0	2.2	0.0	0.0	33.0	0.2	0.0	89.7	137.1	140.7	21.6	0.7	425.1
9	1.6	133.5	179.2	1.8	0.0	0.0	33.0	0.2	0.0	89.7	137.1	133.9	29.0	0.7	425.4
10	1.1	300.9	455.2	1.5	0.0	0.0	33.0	0.2	4.9	89.7	137.1	145.4	54.7	0.7	467.2
11	1.4	18.9	234.8	1.6	0.0	0.0	33.0	0.2	4.9	89.7	137.1	135.0	36.5	0.7	438.7
12	1.6	259.9	85.6	1.7	0.0	0.0	33.0	0.2	4.9	89.7	137.1	154.4	56.4	0.7	478.1
13	1.4	308.7	71.4	1.6	0.0	0.0	33.0	0.2	4.9	89.7	137.1	135.5	40.6	0.7	443.4
14	2.6	263.9	62.7	1.7	0.0	0.0	33.0	0.2	4.9	89.7	137.1	149.4	64.7	0.7	481.4
15	2.2	292.9	65.6	2.1	0.0	0.0	33.0	0.2	4.9	89.7	137.1	163.0	51.4	0.7	482.1
16	1.5	244.0	54.5	3.3	0.0	0.0	33.0	0.2	4.9	89.7	137.1	168.0	54.7	0.7	491.6
17	1.5	294.0	40.8	3.1	0.0	0.0	33.0	0.2	4.9	89.7	137.1	163.5	39.8	0.7	472.1
18	1.1	300.1	368.4	1.7	0.0	0.0	33.0	0.0	0.0	89.7	137.1	140.0	33.2	0.7	435.4
19	1.1	53.0	588.4	1.0	0.0	0.0	33.0	0.0	0.0	0.0	0.0	78.1	34.8	0.0	146.9
20	1.1	57.4	453.5	0.8	0.0	0.0	33.0	0.0	0.0	0.0	0.0	45.0	26.5	0.0	105.3
21	1.1	91.7	281.6	0.7	0.0	0.0	33.0	0.0	0.0	0.0	0.0	47.9	29.9	0.0	111.4
22	1.1	82.1	199.3	0.5	0.0	0.0	33.0	0.0	0.0	0.0	0.0	37.7	8.3	0.0	79.5
23	1.1	128.4	128.6	0.4	0.0	0.0	33.0	0.0	0.0	0.0	0.0	25.0	7.5	0.0	65.8
24	1.1	187.8	114.4	0.3	0.0	0.0	33.0	0.0	0.0	0.0	0.0	19.3	2.5	0.0	55.1
Average			188.7	1.3	0.0	0.0	33.0	0.1	1.6	44.9	68.6	86.9	27.6	0.3	264.3
Percentage Contribution				0.5%	0.0%	0.0%	12.5%	0.0%	0.6%	17.0%	25.9%	32.9%	10.5%	0.1%	100.0%

3.3 High Wind Emissions Inventory for Selected Design Days

Four dates were selected as representative of exceedances that occurred during high wind conditions.[36] The dates and associated monitoring sites are as follows:

January 1, 2008 – Pinal County Housing
April 27, 2008 – Cowtown
October 27, 2008 – Maricopa
November 21, 2008 – Stanfield

Similar to the evaluation of low wind days, separate modeling domains were defined and emission inventories developed for each of the four design days and monitoring sites. These inventories were used in modeling analyses to quantify source contributions and impacts at the exceeding monitors. The base year inventories for the four modeling domains are presented in Tables 3.4 through 3.7 below. Dominant source categories vary between the four domains. In the Pinal County Housing inventory, agricultural emissions make up more than 76 percent of total emissions. Approximately 71 percent of emissions in the Cowtown inventory are comprised of desert shrubland, CAFOs, and agricultural sources. At Maricopa, construction, cleared areas, and agricultural sources are more than 65 percent of the total inventory. Lastly, for the Stanfield area, CAFOs, desert shrubland, agriculture, and unpaved roads account for approximately 99 percent of the inventory.

[36] Section 3.3, Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains, February 11, 2013.

Table 3.4 - Emissions Inventory (lbs/hour) for the High Wind Day at Pinal County Housing on 1/1/2008																
												Unpaved Road				
Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	Paved Road	Permitted Point Sources	Dairies	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agriculture	AG Road	Public Dirt	Private Dirt	Trail	Total (lbs/hr)
1	1.6	303.8	28.2	0.5	33.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	13.1	2.0	0.0	49.0
2	1.5	318.0	21.0	0.5	33.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	10.6	10.1	0.0	54.4
3	2.0	335.4	22.2	0.4	33.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	12.6	5.0	0.0	51.4
4	2.5	333.7	24.5	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	45.5
5	5.9	352.2	16.4	1.0	33.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	27.5	6.0	0.0	67.7
6	3.2	299.6	19.1	3.4	33.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	62.3	21.1	0.0	119.9
7	3.9	339.3	16.2	5.5	33.0	0.1	0.0	0.0	0.0	0.0	103.4	24.1	122.4	42.3	2.9	333.7
8	5.7	5.0	22.7	4.9	33.0	0.5	0.0	0.0	0.0	0.0	103.4	24.1	182.1	26.2	2.9	377.1
9	4.8	53.9	34.7	4.1	33.0	0.9	0.0	0.0	0.0	0.0	103.4	24.1	166.1	35.2	2.9	369.7
10	16.3	41.2	871.2	0.0	0.0	0.0	119.0	297.2	42.6	11.0	2417.3	169.6	43.9	42.6	12.8	3156.0
11	21.4	46.3	919.3	0.0	0.0	0.0	355.2	823.7	118.2	37.3	8150.5	572.5	148.1	143.9	43.0	10392.4
12	25.1	49.6	1136.1	0.0	0.0	0.0	641.0	1486.2	213.3	67.3	14707.0	1033.0	267.2	259.6	77.7	18752.4
13	23.6	48.5	790.7	0.0	0.0	0.0	275.3	638.4	91.6	28.9	6317.0	443.7	114.8	111.5	33.4	8054.6
14	22.9	48.3	946.1	0.0	0.0	0.0	135.1	313.3	45.0	14.2	3099.9	217.7	56.3	54.7	16.4	3952.5
15	19.2	47.6	320.0	0.0	0.0	0.0	65.5	163.5	23.5	6.1	1330.1	93.3	24.1	23.5	7.0	1736.6
16	22.3	53.6	397.9	0.0	0.0	0.0	87.6	203.2	29.2	9.2	2010.7	141.2	36.5	35.5	10.6	2563.8
17	19.9	53.6	281.9	0.0	0.0	0.0	80.0	199.8	28.7	7.4	1625.7	114.1	29.5	28.7	8.6	2122.5
18	15.0	50.6	65.8	0.0	0.0	0.0	20.5	53.3	7.7	1.8	385.8	27.0	7.0	6.8	2.0	511.9
19	15.5	54.6	50.9	0.0	0.0	0.0	14.6	38.1	5.5	1.3	275.5	19.3	5.0	4.9	1.5	365.6
20	19.4	58.1	61.5	0.0	0.0	0.0	18.2	45.4	6.5	1.7	369.5	25.9	6.7	6.5	1.9	482.4
21	19.3	56.7	70.6	0.0	0.0	0.0	21.8	54.5	7.8	2.0	443.4	31.1	8.0	7.8	2.3	578.9
22	19.2	57.4	67.6	0.0	0.0	0.0	21.8	54.5	7.8	2.0	443.4	31.1	8.0	7.8	2.3	578.9
23	17.2	55.7	32.7	0.0	0.0	0.0	6.6	16.6	2.4	0.6	134.6	9.4	2.4	2.4	0.7	175.8
24	14.9	54.6	139.3	0.0	0.0	0.0	13.0	33.9	4.9	1.1	245.1	17.2	4.4	4.3	1.3	325.2
Average			264.9	0.9	12.4	0.1	78.1	184.2	26.4	8.0	1761.1	125.8	57.1	37.0	9.6	2300.7
Percentage Contribution				0.0%	0.5%	0.0%	3.4%	8.0%	1.1%	0.3%	76.5%	5.5%	2.5%	1.6%	0.4%	100.0%

Shaded Area = High Wind Hours

Table 3.5 - Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Cowtown on 04/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obs (µg/m3)	Rail Road	Permitted Point Sources	Paved Road	Construction	Cleared Area	Desert Shrub-land	Developed Rural Lands	Developed Urban Lands	Unknown	CAFOs	Agriculture		Unpaved Road					Total (lbs/hr)
														County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	6.1	332.4	68.3	1.2	10.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	74.2	0.0	0.0	0.0	15.7	3.0	0.0	1.2	106.2
2	0.7	320.5	73.0	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	74.2	0.0	0.0	0.0	15.4	15.2	0.0	2.5	119.4
3	5.9	314.7	88.1	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	74.2	0.0	0.0	0.0	15.3	7.6	0.0	1.4	110.6
4	3.9	84.4	59.7	1.2	10.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	148.4	0.0	0.0	0.0	13.4	0.0	0.0	0.8	174.8
5	2.2	25.7	92.3	1.2	10.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	370.9	0.0	0.0	0.0	26.2	9.1	0.0	2.7	422.1
6	2.4	156.6	492.9	1.2	10.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	370.9	0.0	0.0	0.0	64.4	31.9	0.0	7.2	492.0
7	1.6	229.1	326.4	1.2	10.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	370.9	160.8	89.1	32.4	142.4	63.9	2.3	20.7	904.1
8	2.1	11.6	222.0	1.2	10.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	370.9	160.8	89.1	32.4	205.4	39.5	2.3	21.9	942.8
9	10.9	33.2	372.4	1.2	10.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	370.9	160.8	89.1	32.4	178.3	53.2	2.3	22.5	928.5
10	20.0	52.9	886.8	0.0	0.0	0.0	454.2	25.6	1607.3	101.0	3.5	0.2	0.0	1850.4	0.0	168.8	29.6	287.3	4.1	0.0	4532.0
11	17.6	44.4	107.7	0.0	0.0	0.0	120.4	33.8	426.0	26.8	0.9	0.1	0.0	490.5	0.0	44.7	7.9	76.1	1.1	0.0	1228.3
12	15.7	43.0	122.3	0.0	0.0	0.0	55.0	45.1	194.6	12.2	0.4	0.0	0.0	224.0	0.0	20.4	3.6	34.8	0.5	0.0	590.7
13	17.7	37.0	72.0	0.0	0.0	0.0	112.4	31.5	397.6	25.0	0.9	0.1	0.0	457.7	0.0	41.8	7.3	71.1	1.0	0.0	1146.2
14	14.7	44.0	38.4	0.0	0.0	0.0	38.5	29.6	146.1	9.2	0.3	0.0	0.0	154.3	0.0	13.6	2.4	23.2	0.3	0.0	417.6
15	16.1	49.6	36.4	0.0	0.0	0.0	55.7	26.8	197.1	12.4	0.4	0.0	0.0	226.9	0.0	20.7	3.6	35.2	0.5	0.0	579.4
16	15.1	50.7	23.1	0.0	0.0	0.0	45.5	15.7	172.5	10.8	0.3	0.0	0.0	182.2	0.0	16.1	2.9	27.4	0.4	0.0	473.9
17	12.1	59.4	69.7	0.0	0.0	0.0	8.7	8.2	33.0	2.1	0.1	0.0	0.0	34.8	0.0	3.1	0.5	5.2	0.1	0.0	95.7
18	9.2	68.9	101.2	1.2	10.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	519.2	160.8	89.1	32.4	204.3	60.8	2.3	23.7	1111.2
19	5.2	40.9	230.1	1.2	10.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	593.4	0.0	0.0	0.0	113.2	63.9	0.0	13.0	798.7
20	4.0	8.0	72.9	1.2	10.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	593.4	0.0	0.0	0.0	63.8	48.7	0.0	8.5	728.8
21	2.9	37.2	79.7	1.2	10.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	519.2	0.0	0.0	0.0	66.4	54.7	0.0	9.3	663.7
22	3.0	35.3	42.6	1.2	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	0.0	0.0	0.0	57.2	15.2	0.0	4.7	461.2
23	3.8	111.6	232.5	1.2	10.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	148.4	0.0	0.0	0.0	39.3	13.7	0.0	3.4	217.5
24	4.7	9.3	127.5	1.2	10.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	148.4	0.0	0.0	0.0	26.3	4.6	0.0	1.9	193.5
Average			168.3	0.8	6.7	2.5	37.1	9.0	132.3	8.3	0.3	0.0	213.3	177.7	14.9	19.1	54.4	43.6	0.7	6.1	726.6
Percentage Contribution				0.1%	0.9%	0.4%	5.1%	1.2%	18.2%	1.1%	0.0%	0.0%	29.3%	24.5%	2.0%	2.6%	7.5%	6.0%	0.1%	0.8%	100.0%

Shaded Area = High Wind Hours

Table 3.6 - Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Maricopa on 10/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	RailRoad	Paved Road	Construction	CAFOs	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Unknown	Agriculture		Unpaved Road					Total (lbs/hr)
													County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	3.8	160.0	239.9	1.0	3.0	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	1.9	0.0	1.1	28.2
2	2.0	106.0	143.5	1.0	2.8	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	9.3	0.0	2.4	34.9
3	1.3	6.0	70.3	1.0	2.8	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	4.7	0.0	1.4	31.1
4	1.3	348.0	73.8	1.0	3.4	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.7	43.6
5	2.5	290.0	98.7	1.0	6.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	5.6	0.0	2.6	112.0
6	2.0	241.0	91.8	1.0	21.3	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.7	19.6	0.0	7.0	155.7
7	1.3	215.0	129.8	1.0	32.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	162.4	76.8	181.8	30.3	39.2	1.1	20.2	634.5
8	5.6	82.0	160.4	1.0	28.8	278.8	89.2	0.0	0.0	0.0	0.0	0.0	162.4	76.8	181.8	46.1	24.3	1.1	21.3	911.6
9	13.0	84.0	326.2	0.0	0.0	316.7	0.0	108.5	52.4	59.9	30.2	8.8	116.2	0.0	16.8	2.2	5.3	0.6	0.0	717.6
10	16.1	85.0	852.9	0.0	0.0	1983.4	0.0	663.4	305.9	349.2	200.6	53.0	687.4	0.0	111.3	14.8	35.3	4.0	0.0	4408.3
11	18.3	81.0	496.5	0.0	0.0	1771.6	0.0	592.5	273.3	311.9	179.2	47.3	614.0	0.0	99.4	13.2	31.5	3.5	0.0	3937.5
12	16.3	82.0	293.2	0.0	0.0	773.5	0.0	425.3	119.3	136.2	78.3	20.7	268.1	0.0	43.4	5.8	13.8	1.5	0.0	1885.9
13	17.0	79.0	176.0	0.0	0.0	660.2	0.0	220.8	101.8	116.3	66.8	17.6	228.8	0.0	37.1	4.9	11.7	1.3	0.0	1467.5
14	16.8	74.0	141.9	0.0	0.0	513.5	0.0	171.8	79.2	90.4	51.9	13.7	178.0	0.0	28.8	3.8	9.1	1.0	0.0	1141.4
15	15.4	72.0	84.8	0.0	0.0	218.4	0.0	71.5	36.2	41.3	20.8	6.1	80.2	0.0	11.6	1.5	3.7	0.4	0.0	491.7
16	13.6	71.0	76.6	0.0	0.0	79.2	0.0	27.1	13.1	15.0	7.6	2.2	29.1	0.0	4.2	0.6	1.3	0.1	0.0	179.4
17	13.0	72.0	68.6	0.0	0.0	52.8	0.0	18.1	8.7	10.0	5.0	1.5	19.4	0.0	2.8	0.4	0.9	0.1	0.0	119.6
18	8.7	62.0	60.4	1.0	23.1	0.0	124.8	0.0	0.0	0.0	0.0	0.0	162.4	76.8	181.8	36.7	35.6	1.0	22.5	665.7
19	7.2	61.0	56.2	1.0	13.5	0.0	142.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.6	37.4	0.0	12.3	226.5
20	7.4	68.0	45.1	1.0	10.7	0.0	142.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	28.5	0.0	8.1	200.5
21	9.6	70.0	36.1	1.0	9.2	0.0	124.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	32.0	0.0	8.8	185.3
22	9.8	80.0	30.8	1.0	6.8	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	8.9	0.0	4.4	117.8
23	9.2	82.0	33.2	1.0	5.0	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	8.0	0.0	3.2	58.8
24	8.9	78.0	38.7	1.0	3.8	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.7	0.0	1.8	50.0
Average			159.4	0.6	7.2	277.0	47.5	95.8	41.2	47.1	26.7	7.1	112.8	9.6	37.5	10.5	15.4	0.7	4.9	741.9
Percentage Contribution				0.1%	1.0%	37.3%	6.4%	12.9%	5.6%	6.3%	3.6%	1.0%	15.2%	1.3%	5.1%	1.4%	2.1%	0.1%	0.7%	100.0%

Shaded Area = High Wind Hours

Table 3.7 - Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Stanfield on 11/21/2008

Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	Paved Road	Construction	CAFOs	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agriculture	Unpaved Road				Total (lbs/hr)
												AG Road	Public Dirt	Private Dirt	Trail	
1	4.1	119.2	112.4	0.2	0.0	26.9	0.0	0.0	0.0	0.0	0.0	0.0	18.5	2.2	0.0	47.9
2	3.5	161.6	59.4	0.2	0.0	26.9	0.0	0.0	0.0	0.0	0.0	0.0	23.0	11.2	0.0	61.3
3	3.9	117.3	157.4	0.2	0.0	26.9	0.0	0.0	0.0	0.0	0.0	0.0	17.1	5.6	0.0	49.9
4	4.3	125.4	158.4	0.3	0.0	53.8	0.0	0.0	0.0	0.0	0.0	0.0	17.1	0.0	0.0	71.2
5	3.7	274.2	102.3	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	34.4	6.7	0.0	176.2
6	4.0	240.9	234.2	1.7	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	74.0	23.5	0.0	233.8
7	15.9	85.5	357.4	0.0	0.0	81.3	2.1	112.8	9.5	0.1	786.6	38.0	11.6	3.3	0.5	1045.8
8	18.3	81.9	326.6	0.0	0.0	133.3	3.4	185.0	15.5	0.2	1289.6	62.4	19.0	5.5	0.8	1714.7
9	20.4	82.2	584.6	0.0	0.0	585.6	14.8	812.6	68.2	0.8	5665.3	273.9	83.6	24.1	3.7	7532.6
10	19.9	81.1	429.2	0.0	0.0	217.3	5.5	301.5	25.3	0.3	2101.9	101.6	31.0	8.9	1.4	2794.7
11	20.0	80.2	334.3	0.0	0.0	147.7	3.7	205.0	17.2	0.2	1429.3	69.1	21.1	6.1	0.9	1900.4
12	18.2	80.4	186.1	0.0	0.0	68.1	1.7	94.5	7.9	0.1	659.1	31.9	9.7	2.8	0.4	876.4
13	14.7	79.2	93.9	0.0	0.0	23.6	0.6	36.0	3.0	0.0	222.8	10.8	3.3	0.9	0.1	301.3
14	13.4	78.5	65.1	0.0	0.0	10.0	0.3	15.2	1.3	0.0	94.3	4.6	1.4	0.4	0.1	127.5
15	12.3	75.3	64.8	0.0	0.0	4.1	0.1	6.2	0.5	0.0	48.3	1.9	0.6	0.2	0.0	61.8
16	9.9	77.2	65.2	3.9	1.4	107.6	0.0	0.0	0.0	0.0	139.1	63.4	309.4	74.0	2.1	700.9
17	7.1	74.7	87.1	3.7	1.4	134.5	0.0	0.0	0.0	0.0	139.1	63.4	296.1	53.8	2.1	694.1
18	4.7	73.8	104.6	2.0	0.0	188.4	0.0	0.0	0.0	0.0	139.1	63.4	260.4	44.8	2.1	700.2
19	6.3	75.1	88.3	1.1	0.0	215.3	0.0	0.0	0.0	0.0	0.0	0.0	147.0	47.1	0.0	410.5
20	5.6	86.2	56.1	0.9	0.0	215.3	0.0	0.0	0.0	0.0	0.0	0.0	87.1	35.9	0.0	339.1
21	2.6	158.4	98.3	0.7	0.0	188.4	0.0	0.0	0.0	0.0	0.0	0.0	92.8	40.3	0.0	322.2
22	2.2	230.2	249.6	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	76.3	11.2	0.0	222.6
23	2.9	270.1	171.6	0.4	0.0	53.8	0.0	0.0	0.0	0.0	0.0	0.0	50.3	10.1	0.0	114.7
24	2.4	291.4	99.5	0.3	0.0	53.8	0.0	0.0	0.0	0.0	0.0	0.0	34.3	3.4	0.0	91.7
Average			178.6	0.7	0.1	123.6	1.3	73.7	6.2	0.1	529.8	32.7	71.6	17.6	0.6	858.0
Percentage Contribution				0.1%	0.0%	14.4%	0.2%	8.6%	0.7%	0.0%	61.7%	3.8%	8.3%	2.0%	0.1%	100.0%

Shaded Area = High Wind Hours

3.4 Summary of Annual Emissions Inventory for the West Pinal PM_{10} Nonattainment Area

This section provides a summary of the 2008 annual emissions inventory for the nonattainment area. Table 3.8 presents the emissions for high wind days. As previously noted in this chapter, the number of hours classified as high wind is less than10 percent per year. Even though this is a small amount of time, the emissions produced during those hours account for approximately 70 percent of the inventory and are estimated at 102,921 tons per year (tpy) (Table 3.9). Desert shrubland and agricultural croplands are estimated to produce 85,033 tpy and account for about 83 percent of the inventory.

Table 3.8
Summary of the 2008 Annual High Wind Emissions in Western Pinal County

Land Use Category	Emissions (Tons/year)	Percentage
Developed Urban Lands	253	0.2%
Developed Rural Lands (low density residential)	2,482	2.4%
Unpaved Roads	5,858	5.7%
Cleared Areas	475	0.5%
Residential Construction	633	0.6%
CAFOs and Dairies	1,009	1.0%
Desert Shrubland	52,531	51.0%
Agricultural Croplands	32,502	31.6%
Commercial Construction	575	0.6%
Other	5,826	5.7%
Site Development	777	0.8%
Total High Wind Emissions	102,921	100%

Table 3.9 provides a summary of the total annual emissions inventory for 2008, including high wind emissions and the remaining low wind emissions. The source category with the highest emissions is unpaved roads, about 22 percent of low wind emissions (Table 3.9). Considering the emissions of unpaved roads during low winds and the total high wind emissions as source categories, the contribution from these two categories accounts for approximately 91 percent of the total annual emissions inventory.

Table 3.9
Summary of the 2008 Annual PM_{10} Emissions in the Western Pinal County Nonattainment Area

Source Category		PM_{10} Emissions		
		(lbs/day)	(tons/year)	% of Annual Total
Agriculture	Harvesting	6,726	289	0.2%
	Tilling	25,482	2,347	1.6%
CAFOs		11,892	2,176	1.5%
Paved Road		6,208	1,136	0.8%

Table 3.9 Summary of the 2008 Annual PM_{10} Emissions in the Western Pinal County Nonattainment Area			
Source Category	**PM_{10} Emissions**		
	(lbs/day)	**(tons/year)**	**% of Annual Total**
Unpaved Road	182,149	33,333	22.3%
Non-Road	650	107	0.1%
Railroad	470	86	0.1%
Construction	45,776	6,042	4.1%
Dairy	1,037	190	0.1%
Permitted Sources	2,822	516	0.3%
Sub-Total: Low Wind Emissions		46,222	31.0%
Windblown Emissions		102,921	69.0%
Total Emissions		149,143	100.0%

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4.0 BASE YEAR MODELING

This section provides a summary of the base year modeling for the selected design days and modeling domains. This analysis quantified each source's contribution to PM_{10} emissions for the 2008 base year.

Identifying the contribution of emissions sources to ambient concentrations allows sources to determine and select control strategies that are feasible and effective. Basecase modeling was performed for both stagnation/low wind and high wind conditions. More detailed information is contained in Appendix C (Modeling Technical Support Document).

4.1 Stagnation/Low Wind Modeling

In order to assess the contribution of each PM_{10} source during stagnation/low wind conditions, Sierra Research Inc. evaluated various models to determine which would be most suitable to evaluate hourly source contributions and the conditions in Pinal County. AERMOD is a steady-state Gaussian plume dispersion model that assesses pollutant concentrations from a variety of source types. Adopted by EPA as a regulatory model on December 9, 2005, AERMOD contains improved algorithms for addressing low wind speed (near-calm conditions) and can provide estimates for conditions when wind speeds are less than 1 m/sec,[37] [38]which are common on the selected stagnation design day. Primary inputs include the emissions inventory and meteorological information.

As previously discussed in Chapter 3, October 29, 2008, was selected as being representative of meteorological conditions leading to PM_{10} exceedances on stagnation days (Chapter 3 and Appendix B). Hourly concentrations were modeled for the Cowtown, Pinal County Housing, and Stanfield monitors for the selected stagnation design day. Figures 4.1 through 4.3 shows the modeled source specific concentration at the Cowtown, Pinal County Housing, and Stanfield monitors.

[37] "Revisions to the Guideline on Air Quality Models: Adoption of Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions," U.S. Environmental Protection Agency, Federal Register, Vol. 70, No. 216, p. 68218, November 9, 2005 (Attachment IV)

[38] User's Guide for AERMET, EPA-454/B-03-002, November 2004

Figure 4.1
Modeled Stagnation Day Emission Source Apportionment (%) for the Cowtown (CTW) Monitor on 10/29/2008

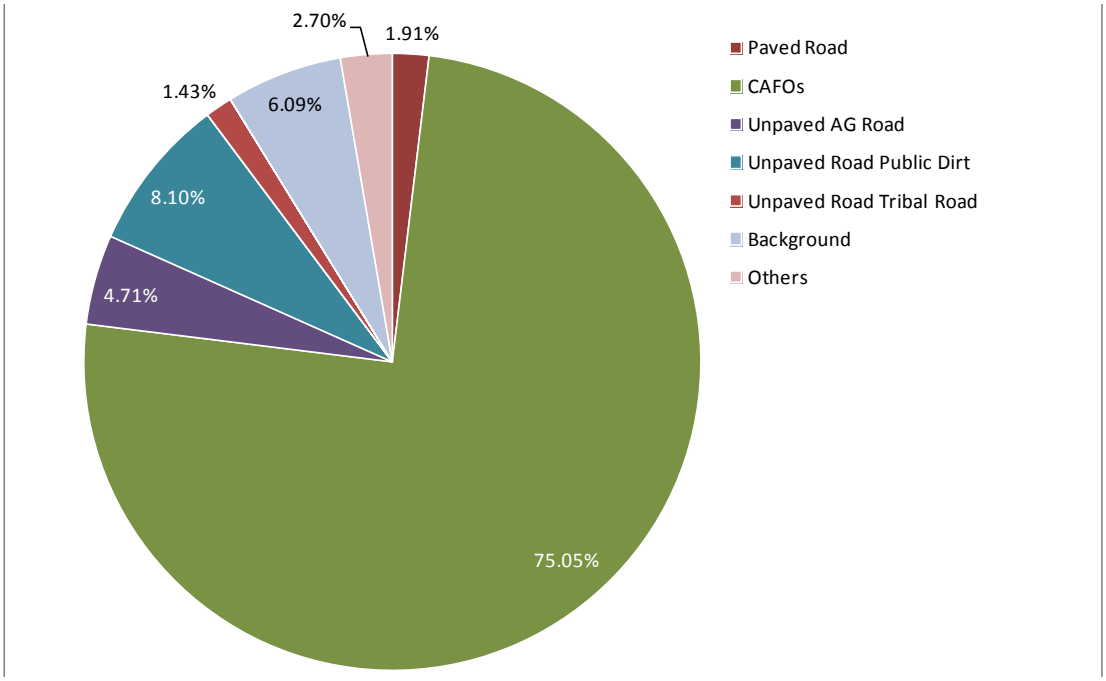


Figure 4.2
Modeled Stagnation Day Emission Source Apportionment (%) for the Pinal County Housing (PCH) Monitor on 10/29/2008

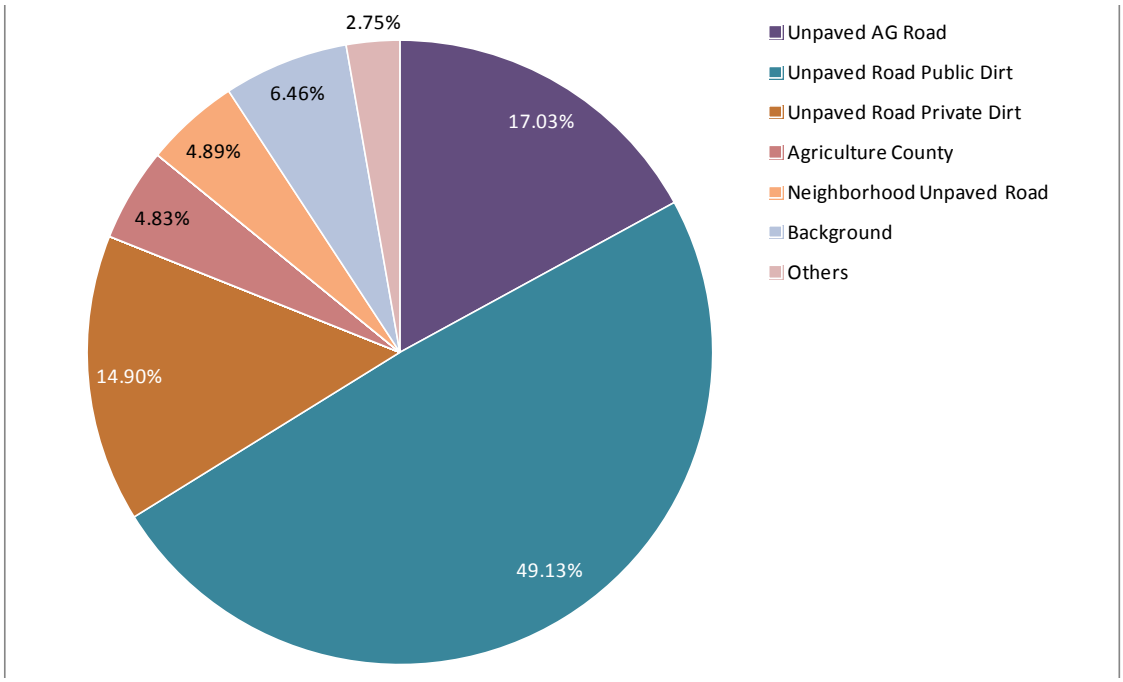
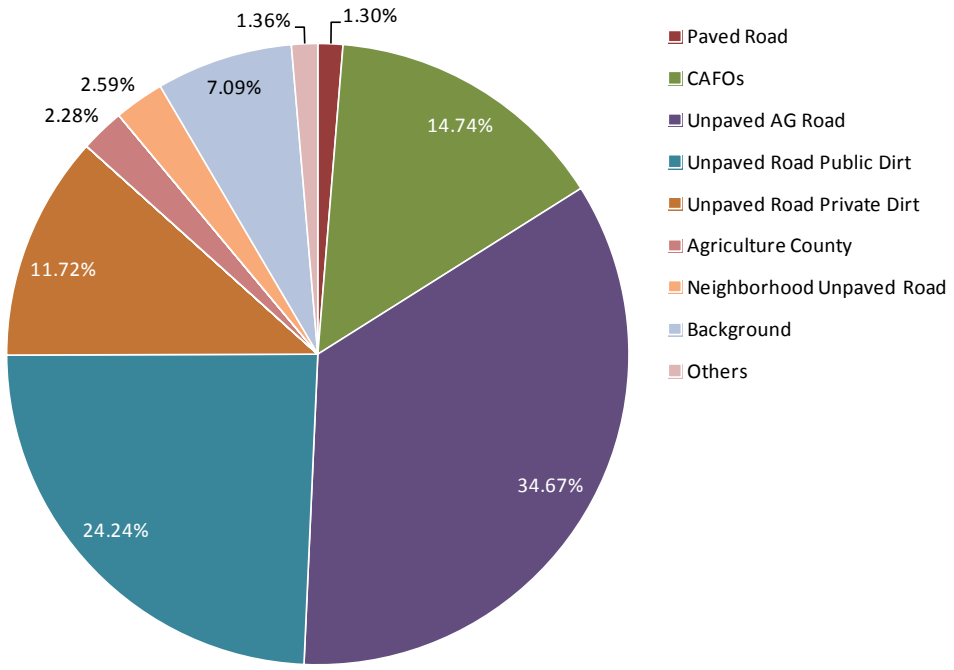


Figure 4.3
Modeled Stagnation Day Emission Source Apportionment (%) for the Stanfield (STF) Monitor on 10/29/2008



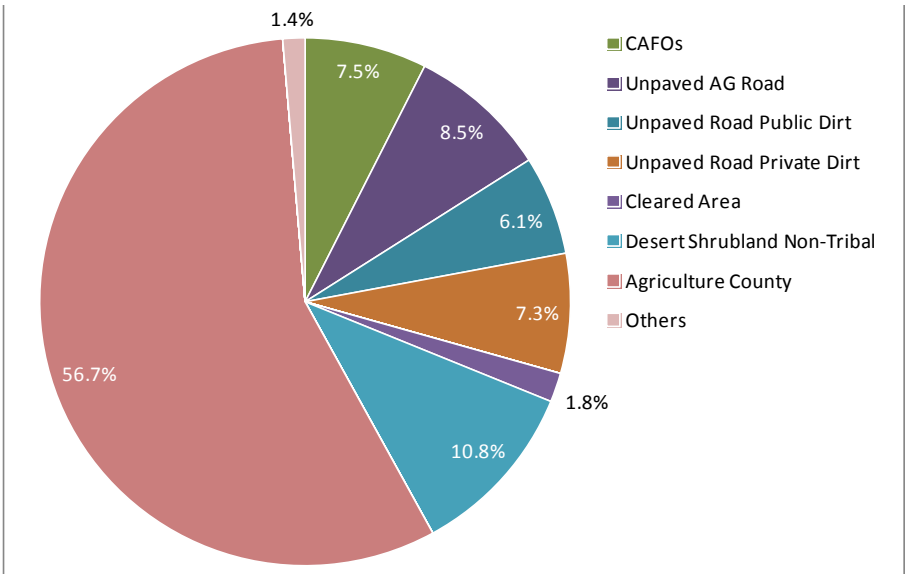
4.2 High Wind Modeling

Sierra Research Inc. assisted the Maricopa Association of Governments (MAG) prepare the Five Percent plan for the Maricopa County Serious PM_{10} Nonattainment Area[39]. As a result of this experience, Sierra Research determined that neither photochemical grid models nor AERMOD would perform well to quantify source contribution on high wind days. In order to appropriately model source contribution of PM_{10} emissions in Pinal County, a weighted rollback model similar to the one in the Five Percent Plan was used for the high wind modeling in the nonattainment area. The model was altered to account for differences in the modeling domains and conditions in Pinal County.[40]

The contribution of PM_{10} emissions was separated into low and high wind hours during high wind conditions.[41] The primary reason for the separation is to account for differences how PM_{10} is emitted based on whether average hourly wind speeds exceeded 12 mph. The Inventory Preparation and the documentation for the emissions inventory provide detailed discussions regarding the apportionment modeling.

Figures 4.4 through 4.7 show the modeled high wind source apportionment for Stanfield, Pinal County Housing, Maricopa, and Cowtown monitors.

Figure 4.4
Modeled High Wind Day Emission Source Apportionment (%) for the Stanfield (STN) Monitor on 11/21/2008



[39] Chapter 6, Attainment Demonstration, "MAG Five Percent Plan for PM-10 for Maricopa County Nonattainment Area," May 2012.
[40] Pinal County PM Inventory Preparation Plan, February 11, 2013.
[41] Ibid.

Figure 4.5
Modeled High Wind Day Emission Source Apportionment (%) for the Pinal County Housing (PCH) Monitor on 1/1/2008

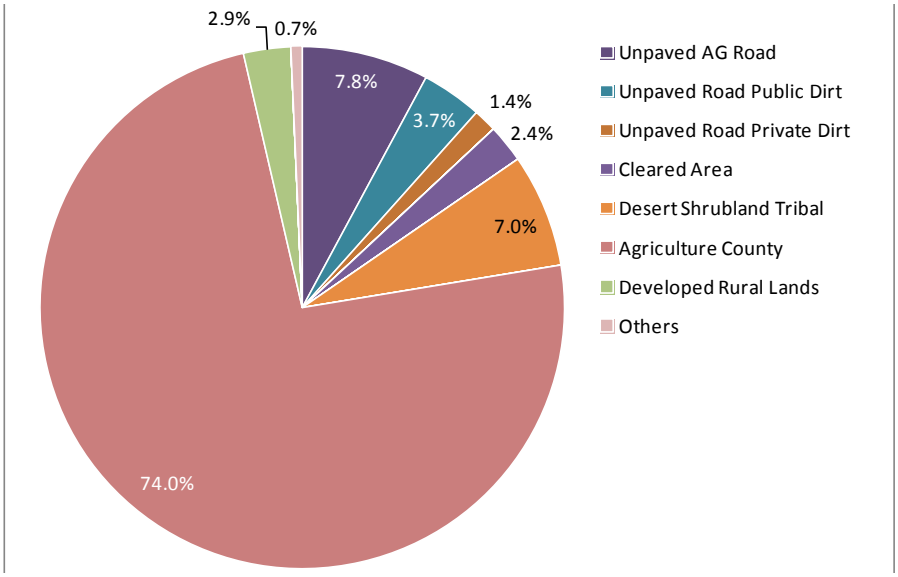


Figure 4.6
Modeled High Wind Day Emission Source Apportionment (%) for the Maricopa Monitor on 10/27/2008

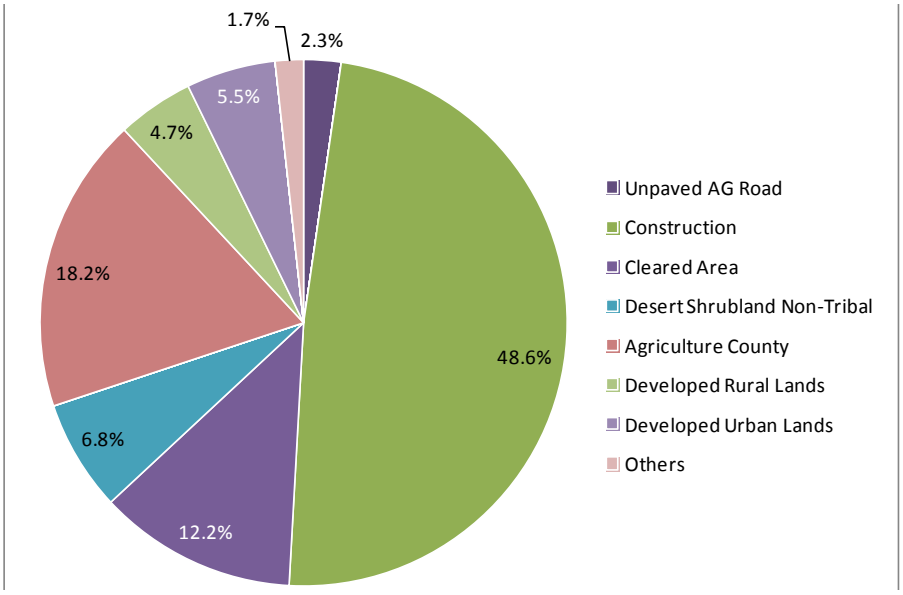
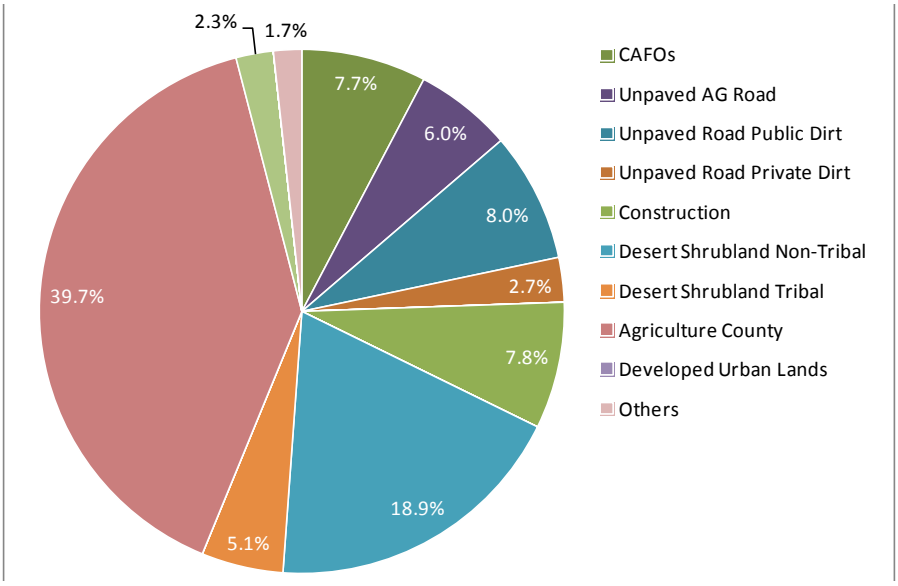


Figure 4.7
Modeled High Wind Day Emission Source Apportionment (%) for the Cowtown (CTW) Monitor on 4/27/2008



5.0 COMMITMENTS

To comply with remaining CAA requirements, ADEQ commits to submitting the following: control measure selection and analysis, reasonable further progress, prevention of significant deterioration/new source review, transportation conformity, contingency measures, attainment demonstration, and commitments. Table 5.1 provides an expected timeline for completion of the outstanding CAA requirements.

Table 5.1 – TIMELINE
West Pinal County PM_{10} Nonattainment Area

Date	Activity
January 1, 2014 – February 14, 2014	Finalize control measure modeling; reasonable further progress; attainment demonstration modeling; continue rulemaking process
February 17, 2014 – March 21, 2014	Finalize draft proposed SIP; incorporate rule/ordinance/policy revisions; PSD/NSR; control measure/RACM analysis; attainment demonstration; transportation conformity; contingency measures; commitments
March 24, 2014 – April 11, 2014	Management review of draft proposed SIP; prepare SIP and related documents for public comment period
April 14, 2014	Begin comment period
May 15, 2014	End comment period; public hearing
May 16, 2014 – June 1, 2014	Management review; prepare final SIP submittal
June 2, 2014	Submit full SIP to EPA

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APPENDIX A

Inventory Preparation Plan

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Report No. SR2013-01-01

Pinal County
PM Inventory Preparation Plan

Prepared for

Arizona Department of Environmental Quality

February 11, 2013

prepared by:

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Report No. SR2013-01-01

Pinal County PM Inventory Preparation Plan

prepared for:

Arizona Department of Environmental Quality

February 11, 2013

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Pinal County PM Inventory Preparation Plan

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1. INTRODUCTION

On February 3, 2011, the U.S. Environmental Protection Agency (U.S. EPA) designated the central portion of Pinal County as nonattainment for the 24-hour PM2.5 National Ambient Air Quality Standard (NAAQS), and designated the same area as attainment or unclassified for the annual PM2.5 NAAQS.[1] The rationale for the latter designation was based on the finding that the single monitoring site exceeding the annual standard, Cowtown, was a population-oriented microscale (i.e., localized hot spot) monitor that was not eligible for designation as a nonattainment site for the annual standard. On May 31, 2012, U.S. EPA designated a somewhat larger portion of central Pinal County as nonattainment for the 24-hour PM10 NAAQS.[2] The annual PM10 NAAQS was revoked by U.S. EPA on October 17, 2006. As a result of these decisions, the attainment demonstration for both PM2.5 and PM10 in Pinal County must be based on ambient air quality conditions and contributing emissions on specific design days.

A nonattainment designation reflects monitored airborne pollutant concentrations that exceed the prevailing standard. A nonattainment designation requires a curative amendment to the State Implementation Plan, configured to reduce concentrations below the standard. For purposes of developing that plan, emission inventories define the sources of the offending pollutant. Inventories constitute the practical and regulatory foundation for a plan amendment. Long-term and short-term inventories serve different primary functions. First, an annual inventory defines which sources generate long-term emissions of PM10 across the entire nonattainment area. That general understanding provides the factual basis for discussions regarding long-term emission trends based on changes in underlying activity rates and the impacts of control strategy implementation. In addition, an annual on-road emission inventory is required in order to define an annual emissions budget for transportation planning. Second, attainment demonstrations for the 24-hour PM10 NAAQS require modeling inventories defining the local, short-term emissions that caused specific violations of the 24-hour standard. This document defines a plan for developing those inventories.

Through discussions between U.S. EPA, the Arizona Department of Environmental Quality (ADEQ), and the Pinal County Air Quality Control District (PCAQCD), a base year of 2008 was selected for the preparation of an emission inventory and an attainment demonstration. This is the year of the most recent triennial National Emission Inventory prepared by ADEQ and PCAQCD and approved by U.S. EPA. The EPA implementation rule for preparation of PM2.5 State Implementation Plans (SIP) requires the use of this

[1] Federal Register, Vol. 76, No. 23, Thursday, February 3, 2011
[2] Federal Register, Vol. 77, No. 105, Thursday, May 31, 2012

most recent year for which a complete inventory was required to be submitted to EPA.[3] During 2008, exceedances of the 24-hour PM2.5 NAAQS were recorded at Cowtown; exceedances of the 24-hour PM10 NAAQS were recorded at Maricopa, Cowtown, Stanfield, Casa Grande, Combs School, and Pinal County Housing. At each of these latter sites, continuously recording TEOMs are used to record hourly averaged PM10 ambient concentrations. At the Cowtown site, a filter-based instrument is used to record 24-hour average PM2.5 concentrations.

To support the preparation of PM2.5 and PM10 State Implementation Plans (SIPs), ADEQ commissioned the preparation of an Inventory Preparation Plan (IPP) and an emission inventory based on the IPP. The Plan identifies key requirements, procedures, and data sources to be used in preparing emission inventories for the nonattainment area and for the modeling domains of monitors selected to represent exceedance conditions within the nonattainment area. Standard elements of an IPP include the presentation of EPA guidance and related requirements, a summary of the sources to be addressed and those not to be included, documentation of the procedures to be followed in computing emissions, data sources available to characterize activity and emission factors, local conditions affecting emissions, and quality control procedures to be followed.

To provide a better understanding of the conditions influencing fugitive dust production in the nonattainment area, additional tasks were undertaken (1) to gauge the influence of local versus regional emission sources impacting nonattainment monitors and (2) to select design days and modeling domains of monitors representative of exceedance conditions. Presented below is a summary of EPA guidance on IPP development.

1.1 Emission Inventory Guidance

EPA emission inventory guidance is summarized at the Clearinghouse for Inventories and Emission Factors (CHIEF) website. Guidance for the development of PM10 and PM2.5 emission inventories is available from the documents listed below.

- *PM-10 Emission Inventory Requirements*[4]
- *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*[5]
- *1996 Air Quality Criteria for Particulate Matter, Vol. 1*[6]

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[3] Federal Register, Vol. 72, No. 79, Wednesday, April 25, 2007
[4] *http://www.epa.gov/ttn/chief/eidocs/PM10eir.pdf*
[5] *http://www.epa.gov/ttn/chief/eiinformation.html*
[6] 1996 Air Quality Criteria for Particulate Matter, Vol. 1, EPA/600/P-95-001aF, (Washington, D.C.: U.S. Environmental Protection Agency, April 1996), Sections 5.2.1, 5.5.1, and 5.5.3

For PM10 nonattainment areas, EPA identifies three basic kinds of inventories that States may need to develop under the CAA: base year inventories, periodic inventories, and modeling inventories. Presented below is EPA's description of the information required for each of the inventory submittals and related IPP requirements.

Base Year Inventory – This is the primary inventory from which all other inventories are derived. All inventories are required to be consistent with data provided in the base year inventory. Section 172(c)(3) of the CAA requires States to ensure that this inventory is comprehensive, accurate, and current for all actual emissions of PM10. The base year inventory must include emissions from all point, area, and mobile sources.

Periodic Emissions Inventory – The CAA states that the emission inventories may be periodically updated as deemed necessary by the Administrator. A periodic inventory may be the consequence of RFP requirements, a maintenance plan for an attainment area, or for other reasons deemed necessary by EPA. The Administrator has determined that states should submit statewide annual and three-year cycle inventories for PM10 and PM2.5.[7]

Modeling Emissions Inventory – The modeling emissions inventory may be used as a tool for a number of purposes, including model performance evaluations, projection to future years, evaluation of the impact of rulemaking, evaluation of control measures and technology, receptor modeling reconciliation, and determination of design concentrations. One of the major roles for modeling inventories is for use in attainment demonstrations. Modeling inventories can be based upon either allowable or actual emissions, depending on the purpose of the modeling. For instance, modeling inventories should be based on the actual daily emissions for model performance evaluation. For control measure evaluations and the attainment demonstration, the modeling emission inventory should consist of allowable emissions for the base year and projected allowable emissions for the attainment year. The phrase "allowable emissions" is a term of art related to permitting and modeling the impacts of stationary sources. The bulk of emissions here are fugitive emissions that are not subject to a stationary source permitting program—for those emissions, base year "allowable emissions" are actual emissions and attainment year "allowable emissions" will reflect base year actual emissions adjusted for the projected control efficiencies of emission reduction measure commitments.

As will be discussed later in this Plan, the emissions inventories to be used in attainment demonstrations will be design-day-specific and specific to the modeling domains computed separately for each design day and monitoring site. None of the modeling domains covers either the entire central Pinal County PM10 or PM2.5 nonattainment areas. At least under stagnation and moderate wind conditions, the spatial and temporal variability in PM10 and PM2.5 exceedances demonstrates that sources within a few miles of each violating monitor are responsible for exceedances, not the totality of sources contained within the boundaries of the nonattainment areas. However, to the extent that land utilization patterns are relatively homogenous across the relevant area, modeling

[7] Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, EPA-454/R-05-001, August 2005, *http://www.epa.gov/ttn/chief/eidocs/eiguid/eiguidfinal_nov2005.pdf*

inventory analyses are expected to fairly represent similar conditions across the nonattainment area. As a result, emission inventory preparation under this plan will focus on the modeling needs of the various attainment demonstrations, and inventory improvements developed in these domains will be extended to the applicable source categories in the baseline inventories for the two nonattainment areas. However, lower priority will be given under this Plan to improving other emission inventory categories in the nonattainment area baselines that do not benefit the modeling domain inventories.

IPP Requirements – For base year inventories, EPA requires States to prepare a brief IPP that specifies how they intend to develop, document, and submit their inventories. The plans provide States the opportunity to notify EPA how they plan to compile the required inventories and to allow EPA to provide important feedback to prevent the use of approaches that are not consistent with the EPA requirements.

In addition to technical data, the IPPs should contain a schedule showing when the State plans to submit the draft and final inventories to EPA. If the State plans to submit an inventory in component pieces (e.g., point source component, area source component, etc.), the IPP must clearly make this distinction and indicate draft and final submittal dates for each component. The final submittal dates should be consistent with the PM10 emission inventory requirements. A complete draft inventory is required to be submitted to the EPA Regional Offices and the EPA headquarters within 12 months after the date that an area is designated nonattainment. The IPP is also required to detail the year chosen as the base year for the inventory, and explain the basis for the selection.

Source Category Requirements – States are required to define how all pertinent emission sources will be identified and located.

Point Sources – States are required to describe how point source activity levels and associated parameters will be developed, and how these data will be used to calculate emission estimates. States must also discuss how and when statewide point source reporting to the EPA will be conducted and how it will be coordinated with reporting for area and mobile sources. States must indicate whether rule effectiveness was applied and, if it was, the basis for determining control efficiencies. States must describe any source surveys that are planned, and if they intend to use existing data contained in the Emissions Inventory System (EIS), individual State emissions systems, or State permitting files.

Area and Mobile Sources – States must explicitly identify in the IPP which source categories will be addressed and which will not be addressed (with justification for exclusion). For included categories, the plan must indicate what calculation methods will be used to estimate emissions. If a State plans on using EPA's inventory guidance for all categories, the IPP must summarize the EPA guidance and contain reference(s) for the guidance. If the EPA guidance offers alternative methods for a category, the IPP shall clearly indicate which method the State intends to use in its inventory. Particular emphasis shall be given to categories for which the State plans to use an approach other than that recommended in the EPA guidance. Any major assumptions that may affect the development of emission estimates in a category must be clearly stated. The IPP must

also identify the sources of activity data, whether rule effectiveness will be applied (and how it was determined if applied), and the basis for determining control efficiencies.

For on-road mobile sources, the IPP must include a discussion of how the State intends to develop vehicle miles traveled (VMT) estimates, and how PM10 emission factors for mobile sources will be determined. EPA's original guidance required the use of a mobile source particulate model (PART5), which has been superseded by AP-42 guidance for paved and unpaved roads.

The IPP must also clearly describe how the State plans to present, document, and submit the inventory to the EPA. The types of documentation that will be provided and the form of this documentation must be described to the extent that EPA can judge if it would be satisfactory for inventory review purposes. The IPP shall specify the written and computerized methods that the State plans to use to compile and submit its emission data. The State must contact its EPA Regional Office to determine computerized data submittal and format requirements, and must describe in its IPP how its data system (e.g., AIRS, State system) will be used to submit the data to EPA.

States are required to submit Quality Assurance (QA) plans as an initial step in their inventory development work and receive EPA approval on their plans early on in the process. The QA plans must be submitted as part of a State's IPP. The content and general form of QA plans must be consistent with previously issued guidance. This plan shall describe the overall QA program that the State intends to use during the compilation of the inventory.

In summary, PM10 IPPs are required to be concise, and provide only as much detail as is necessary to communicate to the agency how the State intends to develop and present its inventory. However, the document must contain sufficient information to enable the EPA to make a judgment that the State's intended inventory approach is sound and consistent with EPA's guidance and requirements.

For PM2.5 nonattainment areas, the guidance is rather general and stresses the need to begin with a description of inventory objectives (e.g., geographic area covered, base year, pollutants included, temporal resolution, etc.). It states that the IPP should contain the following sections that address portions of the inventory:

- Introduction,
- Point Source Inventory,
- Area Source Inventory,
- Nonroad Mobile Source Inventory,
- Mobile Source Inventory,
- Biogenic Source Inventory,
- Documentation Approach, and
- Quality Assurance Plan.

The primary source of guidance referenced for developing an Inventory Preparation Plan (IPP) and related Quality Assurance Plan (QAP) is EPA's Emissions Inventory Improvement Program (EIIP) documentation. Table 1-1 presents an overview of the IPP and QAP planning activities recommended under EPA's EIIP guidance.

Table 1-1
Inventory Preparation Planning and Quality Assurance Planning Steps

Inventory Preparation	Quality Assurance
1. Preliminary Planning Activities:	
1. Define purpose and scope of inventory 2. Define organization and staffing roles (including agency <u>and</u> contractor roles)	3. Define and document data quality objectives 4. Identify quality assurance (QA) coordinator and assign QA responsibilities to inventory staff
2. Prepare Technical Work Plan:	
5. Identify geographical area 6. Delineate pollutants to inventory 7. Establish point/area source cutoffs 8. Prioritize source categories for inclusion in inventory 9. Prioritize data sources 10. Delineate emissions estimation procedures	11. Prepare QA plan concurrently with or after technical work plan 12. Document data-gathering methods in QA plan 13. Select QA procedures to be used 14. Determine indicators that will be used to measure data quality
3. Prepare Inventory:	
15. Data collection 16. Data handling 17. Estimate emissions 18. Document inventory development activities	19. Follow data handling procedures as documented in QA plan 20. Conduct routine QA activities and independent audits 21. Document QA steps coinciding with inventory development activities
4. Inventory Reporting:	
22. Document methods, data sources, adjustments 23. Discuss sources excluded and explain why 24. Present estimated emissions	25. Prepare QA audit reports 26. Document QA findings and resolution of problems 27. Discuss QA in final inventory report and prepare separate QA report
Source: EPA EIIP Document Series, Volume VI: Chapter 2	

The guidance and "blueprints" for inventory development specified in the EIIP are necessarily broad and comprehensive so that they can be used and adopted by individual States based on prioritized objectives, staffing, and resources. Some of the guidance, however, demands substantial rigor. For example, the QAP guidance in the EIIP provides for an extremely high degree of review, auditing, and relative "scoring" or ranking of the emission estimation, spatial and temporal allocation, and forecasting methodologies and data sources for each individual emission source in an inventory. For agencies with significant budgetary resources and staff that are developing rigorous, Level I-type[8] compliance inventories in industrialized urban areas, the high degree of quality assurance (QA) auditing, ranking, and documentation suggested in the EIIP guidance is appropriate. Since these conditions do not apply throughout the central Pinal County nonattainment area, judgment will be applied in establishing data collection, analysis, and related QA requirements.

Each of the steps outlined in Table 1-1 was considered in the development of this IPP. Presented below is a brief review of the issues considered and addressed within the four main categories of effort.

Preliminary Planning Activities – The work plan for this effort must define the purpose and scope of the inventory. It must address the development of source-specific estimates for PM10 and PM2.5 and precursor emissions. Where options are available for the development of emission inventory estimates for specific source categories, these options are identified and discussed. Since the selection of inventory methodologies will be made subsequent to approval of this IPP, only limited information on the organizational structure and assigned staffing roles relative to inventory preparation is contained in this IPP.

Technical Work Plan Development – While EPA guidance calls for the development of an emissions inventory system that will cover all PM10 and fine particulate pollutants and precursors, ADEQ- and PCAQMD-sponsored CMB studies[9] have shown that PM10 and PM2.5 peaks are dominated by crustal source emissions. For this reason, the inventory will focus on crustal sources and not secondary aerosol precursor emissions.

Prepare Inventory – Activity data will be collected for key emission sources following procedures outlined in this report. The activity data will be combined with emission factors also outlined in this report to prepare representative source specific emission estimates. Tests of alternate high wind emission estimates will be conducted to determine which method provides a more representative estimate of concentrations recorded at selected monitoring sites. QA procedures outlined in Table 1-1 will be followed to ensure that emission estimates are reliable and can be replicated.

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[8]The EIIP guidance categorizes emission inventories into four groups (Levels I through IV) based on uses, requirements, and rigor or accuracy. A Level I inventory refers to that developed for enforcement, compliance, or litigation uses with a high degree of accuracy.

[9] Analysis of PM2.5 Exceedances in Pinal County Arizona: Demonstration that PM2.5 Concentrations are Driven by Local Sources of PM10 Near the Cowtown Monitor. *http://pinalcountyaz.gov/Departments/AirQuality/Documents/Other%20EPA%20Regulatory%20Actions/CowtownTechnicalWhitePaper.pdf*

Inventory Reporting – The final steps in Table 1-1 describe the reporting practices and documentation of the emission inventory. These elements include the following:

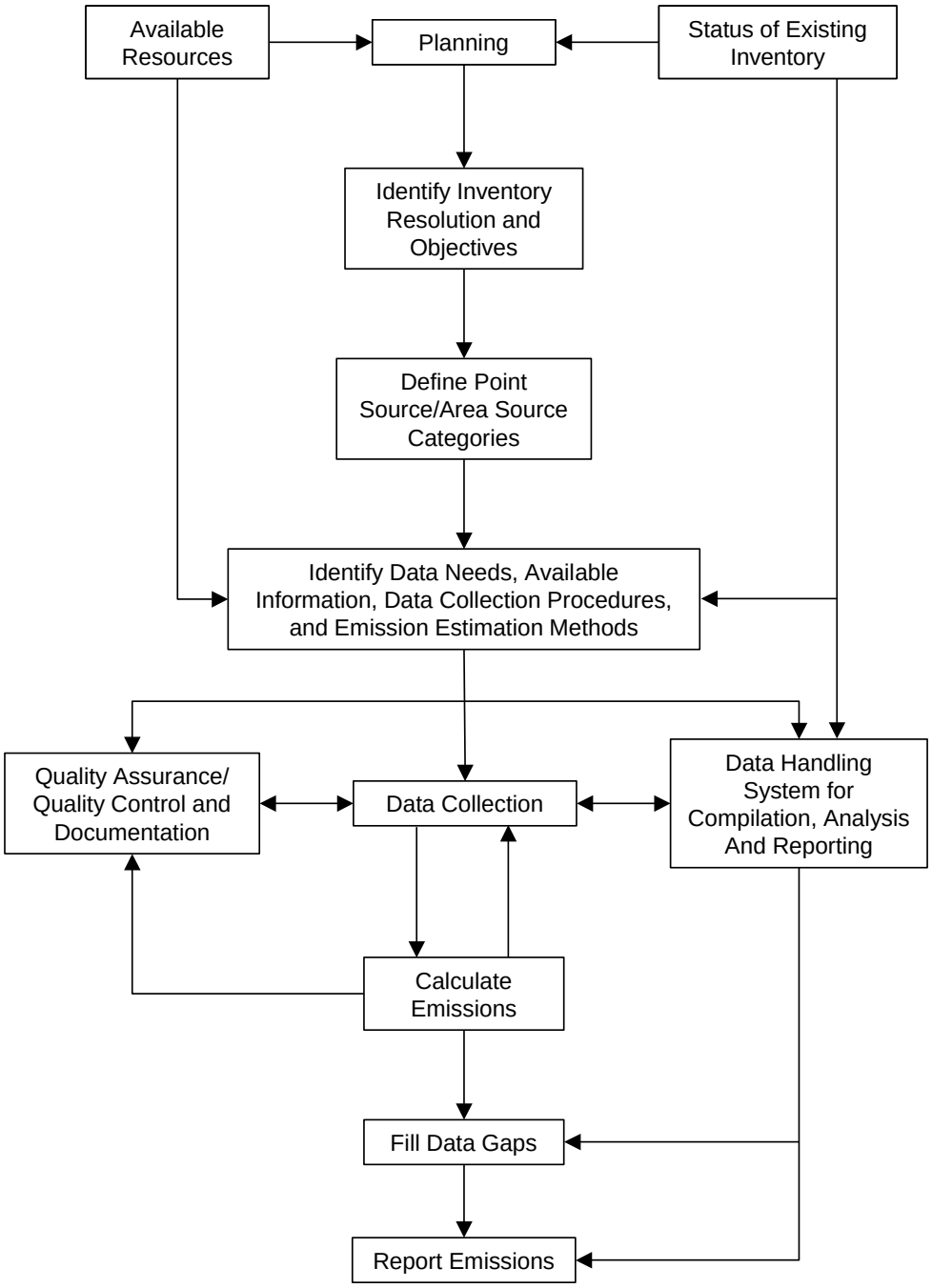
- Documentation of methods and data sources (e.g., MOVES, local travel model outputs, etc.);
- Discussion and explanation of sources excluded from the inventory (e.g., space heating emissions, etc.); and
- Summary reports of the emissions inventory (for both AQ and inventory submittal purposes).

Figure 1-1 illustrates an overview of the processes and issues that were considered in the development of this document. As previously discussed, these processes were largely followed in the development of PM10 SIPs and criteria pollutant inventories elsewhere in Arizona. The challenge is adapting and prioritizing those processes for the central Pinal County nonattainment area and selected modeling domains.

1.2 Report Organization

Following this introduction, Section 2 provides an initial assessment of the diurnal trends and relationships between PM10 hourly averages and meteorological parameters at select Pinal County monitoring stations conducted to gauge the influence of local versus regional sources at these sites. Section 3 presents a summary of design day and modeling domain selections for monitors determined to be representative of exceedance conditions within the nonattainment area. Section 4 presents a review of the emission inventory development procedures for key emission source categories and a summary of data available to characterize activity and conditions within the nonattainment area and selected modeling domains. Section 5 presents a summary of QAPs to be implemented to ensure quality assurance requirements are satisfied.

Figure 1-1
Overview of Inventory Preparation



Source: "Introduction to Stationary Point Source Emission Inventory Development," Emission Inventory Preparation Program, May 2001.

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2. INITIAL ANALYSIS OF BASE YEAR MONITORING DATA

As the first step in developing site-specific, short-term inventories to support attainment analyses, an initial assessment of the diurnal trends and relationships between PM10 hourly averages and meteorological parameters at select Pinal County monitoring stations was conducted to gauge the influence of local versus regional sources at these sites. The monitoring stations at which hourly data were available for this assessment were Cowtown, Stanfield, Casa Grande/Airport, and Pinal County Housing.[10] Prior analysis by both the Arizona Department of Environmental Quality (ADEQ)[11] and the U.S. Environmental Protection Agency (U.S. EPA)[12] demonstrated that windblown dust, generated during high wind events caused by thunderstorm outflows and frontal system passages, was responsible for some of the higher 24-hour average PM10 recordings. This subsequent assessment was designed to determine the prevailing directions from which windblown dust originated and whether higher 24-hour readings were also occurring during low wind conditions and, if so, the relative proximity of sources that might be contributing to these concentrations.[13]

The assessment was conducted in two stages. In the first stage, single-variable analyses were used to rank hourly PM10 averages by wind speed bin and examined diurnal profiles of PM10 hourly averages at each of these four stations. In the second stage, we used two-variable analyses to compute hourly PM10 averages by combinations of wind speed, wind direction, and hour of the day to develop more information about the relative locations and contributions of potential source categories contributing to periods of high, and low, PM10 concentrations at these stations. The data used in these analyses were collected between January 2006 and December 2008 at the Cowtown and Pinal County Housing sites, between March 2007 and December 2008 at the Casa Grande/Airport site, and between July 2007 and December 2008 at the Stanfield site. Because of the influence of very sporadic, but very high, hourly PM10 concentrations, we removed hours during which the average 1-hour PM10 concentration exceeded 10,000 $\mu g/m^3$ from

[10] Although limited hourly data were also available at the Maricopa and Combs School monitoring sites, these data were not included in the initial analyses as the frequencies and magnitudes of PM10 exceedances were lower at these sites, and the control strategy capable of achieving attainment at the initial study sites was believed to be capable of achieving attainment at the Maricopa and Combs Schools sites also.
[11] Boundary Recommendations for the Pinal County 24-hour PM10 Nonattainment Area, Arizona Air Quality Designations Technical Support Document, Arizona Department of Environmental Quality, March 15, 2010
[12] Pinal County, Arizona Area Redesignation for the 1987 24-hour PM10 National Ambient Air Quality Standard, Technical Support Document, U.S. Environmental Protection Agency, Region 9, Sept. 21, 2010
[13] These initial analyses were conducted prior to final selection of design days and monitoring sites.

the analysis to prevent the resulting statistics from being unduly influenced by outlier data.[14]

2.1 Cowtown

Single-Variable Analyses – Table 2-1 summarizes hourly PM10 average and maximum concentrations ranked by wind speed bin. A review of these data suggests several relationships that shed light on source contributions. First, the combination of the relatively uniform magnitude of PM10 average concentrations between 0 and 7 meter-per-second (m/sec) wind speeds—at levels in excess of the federal 24-hour standard of 150 µg/m^3—and the very high maximum concentrations across this range indicates that local sources produce significant and persistent emissions of PM10. The elevated PM10 average of 536 µg/m^3 found in the 8 to 9 m/sec wind speed bin, with an observation count of 105 hours (0.40% of all hours), suggests that high wind conditions are also responsible for a portion of the 24-hour PM10 exceedances at this site. The relatively high average PM10 concentration in this wind speed bin, in comparison to those of other wind speed bins below 8 m/sec, suggests that this is the threshold velocity for a land use category or soil type producing significant emissions upwind of the station.

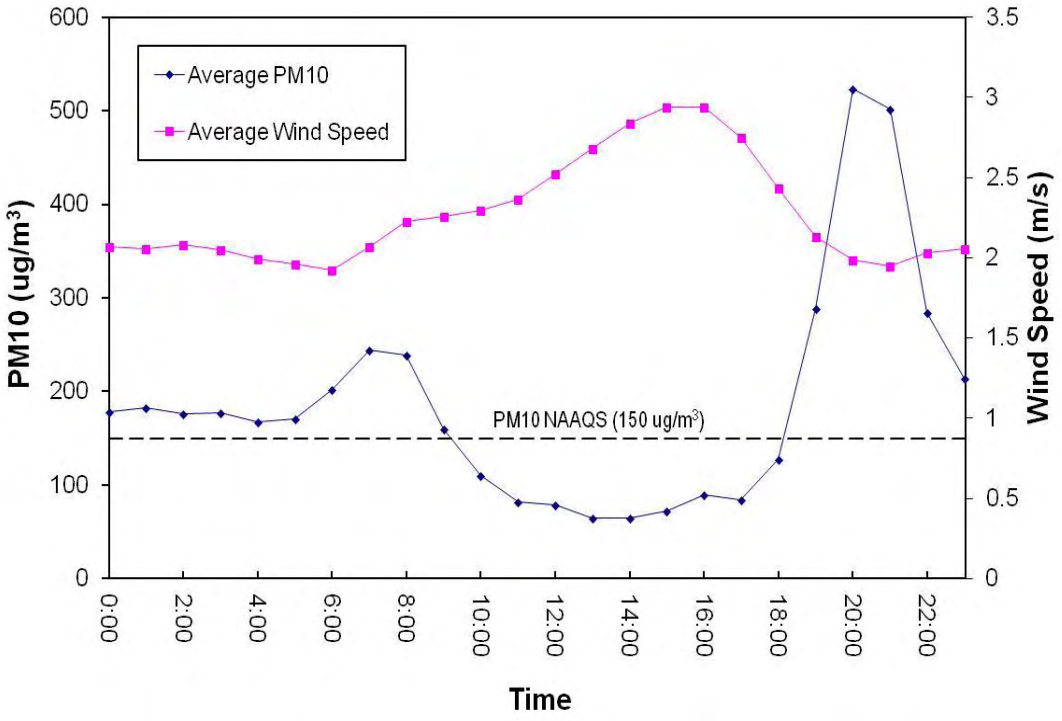
Table 2-1
Cowtown Hourly Average and Maximum PM10 – All Hours
(No Outliers)

Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	3,018	216	6,373
1~2	10,657	196	7,511
2~3	6,655	171	6,175
3~4	2,859	159	7,300
4~5	1,301	146	5,316
5~6	667	146	3,182
6~7	391	195	3,083
7~8	222	292	4,047
8~9	105	536	4,989
9~10	33	403	2,250
10~11	9	446	1,084
11~12	1	2,328	2,328
12~13	1	1,046	1,046
Total Count	25,943	N/A	N/A

[14] At Pinal County Housing, Casa Grande and Stanfield, the hours exceeding 10,000 µg/m^3 were consistently associated with hourly average wind speeds exceeding 12 mph. The Cowtown concentrations exceeding 10,000 µg/m^3 were predominately at night.

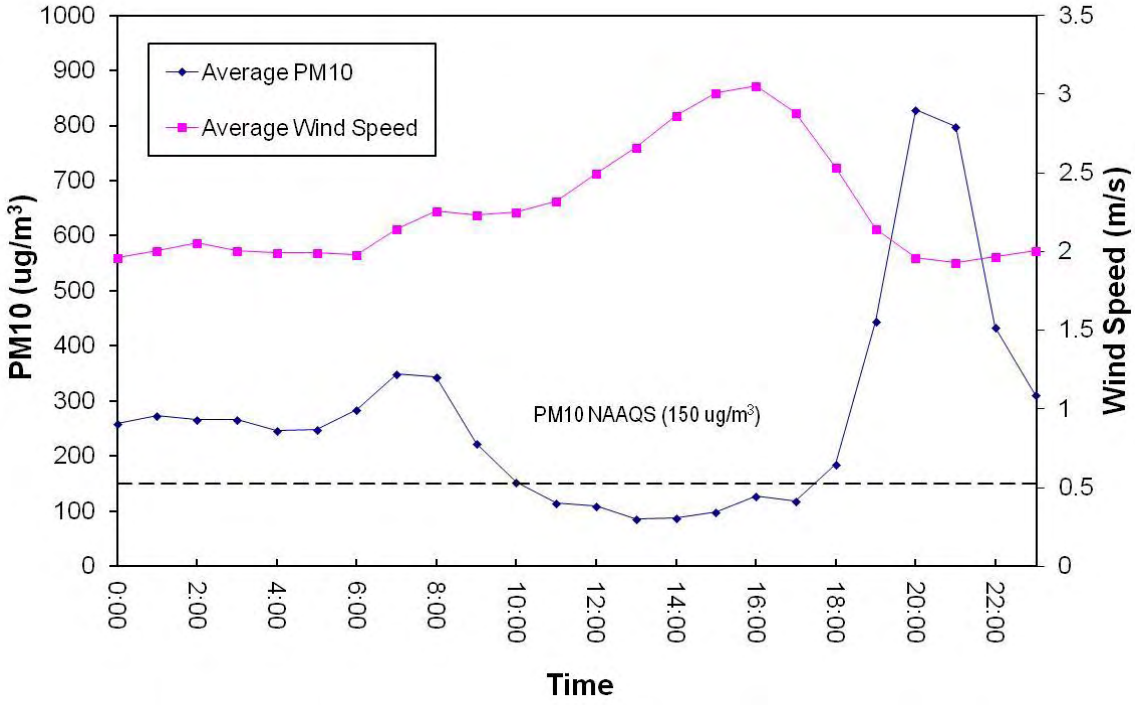
The diurnal distribution of hourly PM10 averages at Cowtown was examined, but did not reveal significant insights with respect to potential source contributions. The diurnal distribution for this site is shown in Figure 2-1. The early-morning smaller peak between 0600 and 0900 hours and much higher peak in PM10 between 1800 and 2400 hours may result from several different phenomena that warrant evaluation in the preparation of the emission inventory. These phenomena include, but are not limited to, the timing and severity of nocturnal inversions at this site (which would concentrate emissions from groundlevel sources in shallow mixing layers) and diurnal variations in mechanical source activity (such as traffic flows on nearby paved and unpaved roads).

Figure 2-1
Cowtown Hourly PM10 Averages by Time of Day, All Hours
(No Outliers)



A refinement of the diurnal distribution pattern at Cowtown, limited to exceedance days, is shown in Figure 2-2. This time plot again shows a low early-morning peak in PM10 and a corresponding evening peak between 1800 and 2400 hours.

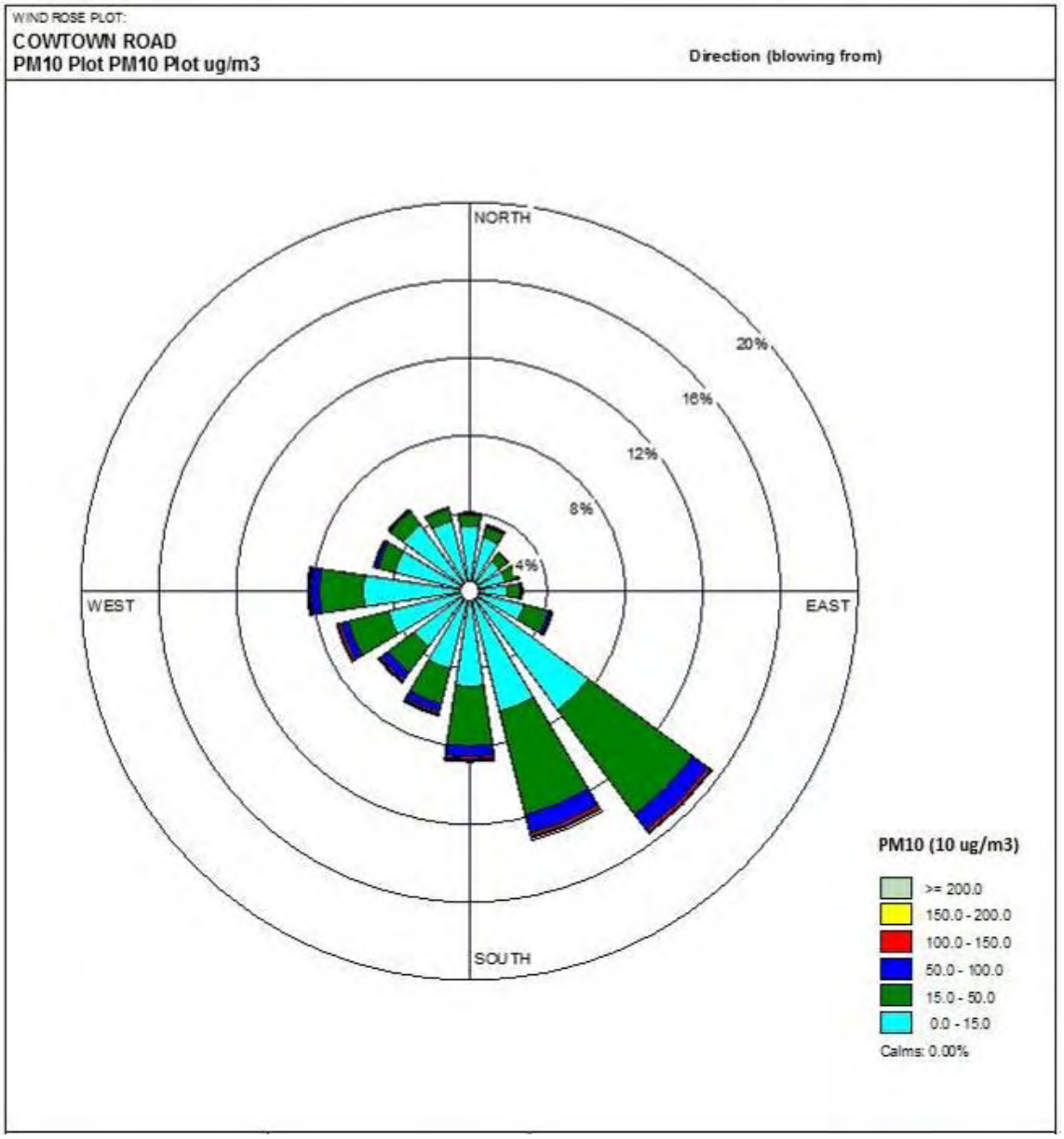
Figure 2-2
Cowtown Exceedance Day Hourly PM10 Averages by Time of Day, All Hours (No Outliers)



A PM10 rose was constructed of the hourly PM10 and wind direction data from the Cowtown monitor using techniques originally developed to generate wind speed and direction roses. This rose is shown in Figure 2-3.[15] The lengths of wind direction radii reflect the fractions of the total number of hours during the monitoring period that the wind blew from the directions to which the wedges point. This plot shows that the prevailing winds at Cowtown are from the southeast, with the southwest quadrant contributing the next highest fraction of wind hours. PM10 roses limited to exceedance days and hours of PM10 exceeding 150 µg/m^3 show very similar patterns (not shown in the figures), suggesting that the sources most significantly impacting this monitor lie in the same arc as the prevailing winds.

[15] Because of limitations of the windrose software used to generate this plot, the values displayed in the legend in the lower right need to be multiplied by 10 to reflect the ranges of PM10 concentrations on which this plot is based. For example, the light green band of PM10 concentrations represents hours exceeding 2,000 µg/m^3, not 200 µg/m^3. Similar multiples should be applied to values displayed in the other PM10 roses, i.e., Figures 2-11, 2-12, 2-17, and 2-21.

Figure 2-3
Cowtown Hourly PM10 Rose



Two-Variable Analyses – The first two-variable analysis of Cowtown data grouped hourly PM10 averages by wind speed and wind azimuth (direction). Wind speed data were grouped in bins spaced 1.0 m/sec apart, and wind azimuth data were grouped in bins spanning 10 degrees of compass arc. The hourly Cowtown PM10 averages by wind speed and azimuth are presented in Figure 2-4. In this figure and the other two-variable tables, data are color-coded to indicate highest (red) through lowest (dark green) values to highlight data clusters. The numerical ranges included in each color band are shown in a legend just below each data table.

In Figure 2-4, the presence of highest PM10 averages at 0-1 m/sec wind speed and multiple wind directions suggests that significant nearby sources impact the monitor during stagnant wind conditions. Wind meander that occurs during these very low wind speeds may be responsible for the multi-directionality of high averages, meaning that significant sources may not lie in these directions, but rather that emissions from any significant nearby sources approach the monitor from a variety of directions as a result of winds meandering between source and monitor. The cluster of moderate PM10 averages at 1-2 m/sec wind speeds between 140 and 260 degrees suggests that the most significant nearby sources lie within this quadrant. This figure also shows a high PM10 cluster at 7 to 10 m/sec wind speeds and 240 to 290 degrees wind direction. This cluster suggests that disturbed soils lying upwind of the monitor within this wind direction arc produce high impacts at the monitor at higher frequencies than disturbed soils in other directions during high wind conditions. This tendency may be due to soils having lower threshold velocities for generating windblown dust in this arc, soils being more continuously disturbed, or greater quantities of deposited dust available for re-entrainment in these upwind directions.

A subsequent analysis examined the relationship of peak hour PM10 concentrations to the same wind speed and direction bins. The resulting table of values is presented in Figure 2-5, showing that high PM10 maxima at 1 to 3 m/sec wind speeds occur in most wind directions, suggesting the presence of multiple high-strength episodic sources surrounding the monitor. Because episodic sources generate high emission rates for short periods of time, initial identification of these sources will depend more on interviews of people who spend time in areas near the monitor than on further statistical analysis of the hourly PM10 and meteorological data. Once potential candidate sources are identified, followup inquiries will be made of any parties responsible for source operation and emission rates will be estimated using reverse dispersion modeling techniques.

Figure 2-4
Cowtown Hourly PM10 Averages by Wind Speed and Azimuth, All Hours (No Outliers)

Cowtown	Hourly PM10 Averages by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)													
Average of	Column													
Row Labe	0	1	2	3	4	5	6	7	8	9	10	11	12	Count Subto
0	183	109	50	80	320	88		18						493
10	111	138	84	102	85	93	143		25					463
20	84	122	88	54	294	224	191	276						433
30	338	102	99	62	116	107	298	2279	23					381
40	96	134	90	154	84	26	239	33	1307					326
50	455	123	168	217	82	22	25	255						251
60	147	151	104	98	104	99	84	108	550		22			267
70	132	156	157	99	137	122	146	368	136	151	475	365		328
80	432	167	124	80	100	94	133	197	182	330				339
90	142	156	72	149	71	159	127	233	146	98				281
100	136	144	93	99	283	146	83	253	102	403	741			334
110	151	186	127	100	128	100	86	188	95		362			460
120	242	228	168	134	109	74	137	459	186	1214				717
130	494	188	172	200	223	187	246	27	70	158				1580
140	91	253	233	242	176	195	222	25	149		795			1982
150	548	307	235	213	150	148	99	145		131	159			1759
160	166	306	242	188	169	98	190	129	65	2261				1445
170	121	302	200	176	150	199	95	47	1189					1253
180	500	278	190	147	134	141	171	165	31	66				976
190	90	254	225	163	209	146	115	98	58	58	776			822
200	364	261	179	166	181	84	602	127	279	357	716	24	1046	799
210	118	292	184	143	136	95	273	140	174				2328	744
220	171	263	248	161	323	87	113	238	154		440			635
230	135	244	249	229	228	197	360	208	769					679
240	136	314	246	224	177	231	150	261	560	508				736
250	396	254	200	184	134	128	179	96	786					844
260	246	284	179	180	119	130	180	206	685	386	392			1011
270	464	234	134	184	163	130	163	312	528	1558	2055			976
280	163	160	150	145	137	124	137	466	422					784
290	125	180	105	115	88	131	220	323	155	0				596
300	223	144	129	93	79	117	162	599			51	21		564
310	202	144	87	83	149	115	129	130	2803		24			609
320	139	126	70	49	70	119	43	161	217					571
330	297	115	70	73	118	214	42	409	612					547
340	135	101	66	60	78	47	17		255					515
350	126	95	55	96	102	36	37	33	83	53				474
360	124	102	53	77	285	42	374		58	61				233
Count Subto	662	7866	9499	4322	1848	960	510	294	159	60	22	3	2	26207
Color Scale	0	50	100	150	200	300	400							

Figure 2-5
Cowtown Maximum Hourly PM10 Concentration by Wind Speed and Azimuth, All Hours (No Outliers)

Cowtown	Hourly PM10 Maxima by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Max of PM	Column												
Row Lab	0	1	2	3	4	5	6	7	8	9	10	11	12
0	3703	879	276	287	1468	118		18					
10	481	4262	916	1132	492	173	283		31				
20	493	3639	1364	439	3604	1437	995	1041					
30	1273	625	1903	941	488	497	929	4047	23				
40	448	1436	1825	2535	837	72	887	33	4722				
50	2156	1642	6068	2513	475	80	38	372					
60	310	1921	722	712	631	531	288	234	550		22		
70	516	3264	1650	582	1185	686	818	3083	349	484	718	365	
80	2308	4830	917	550	414	548	707	1017	794	976			
90	335	1682	269	552	632	916	741	666	233	134			
100	242	1629	734	574	2776	847	184	253	102	1336	1296		
110	838	3482	874	766	1132	361	217	188	119		362		
120	1099	3547	1903	833	807	271	346	1020	349	1214			
130	1236	3979	1954	2005	5316	735	1009	39	89	158			
140	253	3648	1851	6175	553	1400	652	65	252		795		
150	4391	3493	4927	2958	825	954	253	264		262	213		
160	467	6373	3921	1414	1155	463	640	346	101	2261			
170	365	3228	3565	864	1217	1309	442	123	4989				
180	2863	4429	2365	1730	822	464	814	732	71	90			
190	548	5066	4223	2319	1789	439	286	301	118	206	2250		
200	1894	5580	2989	1049	1039	451	3182	278	1199	1166	1084	24	1046
210	368	3739	5457	2274	1058	318	1627	396	415				2328
220	819	6137	6439	1587	2462	236	361	352	214		440		
230	355	1789	6140	3307	1511	547	1269	373	1028				
240	323	4607	3095	7300	1285	1090	475	1249	2901	508			
250	1274	4369	1821	3713	932	454	546	346	1513				
260	684	4887	2871	3329	619	485	1014	1130	4102	787	392		
270	2476	3776	1997	2355	2677	643	911	1615	1975	2900	2055		
280	641	1245	7511	2065	875	1306	557	2400	1607				
290	234	3127	3270	1527	938	584	622	1335	155	0			
300	716	1763	3552	2492	693	520	201	599			51	21	
310	752	2591	1053	639	966	350	255	406	4658		31		
320	566	1290	1236	258	433	481	162	369	393				
330	1086	3714	820	404	500	725	42	409	612				
340	419	1649	741	426	510	209	29		255				
350	483	967	676	1590	864	100	195	59	102	53			
360	281	802	418	429	632	63	723		58	83			
Color Scale	0	100	200	400	800	1000	1500	2000					

An analysis that accounts for both PM10 average concentrations and the number of hours contributing to each average was performed by grouping sums of hourly PM10 concentrations by wind speed and direction. The results of this analysis are displayed in Figure 2-6. This plot reflects the wind speeds and azimuths associated with the highest cumulative PM10 impacts at the monitor over the period of the data record. As a rough indicator, high PM10 sums within a single wind speed range can be attributed to sources lying along the upwind direction up to X miles of the monitor, where X = (upper end of wind speed range, m/sec)* (2.24 mph/m/sec). Based on this approach, for example, sources that impact the monitor when wind speeds are between 0.0 and 1.0 m/sec are assumed to lie primarily within 2.2 miles of the monitor (= 1.0 m/sec * 2.24 mph/m/sec). Figure 2-6 shows a hot spot at wind speeds between 2.0 and 3.0 m/sec and within the arc

of 140 to 160 degrees southwest of the monitor. Figure 2-7 shows an aerial photograph from May 2011 of the Cowtown monitor with a radius extending up to 6.7 miles away on an azimuth of 150 degrees. Emission sources anywhere along this line are potentially responsible for the higher PM10 sum shown in Figure 2-6 for this wind speed and direction.

Figure 2-6
Cowtown Sum of Hourly PM10 by Wind Speed and Azimuth, All Hours (No Outliers)

Cowtown	Sum of Hourly PM10 by Wind Azimuth (degrees) and Speed (m/sec), All Data													
Sum of PM	Column													
Row Lab	0	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
0	55007	9243	3770	1599	2561	176		18						72374
10	1548	27522	13203	6306	1872	187	429		74					51141
20	925	22156	13039	2719	5881	2464	1143	1378						49705
30	3040	19158	10398	2249	2210	1178	2978	4559	23					45793
40	1442	19074	8552	5066	1846	155	1913	33	5227					43308
50	3184	14069	12789	5857	1318	110	75	765						38167
60	1616	17954	5420	2745	2400	1979	671	432	550		22			33790
70	926	14678	8792	2667	4920	3176	5706	7735	1496	1204	951	365		52616
80	3022	19519	7051	2410	2191	3006	2918	5135	2736	3635				51621
90	1132	19183	4767	3433	1345	2073	1654	2097	730	195				36609
100	1087	18776	10611	3269	5947	1457	831	253	102	1611	1481			45424
110	1361	30549	18730	6587	5514	1897	687	188	190		362			66064
120	1692	41704	44670	22008	6767	1471	960	2295	371	1214				123151
130	2963	52005	88710	106623	43293	7491	1475	107	211	158				303035
140	732	99430	195506	134749	21174	9157	1998	124	598		795			464263
150	4933	134309	201788	65853	12295	6196	1089	724		262	318			427767
160	1165	144369	157551	40770	8458	2648	2280	775	194	2261				360470
170	1336	140942	108806	22901	7824	4786	1238	375	5943					294150
180	6504	110844	69829	13639	4963	2828	3247	3295	153	133				215433
190	1440	85629	67450	13513	7513	2044	1149	1080	292	351	3103			183563
200	4001	77450	52500	14276	7222	2515	9637	888	2233	2144	2148	24	1046	176082
210	1302	72717	53565	11704	6656	2764	3279	1535	1564				2328	157414
220	1705	57089	65759	11426	10010	1830	1354	715	616		440			150945
230	2027	55864	70839	21096	5476	3738	3240	833	1538					164652
240	1491	65715	64787	29807	8337	4856	3593	4432	5600	508				189125
250	5143	39930	56273	34430	14490	6271	5002	1250	5503					168292
260	1473	37465	48395	42321	19134	14445	8820	4736	9593	3089	392			189863
270	7420	35111	31332	37581	27274	13401	8312	10921	6331	4675	2055			184414
280	1627	20269	25683	26603	17127	10673	6556	10723	4225					123485
290	751	25923	19687	14200	5886	5508	4405	1613	155	0				78127
300	1782	25340	29063	8497	3080	2337	325	599			51	21		71093
310	2015	30488	22085	7784	2836	923	257	652	8410		49			75498
320	1672	25388	17292	3024	1404	1542	304	804	651					52081
330	3863	24959	16820	4294	1175	856	42	409	612					53028
340	1480	22258	14677	2321	1165	285	35		255					42474
350	1389	19317	10534	3460	1425	181	261	99	166	53				36885
360	495	10747	4407	1859	2280	85	1122		116	123				21233
Grand Tota	134690	1687141	1655130	739644	285264	126688	88983	71576	66456	21614	12166	410	3374	4893136
Color Scale	0	40000	80000	120000	160000	200000								

Figure 2-7
Example Cowtown PM10 Hot Spot Source Corridor

Diurnal trends in PM10 concentrations were assessed by tabulating hourly PM10 averages by wind azimuth and hours of the day. The results, presented in Figure 2-8, show a cluster of high PM10 averages during 1900 to 2300 hours in the wind directions of 100 to 300 degrees. As noted above (on page 12), these elevated concentrations could be due to the onset of strong nocturnal inversions as ground heating ceases after sunset or to variations in diurnal activity rates of contributing mechanical sources. The presence of moderate PM10 averages between 0000 and 0600 hours and 120 to 190 degrees from the monitor suggests nocturnal mechanical sources may lie in this arc, which is also the arc occupied by the prevailing winds at this site. These impacts may also be driven by nocturnal high wind events.

Diurnal trends in PM10 concentrations were also assessed by contrasting hours of the day against wind speed bins. The results of this analysis appear in a table in Figure 2-9. High PM10 averages between 2000 and 2300 hours and 0 to 5 m/sec wind speeds again suggest the possibility that strong ground-based inversions are forming during these hours while some mechanical source activity is occurring or that significant local sources with pronounced diurnal variability are causing higher emissions during this period of the day. High PM10 averages between 1500 and 2000 hours at wind speeds between 7 and 12 m/sec suggest the predominance of late-afternoon high wind episodes that transport significant windblown dust to the monitor, possibly from thunderstorm outflows that typically occur in the late afternoon and early evening of the summer months. The cluster of moderate PM10 averages between 0600 and 0900 hours at wind speeds from 0 to 4 m/sec indicate monitor impacts from nearby sources that exhibit significant emissions from early morning activity.

Summary – The Cowtown monitor is impacted primarily by emissions from nearby sources lying between 100 and 300 degrees of the monitor and/or the presence of strong nocturnal inversions. Both of these possibilities should be the focus of emission inventory development for this site. Windblown dust generated during high wind events appears to be the next greatest source impacting the monitor. Thunderstorm outflows are suspected of producing a number of these high wind episodes. As a somewhat repeatable occurrence, these flows may follow wind trajectories that are co-axial, crossing the same source areas in transporting dust to the monitor. If further investigation of outflow back-trajectories demonstrates the dominance of a few wind directions, the emissivity of lands along these trajectories should be a focus of inventory development for this site.

Inventory Focus – The emission sources that this initial analysis points to as significant contributors to high PM10 hours at the Cowtown monitor on low wind days appear to lie within a few miles of the monitor across a fairly wide arc from the southeast to the west. Because of the frequency and magnitude of high hourly PM10 concentrations recorded at this monitor, substantial effort should be directed toward identifying all potentially significant emission sources in the area identified in this analysis and collecting activity and emission characteristic data from these identified sources. For the designated high wind design day, hourly wind back-trajectories ending at the monitor on high wind hours should be identified and the soil attributes related to windblown dust emission rates should be evaluated for each combination of land use and soil type found along these back-trajectories.

Figure 2-8
Cowtown Hourly PM10 Averages by Azimuth and Hours of the Day, All Hours (No Outliers)

Cowtown Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Average of	Column L																							
Row Labe	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	190	232	191	162	129	169	258	246	167	165	114	50	49	67	53	56	192	57	91	156	287	438	214	163
10	102	305	83	102	47	60	104	301	163	205	88	68	49	42	42	46	64	36	74	154	917	129	128	137
20	51	119	127	73	106	199	123	143	171	273	95	103	73	45	37	37	38	212	77	331	65	267	73	73
30	119	47	49	130	78	102	147	234	370	140	106	54	45	45	33	36	24	44	91	203	478	219	117	205
40	166	72	91	65	136	114	173	160	233	121	130	55	67	29	22	37	31	51	314	289	159	100	375	141
50	81	56	66	165	78	171	117	192	201	201	110	54	67	29	51	15	722	50	66	362	145	686	45	195
60	130	195	148	72	84	110	151	179	346	148	154	86	89	36	32	40	46	31	100	169	173	93	331	138
70	205	130	65	186	100	99	179	281	349	131	115	250	88	58	120	66	45	44	153	133	432	469	213	202
80	107	208	82	73	86	117	177	198	125	176	162	102	79	141	28	80	29	29	127	120	151	804	438	80
90	69	102	69	121	134	153	197	151	225	106	67	95	136	89	107	41	197	71	183	131	229	71	176	111
100	71	117	155	85	135	153	207	100	194	110	87	61	54	67	66	34	25	68	61	233	233	267	330	201
110	161	118	140	157	110	133	164	242	233	97	72	70	61	39	35	93	31	45	95	69	320	370	213	169
120	129	148	199	186	181	123	148	172	221	133	94	76	61	59	55	52	43	173	72	284	452	424	255	132
130	155	209	195	197	167	187	209	260	255	146	96	65	48	38	46	28	136	64	148	328	392	321	202	178
140	232	247	245	231	215	197	246	285	228	166	100	69	66	35	31	54	157	247	316	188	693	340	257	258
150	219	202	195	233	215	200	237	256	256	163	142	57	54	48	37	43	58	28	90	419	683	574	345	208
160	203	228	233	207	199	188	196	285	305	178	105	91	70	39	65	49	63	54	113	482	728	476	285	230
170	183	191	181	154	171	175	206	260	235	162	129	94	53	37	35	174	58	65	96	444	647	480	346	285
180	158	162	169	176	174	175	170	272	222	148	87	70	81	52	52	50	63	74	120	479	673	520	320	195
190	149	154	134	135	212	181	205	250	256	145	103	68	151	62	63	56	54	84	190	521	585	481	357	214
200	139	174	119	124	150	217	206	229	287	182	176	68	63	80	66	111	106	101	166	312	891	664	275	178
210	259	132	156	159	137	119	257	243	187	179	148	76	60	73	84	62	105	198	100	244	751	876	345	158
220	137	109	192	136	146	199	239	190	180	194	81	59	45	62	54	119	71	87	111	649	741	529	318	193
230	221	167	106	146	125	183	284	354	313	169	106	79	63	50	58	63	133	78	195	296	625	709	270	328
240	184	137	153	199	160	188	160	246	247	192	97	107	229	102	73	148	80	103	166	407	679	655	382	407
250	196	153	97	102	120	105	207	310	191	155	146	200	92	90	80	73	153	131	165	256	397	662	211	212
260	160	117	96	163	116	155	208	186	161	226	129	125	171	121	93	90	109	148	128	203	512	386	240	200
270	118	147	73	80	135	182	153	221	259	203	98	75	154	99	144	121	123	75	153	236	420	633	437	218
280	79	128	148	165	108	183	174	202	191	135	97	72	82	88	90	134	117	115	122	354	410	387	138	120
290	243	107	151	145	60	93	91	225	202	151	88	94	71	54	64	67	94	54	103	246	576	553	190	184
300	46	54	68	60	114	106	49	101	270	178	224	80	56	49	56	43	60	56	76	238	440	1066	200	153
310	131	52	117	79	120	70	194	215	271	224	93	66	66	80	61	54	50	73	262	304	226	592	189	135
320	70	106	85	65	61	161	152	180	184	99	93	76	47	61	49	54	45	43	73	206	206	177	311	126
330	82	149	25	118	102	77	154	209	312	90	92	46	39	45	28	33	48	38	70	161	324	287	165	86
340	82	143	64	253	94	125	210	191	166	110	79	59	58	42	39	28	31	48	74	83	273	89	82	126
350	50	141	101	98	83	92	85	185	182	116	91	59	51	38	39	29	36	36	102	119	155	515	54	104
360	24	29	72	52	28	82	106	338	204	158	76	62	70	43	51	62	39	46	120	270	130	259	70	55
Color Scale:	0	50	100	150	200	250	300																	

Figure 2-9
Cowtown Hourly PM10 Averages by Wind Speed and Hours of the Day, All Hours
(No Outliers)

Cowtown	Hourly PM10 Averages by Wind Speed (m/sec) and Hour of Day, All Data (No Outliers)																						
Averag	**Colu**																						
Row	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
0	151	190	173	171	136	123	234	240	275	149	93	68	56	77	78	58	281	83	110	228	366	518	430	146
1	168	162	155	164	169	166	196	238	249	160	107	80	75	44	41	42	46	50	116	381	611	499	322	199
2	200	190	192	183	174	174	200	238	240	157	104	66	57	50	44	45	60	50	96	232	499	542	281	224
3	158	205	196	198	179	187	223	266	208	166	94	71	96	46	55	48	73	74	108	211	359	535	222	260
4	135	119	122	171	113	172	182	252	267	124	123	102	69	82	99	98	72	113	109	222	420	385	236	168
5	108	165	82	39	111	130	149	206	201	151	121	110	106	97	92	113	135	107	138	172	298	121	176	118
6	111	56	36	72	84	15	237	306	240	188	197	145	94	105	160	108	189	178	140	192	587	464	215	121
7	67	99	121	71	208	237	265	182	223	275	153	321	202	238	130	285	219	157	320	407	857	319	146	205
8	212	120	224	108	142		83	143	234	224	198	241	526	401	219	382	343	492	2354	575	1043	950	382	75
9		825	102	283	49	51			271	190	402	117	200	27	193	202	1281	456	833	740	206	90	134	
10	312								72	519	118	31		125		692	2055	329	566	440	2250		105	1296
11											24		21											365
12																	1046	2328						
Color Scale:		0	50	100	150	200	250	300																

2.2 Stanfield

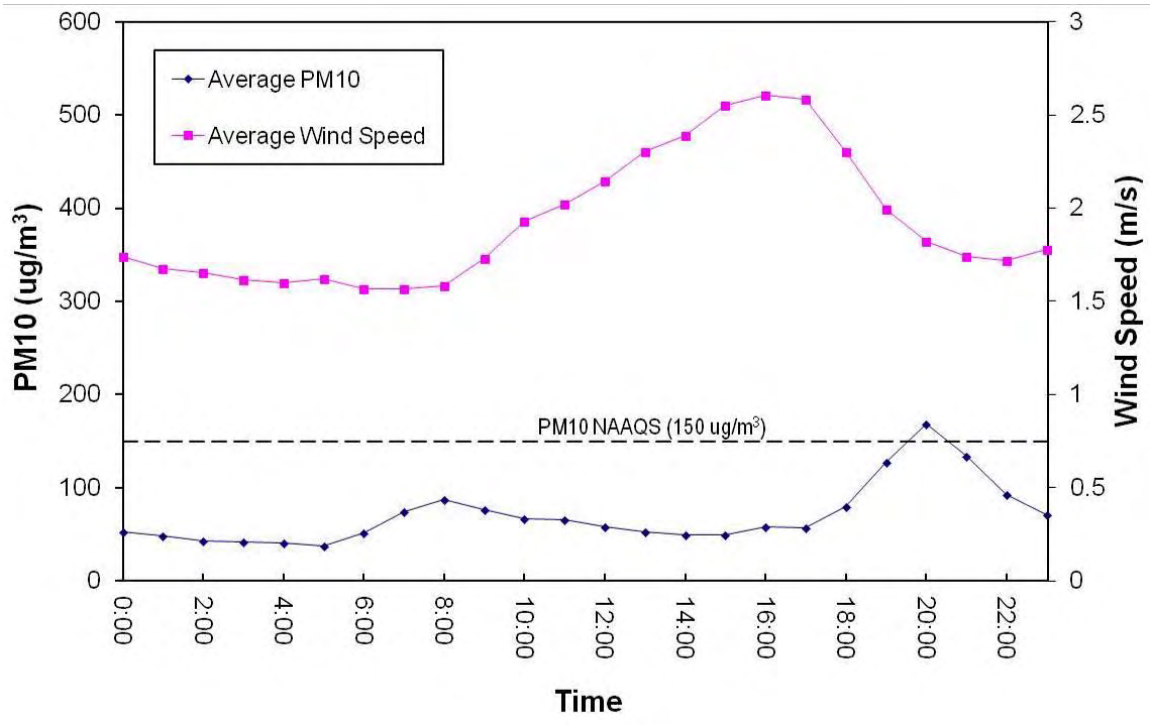
Single-Variable Analysis – Table 2-2 presents hourly PM10 average and maximum concentrations ranked by wind speed bin for the Stanfield site. This table reveals a progression of increasing PM10 average values with increasing wind speed, suggesting that there are no locally significant sources near the monitor. The averages, however, which range from 50 to 85 $\mu g/m^3$ at wind speeds between 0 and 5 m/sec, also suggest that a matrix of comparatively low emission sources surrounds the monitor, producing an elevated background level. The high maximum PM10 values at wind speeds in this same range also suggest that episodic sources periodically impact the monitor.

Table 2-2
Stanfield Hourly Average and Maximum PM10, All Hours
(No Outliers)

Wind speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	2,225	71	1,284
1~2	6,319	62	1,820
2~3	2,336	50	1,979
3~4	802	52	1,548
4~5	475	85	1,553
5~6	252	195	4,063
6~7	136	277	3,485
7~8	46	453	2,497
8~9	20	664	1,770
9~10	8	1,196	2,528
10~11	1	2,098	2,098
12~13	1	3,384	3,384
Total Count	12,622	N/A	N/A

A plot of hourly PM10 averages by hour of the day is shown in Figure 2-10. This plot shows a low morning PM10 peak that possibly represents an initial increase in anthropogenic emissions from nocturnal levels and, after 0800 hours, a decline in these groundlevel concentrations as inversion heights increase with corresponding increases in morning ground heating from solar insolation. The evening peak in PM10 average at 2000 hours could be due to either an increase in emissions from diurnally varying sources and/or the onset of strong nocturnal inversions, as was also possible at the Cowtown monitor.

Figure 2-10
Stanfield Hourly PM10 Averages by Time of Day, All Hours
(No Outliers)



Examination of PM10 roses for this site provides limited information. An example PM10 rose is presented in Figure 2-11. This plot is limited to hours during which the PM10 concentration at the monitor exceeded 150 µg/m^3, which is the federal 24-hour PM10 standard. This plot shows that prevailing directions of winds transporting high PM10 concentrations are primarily from the west and, to a much lesser extent, from the southeast. A second PM10 rose, limited to hours when wind speeds exceeded 5.0 m/sec, is presented in Figure 2-12. This plot suggests that the highest PM10 impacts at the monitor during high wind conditions are generated by sources to the east and east-northeast.

Figure 2-11
Stanfield PM10 Rose of Hours Exceeding 150 µg/m^3

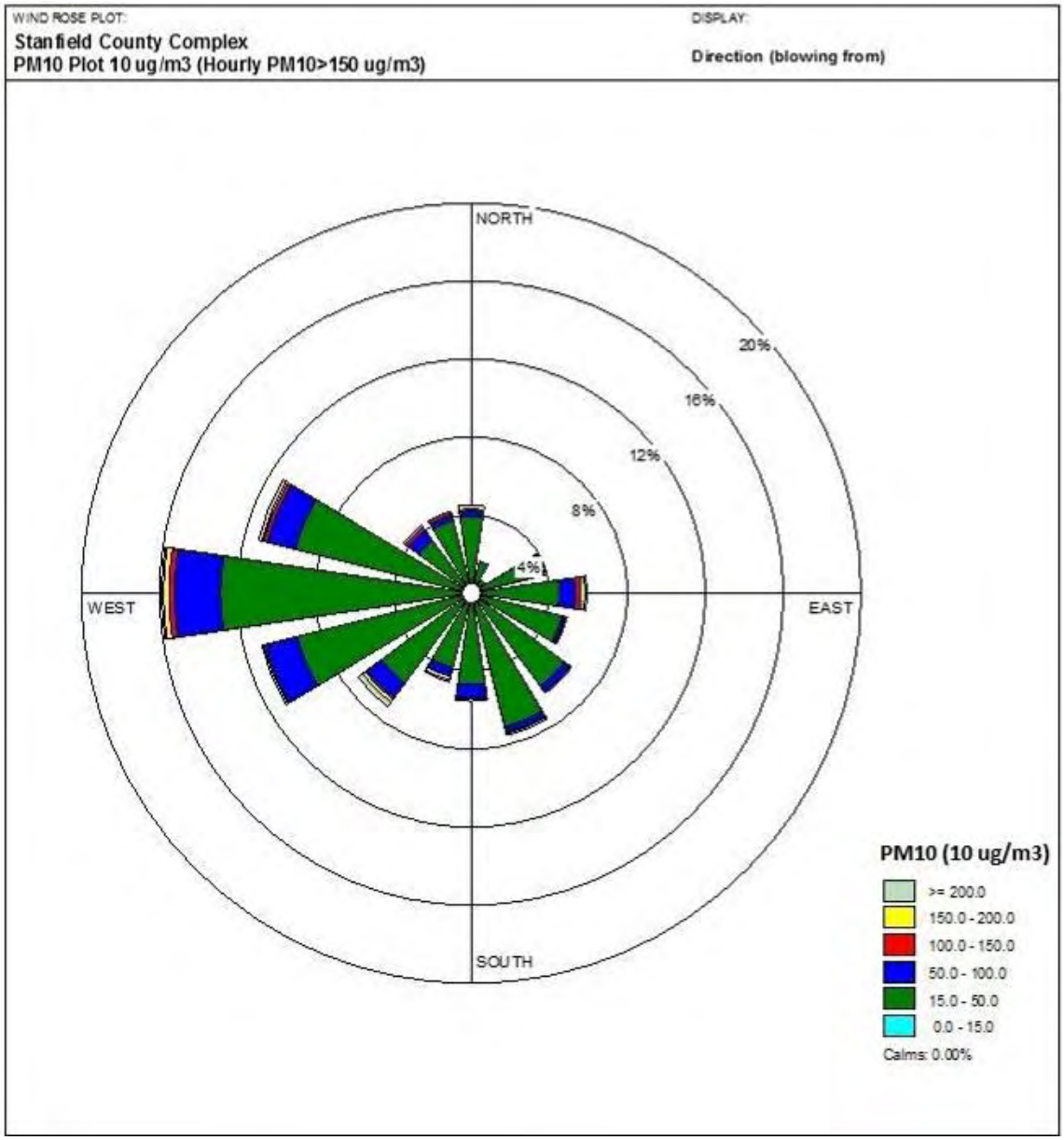
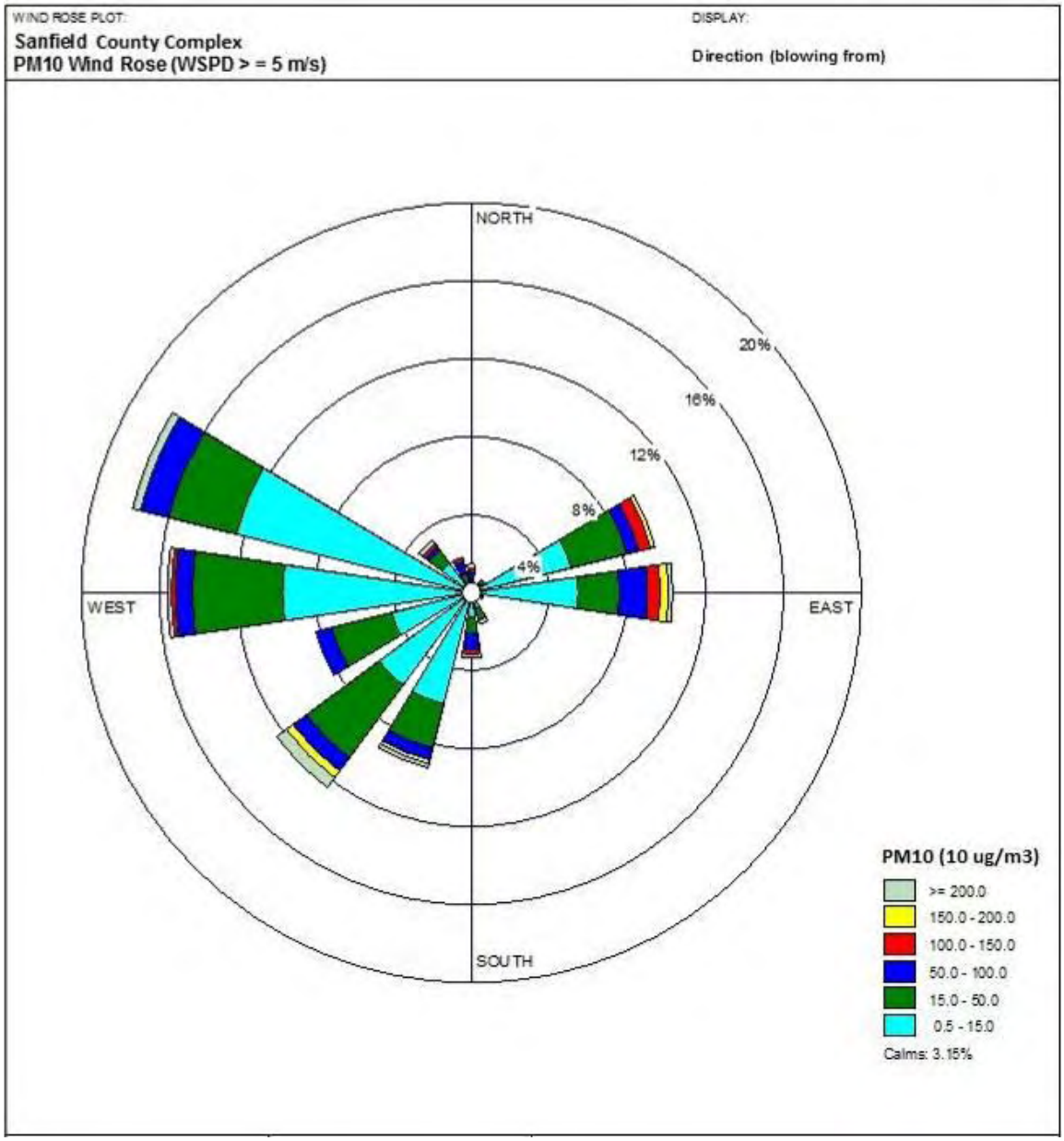


Figure 2-12
Stanfield PM10 Rose of Hours with Wind Speeds > 5.0 m/sec



Two-Variable Analyses – The first two-variable analysis of Stanfield monitoring data sorted hourly PM10 averages by wind speed and wind direction. The table showing this distribution appears in Figure 2-13. High PM10 averages at the highest wind speeds in several directions suggest that episodic windblown dust sources regionally surround the monitoring site. A plot of PM10 hourly counts by wind direction when wind speeds exceed 5.0 m/sec, shown in Figure 2-12 as a PM10 rose, suggest that winds producing high PM10 hour values blow towards the monitor most frequently from the east and east-northeast. Low PM10 averages at low wind speeds in most directions, as shown in Figure 2-13, suggest that few significant PM10 sources are close to the monitor. A review of hourly PM10 maxima by wind speed and azimuth shows that high PM10 concentrations during low wind speeds originate from episodic sources lying in an arc from the south through the northwest of the monitor.

The sums of hourly PM10 concentrations grouped by wind speed and direction are presented in Figure 2-14. This plot suggests that (1) sources within 2.2 miles of the monitor do not significantly contribute to cumulative PM10 concentrations; (2) sources located between 2.2 and 4.5 miles of the monitor and within the arcs of 140-170 degrees and 250-300 degrees produce the highest cumulative impacts at the monitor; and (3) high wind sources in the arcs of 70-90 degrees and 200-240 degrees cumulatively contribute to PM10 measured at the monitor at somewhat higher frequencies or levels than sources lying in other directions. Because the meteorological regimes at Stanfield and Cowtown are somewhat similar, given a separation distance between the two monitors of 8.9 miles over flat terrain, the differences in patterns of PM10 concentrations between the two stations can be attributed almost entirely to the differences in locations, diurnal variabilities, and strengths of the emission sources separately impacting each monitor.

An examination of PM10 averages by hour of day (Figure 2-15) shows that the higher hourly averages of PM10 concentrations occur during the evening hours between 1900 and 2200 hours, with winds from 200 to 330 degrees of the monitor producing higher averages during these hours. Comparison to Figure 2-14 suggests that these higher averages occur more when wind speeds are between 1 and 3 m/sec, suggesting impacts from mechanical sources located within this arc and the possibility of enhancement by the onset of nocturnal inversions. The higher PM10 averages recorded between 0700 and 1000 hours, in comparison with lower averages in hours of 0000 to 0700, suggest that nearby sources related to human activity contribute to daytime background levels at the monitor.

Figure 2-13
Stanfield Hourly PM10 Averages by Wind Speed and Azimuth, All Hours (No Outliers)

Stanfield	Hourly PM10 Average by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Average of I	**Colum**												
Row Labe	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	Count Sub
0	41	70	53	40	107	89	413	1517					303
10	100	67	44	43	46	35	841						278
20	79	50	44	38	67								237
30	24	51	36	47	38	74							188
40	39	51	41	48	48								194
50	41	41	40	34	30	33	28	85					208
60	47	51	41	46	46	37	184	306					235
70	75	54	51	40	107	108	76	528	422	1070			293
80	90	59	51	75	42	123	417	576	973				302
90	20	56	60	61	62	52	85	294	412	1477			378
100	47	57	50	38	23	181	159		122				339
110	51	60	66	94	43	404	237						327
120	45	64	54	40	85	95							371
130	68	55	54	40	236		1020						473
140	73	61	56	62	79	396							568
150	79	62	55	33	59	224							551
160	54	56	57	39	63	737							683
170	69	55	42	72	80	78	424	141					521
180	66	53	41	27	61	258	1002						347
190	102	55	43	34	85	127	322	52		1099			286
200	35	55	37	33	132	90	720	30	111	1683			224
210	85	80	39	39	52	209	151	123	144	539			296
220	177	68	56	34	56	128	318	1077					323
230	82	71	43	40	63	121	355	64		2528			296
240	95	90	69	36	57	68	287	365		467			311
250	103	89	86	38	52	96	197	110					365
260	86	121	97	95	47	76	172	282	218		2098		410
270	81	117	92	45	74	66	126	135	315	842			434
280	53	97	124	90	41	88	123	288		545			427
290	71	85	71	43	77	46	79	151	396	522			494
300	29	92	69	50	47	50	159	575	2497			3384	382
310	100	70	49	44	48	274	89	131	1374				323
320	106	68	45	34	83	105	274						310
330	30	70	48	33	39	233	340	362					322
340	65	63	51	33	71	1060	373						288
350	65	53	46	45	150	120	943						334
Count Subto	185	5583	4309	1294	570	357	202	80	24	15	1	1	12621
Color Scale:	0	50	100	150	200	300	400						

Figure 2-14
Stanfield Sum of Hourly PM10 by Wind Speed and Azimuth, All Hours (No Outliers)

Stanfield Sum of Hourly PM10 Concentrations by Wind Azimuth (degrees) and Speed (m/sec), All Data

Sum of PM	Column												
Row La	0	1	2	3	4	5	6	7	8	9	10	12	Grand Total
0	124	6747	8327	1304	645	267	1238	1517					20169
10	300	7621	5508	1194	232	35	1683						16573
20	787	5013	4710	646	201								11357
30	122	4434	2898	520	113	148							8235
40	78	4735	3122	772	337								9044
50	206	3967	3628	238	179	65	28	85					8396
60	141	5217	3522	731	599	183	1103	1223					12718
70	523	6947	4294	850	1499	1844	760	3696	1267	1070			22749
80	720	8613	4145	1726	464	1722	4167	2303	4867				28727
90	59	10164	7103	1772	986	465	851	2056	1236	2954			27646
100	235	10097	6074	938	46	1088	478		122				19077
110	257	10360	7934	1873	214	1212	474						22323
120	179	11498	8444	969	513	190							21793
130	136	13851	10287	998	707		1020						26999
140	511	17679	12611	2402	158	792							34152
150	394	18915	10620	1223	294	897							32341
160	324	20750	13622	1605	1252	4421							41973
170	689	14743	7685	2897	1037	233	1696	141					29120
180	266	9004	5083	655	797	2067	4010						21882
190	407	6591	3856	1159	1694	1652	1287	104		1099			17850
200	248	4773	1838	1337	2635	719	4323	91	222	1683			17869
210	255	8444	2492	2124	1550	3756	1818	492	288	1078			22295
220	530	8813	3722	1476	2089	2694	6050	4307					29681
230	574	8252	2825	1701	2005	2669	3547	64		2528			24163
240	570	13410	4346	1424	1309	1283	1150	2188		467			26146
250	724	16376	8220	1290	1355	1056	1180	221					30422
260	778	21089	11113	4181	1035	1745	2584	1695	218		2098		46536
270	651	18713	10997	2818	2073	2115	2014	406	629	1683			42098
280	265	17961	15010	4326	942	2123	863	3173		1090			45751
290	282	14560	10530	2626	3010	1623	1738	1058	1187	1044			37656
300	117	12105	8429	3077	1281	891	2064	1725	2497			3384	35570
310	401	7476	5221	2763	1247	3016	268	261	1374				22027
320	423	7655	5487	1754	1327	315	822						17783
330	30	7235	6922	1622	541	1629	1019	362					19359
340	326	6767	5743	1285	1495	1060	746						17422
350	456	5894	6757	2253	1952	481	943						18734
Grand Tot	13084	376470	243122	60525	37809	44453	49923	27165	13907	14696	2098	3384	886634
Color Scal	0	4000	8000	12000	16000	20000							

Figure 2-15
Stanfield Hourly PM10 Averages by Azimuth and Hours of the Day, All Hours (No Outliers)

Stanfield Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Average of I Colum Row Labe	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	37	11		48	20	14	25	65	64	93	82	52	108	58	34	35	53	42	115	139	136	242	45	53
10	51	32	17	36		31	18	109	73	85	39	101	43	37	57	34	35	44	93	99	104	182	29	57
20	24	37	54	38	27	27	34	56	91	107	43	43	36	34	50	35	31	45	61	82	122	65		75
30		10	10	62	32	12	75	132	54	47	43	41	36	31	30	27	24	34	71	121	88		51	71
40	87	21	89	35	31	49	5	77	127	86	38	37	58	33	34	33	27	35	47	54	65	64		26
50	44	28	19	19	60	20	26	46	21	66	56	40	48	41	33	25	27	34	39	58	77	50	71	45
60	35	76	66	32	38	41	42	137	110	72	70	62	41	35	34	45	32	38	56	55	91	83	124	60
70	58	53	66	58	46	43	47	76	92	103	77	196	47	34	79	47	56	42	64	53	68	99	197	67
80	68	37	62	51	78	32	37	78	80	139	120	135	135	96	60	34	33	45	214	192	237	154	69	72
90	45	43	66	61	28	43	53	86	127	115	96	59	51	164	32	38	54	40	45	83	101	146	60	60
100	54	37	53	30	46	25	71	70	97	73	87	51	50	39	27	30	30	33	68	38	64	39	74	47
110	83	77	52	57	39	41	57	82	105	71	55	41	38	38	26	39	6	135	215	46	88	49	229	88
120	67	37	45	63	37	32	57	81	91	80	47	25	34	34	32	23	22	83	63	122	55	155	70	60
130	64	47	38	33	45	43	54	84	78	65	65	35	29	36	45	73	27	85	27	37	27	118	187	49
140	62	50	57	49	45	41	50	85	88	60	38	29	26	26	29	22	15	71	142	346	269	79	113	75
150	54	50	34	39	50	33	70	94	90	73	49	54	41	36	17	23	11	63	43	79	122	140	75	48
160	41	43	42	30	38	43	63	75	85	71	37	38	38	32	42	38	2068	39	59	414	96	59	69	70
170	61	45	40	27	33	40	61	69	80	62	71	67	28	26	19	81	40	21	37	151	148	80	82	54
180	36	86	29	36	28	30	42	69	75	79	31	111	36	79	69	22	36	67	63	31	69	82	62	164
190	57	35	44	39	20	36	40	81	99	65	30	49	96	19	266	68	28		201	126	95	61	71	49
200	22	46	19	27	39	42	34	36	112	174	329	176	56	52	52	61	32	18	42	69	463	76	47	41
210	75	47	25	38	62	27	43	39	81	79	44	51	37	100	29	156	158	74	143	90	185	71	58	130
220	35	63	23	46	53	38	53	61	74	46	52	43	118	51	167	202	93	121	70	78	322	110	85	58
230	62	40	33	45	28	25	35	97	119	63	34	29	209	64	85	47	42	39	135	47	100	199	91	92
240	35	26	55	40	41	42	61	71	35	39	39	58	28	148	71	82	93	111	39	138	191	133	98	53
250	47	27	32	58	48	45	25	67	41	46	68	45	59	29	34	84	35	60	46	163	202	110	81	66
260	41	54	39	39	44	36	29	42	98	88	156	137	79	45	78	80	46	250	93	167	240	189	133	66
270	58	69	67	58	50	44	46	77	91	70	39	42	116	117	100	36	94	35	61	155	209	153	129	59
280	50	54	63	40	56	69	60	71	88	65	50	61	52	35	43	49	89	58	123	201	228	236	94	84
290	84	63	48	39	34	27	30	51	80	46	77	38	88	32	53	38	74	64	55	147	142	121	145	75
300	64	41	42	47	12	28	68	53	99	62	109	196	40	41	39	76	58	38	104	201	143	241	64	69
310	55	38	41	54	29	53	27	104	30	87	56	64	44	57	36	32	109	82	70	86	115	90	63	52
320	48	66	42	31	18	34	45	59	90	38	38	48	41	86	34	36	34	52	43	99	197	64	109	36
330	66	45	32	28	35	39	43	40	55	147	44	42	35	31	37	60	39	38	81	96	103	136	72	27
340	32	59	60	48	80	25	15	15	36	71	142	40	38	65	52	34	35	52	65	105	117	120	84	74
350	68	36	32	30	39	15	18	25	138	52	43	35	36	41	40	66	35	52	65	86	83	356	81	15

Color Scale:	0	50	100	150	200

Summary – A cluster of sources lying within 4.5 miles to the south through northwest of the monitor appears to produce the highest impacts at the monitor during low wind conditions. No sources within 2.2 miles of the monitor appear to produce high impacts. Windblown dust sources producing the highest impacts at the monitor appear to lie to the east and east-northeast of the monitor. Mechanical source activity occurring in the late evening should be investigated to determine the sources of high PM10 impacts during these hours.

Inventory Focus – Mechanical sources lying within 4.5 miles and 200 to 330 degrees of the monitor should be identified through field inspection and interviews of people living or working near the monitoring station. Activity rates and emission characteristics of these sources should be estimated from available records or field observation. Land uses and soil characteristics lying along the back-trajectories of high wind hours on the selected high wind design day should be identified from record data or evaluated from sample collection and analysis.

2.3 Casa Grande

The hourly PM10 data were collected at an urban site within the city of Casa Grande, while the meteorological data were collected at the city's airport, approximately 4 miles to the north. For this analysis, we assumed that the wind patterns at the downtown site were very similar to those recorded at the airport. Because of this separation distance, however, the relative locations of some sources, especially those close to the monitor producing impacts during low wind "meander" conditions, cannot be estimated with the same accuracy as those near other monitors where meteorological monitors are co-located with PM10 instruments.

Single-Variable Analyses – A table of hourly PM10 averages and maxima grouped by wind speed is shown in Table 2-3. This table suggests that there are no significant sources operating in a continuous fashion within a few kilometers of the monitor. An elevated maxima PM10 hour when wind speeds are between 3 and 4 m/sec, however, suggests that an occasional episodic emission event may occur within the urbanized area of Casa Grande. Higher hourly PM10 averages and maxima at wind speeds above 9 m/sec indicate that this monitor is impacted by windblown dust sources within the surrounding region.

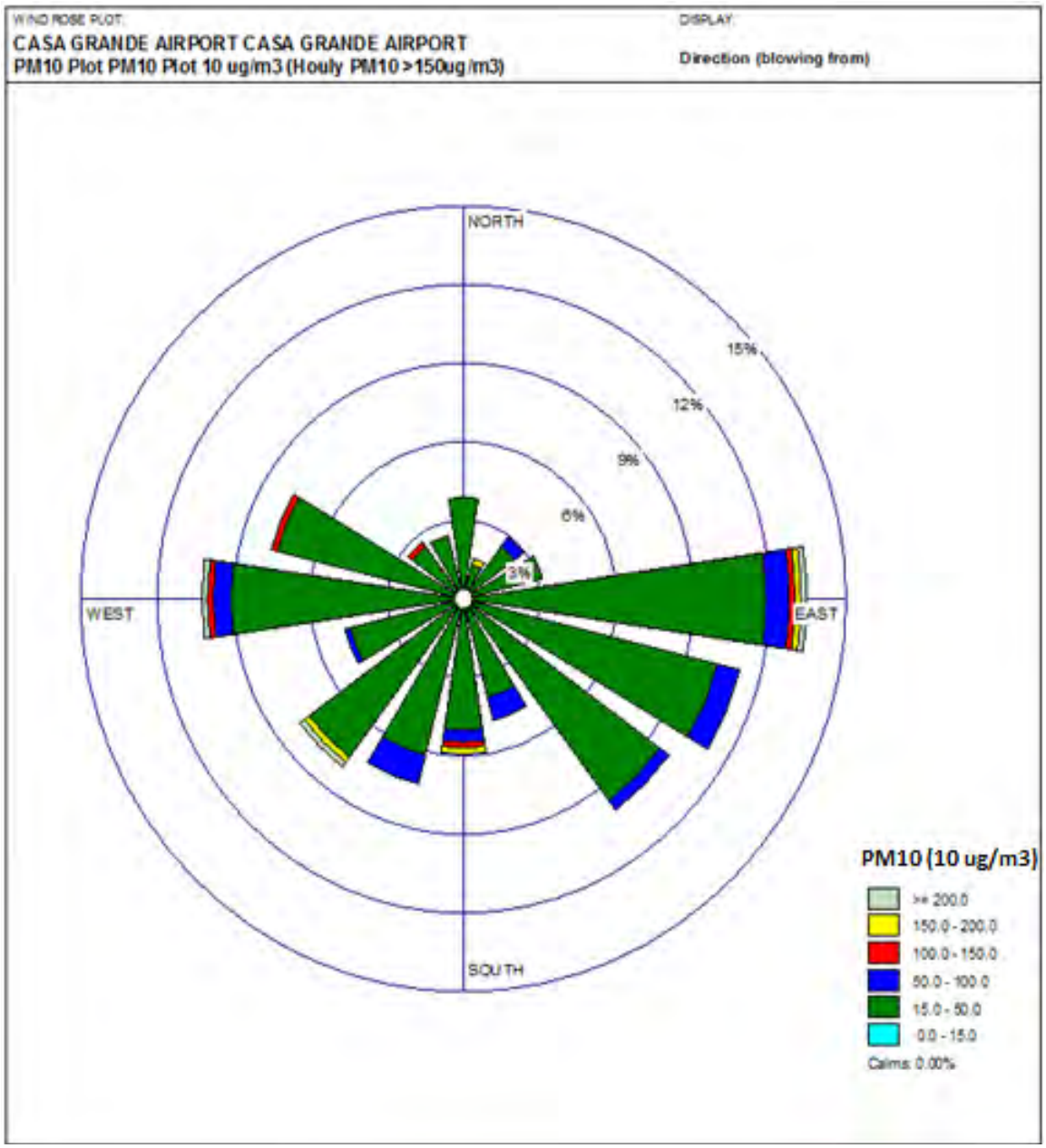
Confirmation of the absence of significant sources, and the presence of episodic emission events, in the urbanized area is shown in Table 2-4. This table represents hourly PM10 averages and maxima for all hours during which hourly PM10 concentrations at the monitor exceeded 150 $\mu g/m^3$. The relatively low numbers of hours shown in the Observation Count column for wind speeds less than 5 m/sec suggests that high PM10 hours at the monitor at low and moderate wind speeds are relatively infrequent and that local and nearby sources are not continuously significant in emission strength, but rather may be significant on an episodic basis.

Table 2-3 Casa Grande Hourly Average and Maximum PM10, All Hours (No Outliers)			
Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	1,771	52	417
1~2	5,101	48	400
2~3	3,419	42	561
3~4	2,109	42	2,172
4~5	1,309	44	757
5~6	736	57	1,972
6~7	458	73	1,698
7~8	254	76	693
8~9	151	101	902
9~10	85	202	3,565
10~11	44	290	1,603
11~12	11	562	4,173
12~13	6	463	1,453
13~14	1	38	38
Total Count	15,455	N/A	N/A

Table 2-4 Casa Grande Hourly Average and Maximum PM10, Hours > 150 µg/m^3 (No Outliers)			
Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	43	188	417
1~2	96	196	400
2~3	47	206	561
3~4	34	316	2,172
4~5	32	233	757
5~6	36	327	1,972
6~7	27	470	1,698
7~8	27	275	693
8~9	27	275	902
9~10	30	444	3,565
10~11	29	409	1,603
11~12	8	760	4,173
12~13	5	527	1,453
Total Count	442	N/A	N/A

The count of PM10 hours during which concentrations at the Casa Grande monitor exceed 150 µg/m^3 is presented in a PM10-rose format in Figure 2-16. This figure shows that during hours of elevated PM10, winds typically blow from the east through southeast and the west through west-northwest quadrants.

Figure 2-16
Casa Grande PM10 Rose of Hours Exceeding 150 µg/m^3
(No Outliers)



Two-Variable Analyses – The distribution of hourly PM10 averages by wind direction and wind speed at the Casa Grande monitor is shown in Figure 2-17. Relatively uniform and low PM10 averages at wind speeds of less than 5 m/sec suggest the absence of continuously significant sources within a few miles of the monitor. Scattered high PM10 averages at wind speeds above 7 m/sec suggest variability in emissions rates from windblown dust sources in the region surrounding the urbanized portion of Casa Grande. This variability could be due to emission seasonality resulting from high wind seasonality driven by monsoon conditions.

Emission variability is also borne out by the distribution of hourly PM10 maxima by wind direction and speed, as presented in Figure 2-18. Scattered hot spots in this figure suggest the episodic nature of PM10 emissions from sources impacting the monitor. This pattern suggests that controls implemented to bring the Cowtown and Stanfield monitors into attainment will probably reduce high episodic emission rates in the area surrounding the Casa Grande monitor and obviate the need to conduct inventory research focused on sources near this monitor.

The sum of hourly PM10 distributed by wind direction and wind speed is displayed in Figure 2-19. This plot shows that emission sources lying in an arc between 60 and 140 degrees and within 6.7 miles of the monitor are responsible for the highest cumulative impacts at the monitor.

Summary – No significant sources within the urbanized portion of Casa Grande were found to impact the monitor. Periodic high impacts from surrounding rural areas suggest the generation of significant emissions during high events entraining dust from disturbed lands.

Inventory Focus – As the Casa Grande monitoring site was not selected for a design day attainment demonstration, no modeling domains that included this site were developed, and no focused emission inventory will be researched and compiled at this site. Although the Maricopa monitoring site was selected for an attainment demonstration, no meteorological data have been collected at this site and, as a result, this site was not included in initial study analyses.

Figure 2-17
Casa Grande Hourly PM10 Averages by Wind Azimuth (degrees) and Wind Speed (m/sec)

Casa Grande	Hourly PM10 Average by Wind Azimuth (degrees) and Speed (m/sec), All Data													
Average Colun														
Row L	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
0	58	61	43	38	48	19	48							
10	71	42	40	40	33	55	27	537		48				
20	51	53	49	44	27	41	11	29						
30	45	49	49	34	25	65	23	27	40					
40	32	48	42	34	24	22	41	23	34	17				
50	55	54	50	36	40	31	116	380	76	47				
60	63	56	49	31	37	22	74	68	20	78	25			
70	46	49	44	46	35	34	45	39	83	68	40	28		
80	68	51	38	34	40	37	47	142	58	292	1603			
90	57	53	44	44	40	49	37	46	82	163	452	422		
100	35	53	48	37	46	50	47	100	62	66	212		21	
110	92	57	51	48	47	49	64	206	247	547	849			
120	51	58	55	42	68	41	35	57	126		64			
130	39	59	58	51	37	175	23	98	156					
140	46	57	58	47	43	69	64	273						
150	46	54	51	47	35	42	113	294						
160	49	52	47	47	24	117	92	92	302	151				
170	50	52	48	41	44	77	58	33	28		533			
180	33	54	43	43	51	41	307	42	340					
190	49	51	47	35	23	45	100	88	395	281	152		56	
200	44	46	42	37	41	41	56	43	42	67	228	594		
210	68	52	39	40	32	71	84	82	109	407	287			
220	67	52	41	36	80	63	244	138	68	37				
230	40	42	39	47	64	69	97	124						
240	39	41	45	40	38	80	98	67	131					
250	44	46	38	38	47	85	51	81	103	105				
260	35	47	41	48	43	49	43	67	52	84	71	126		301
270	207	38	41	42	42	51	57	111	67	128	116	313	142	420
280	95	47	36	42	51	42	57	52	81	74	112	215	1247	38
290	44	40	37	41	47	47	46	55	83	66	95	103	673	
300	33	41	40	35	39	39	43	49	77	85	277	264		
310	89	50	37	35	32	56	36	60	116	71	252	687		
320	74	54	38	35	36	48	50	37	38		191			
330	59	48	31	34	38	22	96	30	36	158				
340	52	48	38	34	34	28	44	19			56	263		
350	34	50	37	38	42	27	29	45	255	118	242			
360	21	47	43	42	41	17	29		178	171	105			
Color Sca	0	50	100	150	200	250	300							

Figure 2-18
Casa Grande Hourly PM10 Maxima by Wind Azimuth (degrees) and Wind Speed (m/sec)

Casa Grande	Hourly PM10 Maxima by Wind Azimuth (degrees) and Speed (m/sec), All Data														
Max of P Colun															
Row L	0	1	2	3	4	5	6	7	8	9	10	11	12	13	(blank)
0	67	236	170	147	161	28	120								
10	182	180	154	109	62	276	27	1556		48					
20	75	173	156	111	41	109	12	29							
30	45	208	197	94	45	109	34	42	40						
40	62	261	124	97	73	44	67	27	34	17					
50	81	292	178	153	170	87	583	693	103	47					
60	133	230	167	95	187	44	120	87	20	124	25				
70	61	203	159	163	138	118	99	68	83	74	40	28			
80	217	165	196	105	99	96	121	635	129	292	1603				
90	122	188	152	515	159	161	93	112	348	384	3565	704			
100	90	157	166	120	328	152	209	750	153	142	330		21		
110	158	384	377	561	339	236	199	411	247	547	849				
120	119	263	382	164	486	100	67	61	200		64				
130	55	400	223	234	137	892	31	98	287						
140	102	244	329	195	308	205	152	550							
150	73	246	513	179	108	122	343	548							
160	81	176	183	139	43	757	310	148	721	187					
170	114	164	248	186	125	281	98	60	44		533				
180	65	235	236	267	148	84	1972	119	340						
190	126	203	322	88	93	242	1461	409	902	281	152		56		
200	133	143	286	148	266	120	385	106	192	140	284	954			
210	118	170	120	339	89	934	262	240	281	801	552				
220	167	376	176	259	2172	312	1698	205	68	37					
230	64	192	176	331	325	283	284	166							
240	43	204	291	199	124	204	167	159	259						
250	116	152	172	200	174	251	166	107	185	146					
260	92	264	197	847	136	103	92	196	56	84	71	126		301	
270	207	121	164	150	344	512	326	1031	175	335	239	733	142	420	
280	145	137	203	215	264	168	700	152	241	175	291	301	4173	38	
290	123	146	116	178	323	185	127	203	220	123	143	186	1453		
300	44	157	210	183	135	169	112	130	180	152	277	449			
310	157	141	122	132	91	285	64	89	116	73	272	1140			
320	117	202	148	135	139	187	130	37	38		191				
330	70	207	108	164	131	46	226	53	36	179					
340	99	417	142	112	131	59	56	19			56	263			
350	61	241	122	116	151	58	34	70	397	118	242				
360	39	138	164	132	109	31	43		259	182	105				
(blank)															
Color Sca	0	200	400	600	800										

Figure 2-19
Casa Grande Sum of PM10 by Wind Azimuth (degrees) and Wind Speed (m/sec), All Hours (No Outliers)

Casa Grande	Sum of Hourly PM10 by Wind Azimuth (degrees) and Wind Speed (m/sec)															
Sum of PM Columr																
Row Lal	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		**Grand Tota**
0	115	2581	2212	2071	1348	116	193									8636
10	284	3182	2963	2091	685	549	27	1612		48						11443
20	303	4183	2931	1051	216	204	21	29								8939
30	45	4406	2989	615	150	196	69	82	40							8590
40	192	4515	2650	509	341	223	82	46	34	17						8608
50	218	7608	3002	572	802	307	926	761	153	47						14394
60	252	9387	3884	645	675	130	444	137	20	156	25					15754
70	185	9146	4931	1459	700	372	627	117	83	137	40	28				17826
80	613	9811	5527	1545	1555	1227	793	1418	174	292	1603					24556
90	687	12353	8850	2929	2748	2639	1850	1904	3831	3106	7235	1687				49817
100	176	12968	14015	2610	2381	1643	1083	1296	868	856	1061		21			38979
110	461	13683	15045	4344	932	728	514	617	247	547	849					37969
120	717	10920	12783	4088	2248	497	69	114	253		64					31752
130	195	7798	12582	4850	1205	1403	68	98	312							28509
140	229	8441	9839	3717	904	625	192	819								24765
150	138	5756	6737	2270	451	250	563	588								16754
160	438	5165	4654	1424	291	1055	462	184	907	302						14881
170	198	5635	4593	1452	614	919	231	99	55		533					14328
180	134	5865	4465	2065	1019	493	2457	167	340							17003
190	388	6005	5454	1356	551	675	2507	791	1581	281	152		56			19796
200	309	5790	4763	2210	1738	1176	1340	639	466	269	456	1188				20344
210	408	6406	5204	3285	1938	3314	2521	1639	1307	814	575					27410
220	606	7910	7048	2486	4620	2384	4395	691	68	37						30243
230	359	5156	5082	3041	2869	1652	773	495								19427
240	77	5548	5361	2590	1531	1202	294	734	523							17860
250	266	4774	4597	2928	1545	1105	560	243	517	210						16744
260	176	4555	5065	5500	2637	1481	894	535	313	84	71	126		301		21738
270	207	2829	4815	5589	5410	3058	2577	2101	1473	1156	696	1251	142	420		31724
280	285	2333	3590	6667	8609	5048	4808	2387	2023	1327	1121	858	4987	38		44078
290	218	1660	3180	5041	8429	7558	3284	2825	1571	461	851	206	2019			37303
300	201	2371	3157	3370	4042	3043	1899	976	692	510	277	792				21328
310	178	2379	2513	2751	1396	1841	287	480	116	141	503	1374				13961
320	221	2483	3792	3114	1860	913	351	37	38		191					13000
330	235	2761	2715	3169	1604	200	288	91	36	475						11574
340	156	3045	4182	3616	1488	389	133	19			56	263				13347
350	68	3131	3465	5881	2319	384	117	90	1020	118	242					16834
360	62	1075	2052	2794	1424	100	115		356	342	105					8424
Grand Tota	**10001**	**213612**	**200684**	**105692**	**73271**	**49097**	**37813**	**24860**	**19416**	**11732**	**16704**	**7773**	**7225**	**758**		**778638**
Color Scale	0	2500	5000	7500	10000											

2.4 Pinal County Housing

Single-Variable Analyses – An analysis of PM10 impacts grouped by wind speed is presented in Table 2-5. The low averages for wind speeds less than 5 m/sec indicate the absence of continuously significant mechanical sources within a few miles of the monitor. The moderately high maximum hourly PM10 values, up to 5,000 µg/m^3, at wind speeds of 0 to 2 m/sec suggest, however, the presence of significant episodic sources near to the monitor that periodically contribute to elevated 24-hour average PM10 concentrations.

Table 2-5
Pinal County Housing Average and Maximum PM10, All Hours
(No Outliers)

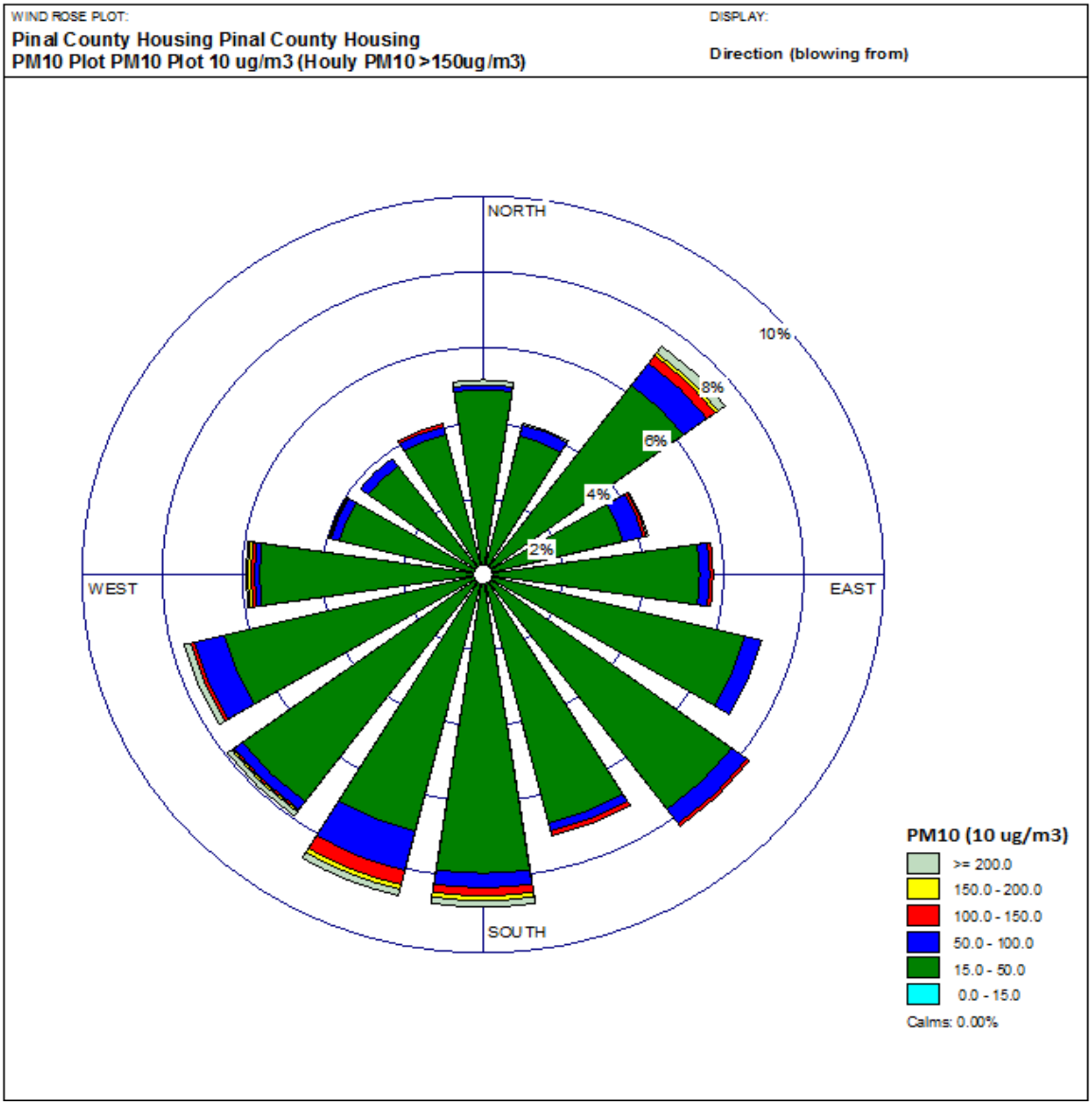
Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	10808	74	2292
1~2	8564	56	5004
2~3	3486	47	937
3~4	1593	63	2914
4~5	869	105	8608
5~6	481	213	5591
6~7	212	408	8449
7~8	81	475	2311
8~9	24	954	5774
9~10	8	1098	4281
10~11	4	1302	3141
Total Count	26130	N/A	N/A

The relationships of hourly PM10 impacts and wind speeds were further studied by limiting the above analysis to those hours during which the monitor recorded hourly PM10 concentrations greater than 150 µg/m^3. The results of this analysis are shown in Table 2-6. The relationship between increasing wind speed and increasing fraction of hours when PM10 is greater than 150 µg/m^3 suggests that soils in the region of Pinal County Housing are frequently disturbed and available to contribute entrained PM10 emissions during high wind events. The higher fraction of elevated PM10 hours when wind speeds are less than 1 m/sec, compared to hourly fractions when wind speeds are between 1 and 4 m/sec, suggests the presence of PM10 sources close to the monitor that produce impacts when wind meander and limited dispersion occur at these low wind speeds.

Table 2-6 **Pinal County Housing Average and Maximum PM10, Hours Exceeding 150 µg/m^3** **(No Outliers)**			
Wind Speed Category (m/s)	Observation Count (Hours > 150 µg/m^3)	Fraction of Total Hours	Average PM10 (Hours > 150 µg/m^3)
0~1	1202	51%	241
1~2	475	20%	240
2~3	104	4%	259
3~4	103	4%	351
4~5	119	5%	446
5~6	152	7%	541
6~7	106	5%	748
7~8	52	2%	707
8~9	15	1%	1498
9~10	6	<1%	1442
10~11	3	<1%	1736
Total Count	2337	100%	N/A

A PM10 rose based on hours when PM10 concentrations exceed 150 µg/m^3 is presented in Figure 2-20. This rose shows that sources producing hourly PM10 concentrations above 150 µg/m^3 appear to surround the monitor. Sources producing the highest hourly concentrations appear to lie to the northeast, south, and south-southwest of the monitor.

Figure 2-20
Pinal County Housing PM10 Rose of Hours Exceeding 150 µg/m^3
(No Outliers)



Two-Variable Analyses – Hourly PM10 averages grouped by wind speed (m/sec) and direction (degrees) at Pinal County Housing are displayed in Figure 2-21. Uniform and moderate hourly PM10 averages at wind speeds less than 5 m/sec suggest that continuously emitting sources surround the monitor. These sources appear to produce an elevated background concentration of PM10 at the monitor, but not at levels that exceed the 24-hour standard. The uniformity of hourly averages within this range of wind speeds and in all directions also suggests the presence of mechanical dust sources of uniform emission strength. High hourly PM10 averages at wind speeds greater than 6 m/sec in many directions also suggests that disturbed soil surfaces surround the monitor, with sources centered on 50, 200, and 250 degrees from the monitor producing the highest impacts primarily because of the prevailing directions of highest wind speeds.

A corresponding table of hourly PM10 maxima by wind speed (m/sec) and direction (degrees) is presented in Figure 2-22. The occasional elevated PM10 maxima at wind speeds of less 6 m/sec indicate that sources relatively close and within arcs spanning 0 to 80 degrees and 180 to 270 degrees of the monitor periodically generate high levels of emissions.

The combinations of wind speeds and wind directions responsible for the greatest cumulative PM10 impacts are shown in Figure 2-23, which presents the sums of hourly PM10 concentrations grouped by wind speeds and directions. The highest cumulative subtotals at wind speeds of 1 to 2 m/sec suggest that sources within 4.5 miles, and in almost all directions, of the monitor are responsible for a majority of PM10 measured. At these wind speeds, mechanical generation will be the primary mechanism for emission generation.

Figure 2-21
Pinal County Housing Hourly PM10 Averages by Wind Azimuth (degrees) and Wind Speed (m/sec), All Data (No Outliers)

Pinal County Housing	Hourly PM10 Averages by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Average	**Colum**												
Row L	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Average**
0	108	65	45	60	29	77							77
10	76	62	51	60	182	71	1002						77
20	81	61	61	54	60	92	2065	57					78
30	65	58	51	103	72	115	348	300					69
40	77	54	50	50	80	215	406	1839					83
50	61	57	53	61	60	280	187	780	1016	919			106
60	68	69	60	56	55	71	288	223	302				79
70	73	55	46	55	137	168	179	464					69
80	72	61	47	56	250	1237	406						87
90	82	71	60	87	25	156	95						74
100	84	69	47	75	213	140		8449					88
110	86	71	60	70	198	304	250						76
120	75	73	48	58	267	64							73
130	72	72	45	49	42	112							67
140	73	64	45	77	81	167	108	410	90				65
150	65	61	48	43	78	184	413	655					62
160	76	64	46	41	87	392	257				108		63
170	79	60	55	36	81	48	176	100					61
180	73	66	56	44	79	47	218	727	744	800			80
190	80	74	54	74	70	116	194	235	239	510			82
200	87	69	55	53	55	77	213	281	320	1484	2235		91
210	68	71	53	48	62	84	208	495	525	413		370	84
220	84	67	49	48	62	99	364	122					73
230	84	74	48	53	61	59	496	409					71
240	73	68	49	56	53	290	174	1040	118				76
250	96	70	45	47	78	107	161	721	2198	661	570		79
260	95	66	41	47	66	102	277	576	234	5774			74
270	99	61	43	53	84	152	265	264					67
280	87	59	44	46	62	121	318	690					61
290	72	64	40	48	224	86	653	700					63
300	93	59	44	59	118	41							60
310	78	53	39	48	45	157							55
320	91	56	37	36	75	358							58
330	84	59	82	42	170	197	412						71
340	78	70	58	33	125	182							68
350	73	61	41	40	96	169							60
360	73	60	58	39	74	137							63
Average	**79**	**65**	**49**	**52**	**77**	**144**	**278**	**521**	**631**	**1229**	**1287**	**370**	**72**
Color Scale:		0	50	100	150	200	300	400					

Figure 2-22
Pinal County Housing Hourly PM10 Maxima by Wind Azimuth (degrees) and Wind Speed (m/sec), All Data (No Outliers)

Pinal County Housing	Hourly PM10 Maxima by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Max of P Colum													
Row L	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Max**
0	2052	554	237	344	69	146							2052
10	578	355	374	376	2234	359	3619						3619
20	633	455	417	171	444	219	5591	82					5591
30	498	697	379	2914	425	432	696	300					2914
40	976	463	224	357	597	1208	2922	1839					2922
50	369	450	288	235	321	2518	479	3731	2316	919			3731
60	588	505	1444	296	322	381	3883	1285	460				3883
70	503	336	301	198	543	730	382	622					730
80	490	431	180	184	1279	8608	1069						8608
90	454	531	371	636	42	217	95						636
100	522	442	188	511	629	259		8449					8449
110	565	667	837	192	449	558	250						837
120	395	622	168	410	1421	92							1421
130	436	540	159	203	248	396							540
140	387	557	583	1074	386	869	187	443	90				1074
150	310	441	524	417	711	850	1467	655					1467
160	457	386	376	255	617	1436	363				108		1436
170	341	568	422	163	1269	443	1402	190					1402
180	290	400	400	320	997	349	2265	3771	1880	800			3771
190	389	1049	379	2193	437	1134	2471	997	964	856			2471
200	587	721	670	317	552	765	2806	1439	814	4281	3141		4281
210	308	475	658	322	251	412	1108	2400	1579	826		740	2400
220	562	320	444	192	444	457	2033	250					2033
230	490	490	191	323	223	120	1737	781					1737
240	298	478	706	1139	216	3714	541	2311	118				3714
250	790	626	261	288	1104	722	732	3555	3875	661	570		3875
260	474	526	408	169	328	538	1589	718	252	5774			5774
270	2292	433	277	314	776	808	1088	264					2292
280	478	294	343	151	310	403	457	1568					1568
290	620	675	292	142	1289	86	2863	700					2863
300	648	421	619	506	215	41							648
310	435	949	313	163	104	296							949
320	484	341	133	118	127	498							498
330	613	549	5004	209	352	487	412						5004
340	457	1133	937	172	265	182							1133
350	452	1145	252	135	169	203							1145
360	319	479	372	187	206	202							479
Max	**2292**	**1145**	**5004**	**2914**	**2234**	**8608**	**5591**	**8449**	**3875**	**5774**	**3141**	**740**	**8608**
Color Scale:		0	100	200	400	800	1000	1500	2000				

Figure 2-23
Pinal County Housing Sum of Hourly PM10 by Wind Azimuth (degrees) and Wind Speed (m/sec), All Data
(No Outliers)

Pinal County Housing			Sum of Hourly Average PM10 by Wind Azimuth (degrees) and Speed (m/sec), All Data										
Sum of PI	**Colum**												
Row La	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Sum**
0	11853	7454	2113	1324	116	385							23245
10	11996	12886	4791	1750	4188	498	4006						40114
20	8964	11448	5741	2381	1797	1008	6195	114					37647
30	7647	11314	6312	6208	2367	2177	1739	300					38064
40	10431	10321	5752	4116	3857	7542	8518	1839					52376
50	6739	11466	4754	2078	2693	12037	5801	7802	6094	919			60384
60	8285	15428	3963	2031	1430	2066	5751	2895	603				42452
70	10225	11967	3024	1315	2459	1179	1076	1857					33102
80	11205	13933	3120	1070	2002	9893	1217						42439
90	12781	20054	3083	1040	76	312	95						37441
100	14204	23042	2503	1346	1276	700		8449					51520
110	17234	28992	3947	1048	988	609	250						53069
120	19553	39826	3867	1339	2402	128							67115
130	19455	40666	6283	1435	883	670							69392
140	14088	35070	7247	2678	2267	1499	216	820	90				63975
150	11192	31643	10415	2631	2956	1104	2480	655					63075
160	14686	31841	14009	4917	3137	3924	771				108		73393
170	13466	28077	16701	4498	3624	1104	2819	200					70488
180	9653	22096	12614	3995	4169	932	4584	7265	5209	800			71316
190	10005	22903	10572	8034	3877	3833	5614	3989	1194	2040			72060
200	9106	17006	9479	6983	5702	4993	8962	5900	2241	7419	4469		82260
210	9040	20432	11316	4326	5321	4791	6446	8905	5777	826		740	77920
220	10615	21524	9644	4429	4602	4929	7998	611					64353
230	9317	21636	9037	5517	1880	892	3473	1638					53389
240	7996	17191	10755	6582	2472	5800	2614	6242	118				59770
250	9613	15910	11680	8193	7161	4267	3210	5045	6593	661	570		72902
260	7490	15436	9878	7497	5804	4194	5822	1727	467	5774			64088
270	9105	14833	10070	5928	4044	4110	2918	264					51271
280	7739	15803	10367	3894	1799	1692	955	2071					44319
290	7483	16923	9145	1967	1795	86	3265	700					41363
300	9353	18480	7907	1818	355	41							37954
310	9650	14583	5842	869	136	315							31394
320	10170	15702	5577	1229	226	716							33620
330	8702	16278	10748	1093	681	590	412						38502
340	7672	16886	6731	756	627	182							32854
350	8698	14902	3292	889	383	338							28501
360	4642	5997	2211	815	517	410							14591
Sum	**390051**	**709945**	**274486**	**118017**	**90068**	**89946**	**97205**	**69284**	**28388**	**18439**	**5147**	**740**	**1891716**
Color Scale:		0	5000	10000	15000	20000							

Diurnal variations in PM10 impacts were analyzed by grouping hourly PM10 concentrations by hour of the day and wind speed or wind direction. The table showing hourly PM10 averages by wind direction and hour of the day is presented in Figure 2-24. Increasing hourly PM10 averages between 0700 and 1000 hours suggest that mechanical activities produce higher emissions from sources near the monitor than occur between 0100 and 0700 hours. Decreasing hourly PM10 averages between 1000 and 1500 hours, compared with averages between 0700 and 1000 hours, suggest either lower emission rates or, more probably, increasing mixing height overcoming higher morning emissions. Scattered elevated PM10 averages between 1600 and 2100 hours suggest episodic source impacts, possibly resulting from high wind events.

Figure 2-25 shows the hourly PM10 averages by wind speed and hour of the day. The cluster of highest averages between 0900 and 2300 hours and between 6 and 11 m/sec wind speeds suggests that high wind events produce the highest consistent concentrations at the monitor, and that high wind events tend to occur during these hours and not during nocturnal hours after 2300 hours.

Figure 2-25 also shows the increase in PM10 averages from 0700 to 1000 hours at all wind speeds, possibly due to increases in mechanical source emissions near the monitor. Correspondingly, averages are seen to rise between 1900 and 2200 hours, especially at very low wind speeds, but these increases occur after the evening traffic peak. Looking back at Figure 2-24, evening increases in PM10 appear when winds are blowing from some, but not all, directions toward the monitor. Emission investigations at this site should include an assessment of mechanical activities occurring during these hours of the day within one or two miles and within the arc of 60 to 200 degrees of the monitor.

Finally, fairly low PM10 averages are seen at wind speeds between 6 and 8 m/sec during the nocturnal hours of 0400 to 0800. The lack of windblown dust at these wind speeds and during these hours suggests the presence of a mitigation factor unique to this time period. The source of this mitigating influence should also be included in emission investigations at this site.

Figure 2-24
Pinal County Housing Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Pinal County Housing Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Averag Colu																									
Row	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**Averag**
0	43	24	70	37	37	47	71	89	130	116	97	60	37	38	37	51	22	71	174	98	110	79	88	40	77
10	55	36	27	43	31	49	65	97	123	121	66	52	57	41	27	27	40	63	55	124	135	101	160	262	77
20	42	41	55	40	34	32	52	79	112	105	86	57	55	41	69	34	35	36	266	116	147	62	41	58	78
30	47	50	34	33	35	39	56	72	128	87	59	65	95	84	45	217	65	53	48	103	78	82	38	83	69
40	46	40	43	52	28	34	44	86	104	127	260	199	94	85	170	105	63	61	118	71	90	68	62	54	83
50	47	42	39	35	34	42	38	74	75	81	165	224	315	146	179	76	81	113	299	97	117	84	78	50	106
60	96	64	40	35	44	37	39	90	110	81	54	74	57	53	23	32	55	416	100	160	159	83	58	28	79
70	59	66	45	50	40	39	51	72	98	63	88	96	43	42	59	58	19	24	80	146	97	77	109	87	69
80	58	56	99	47	44	38	58	77	70	45	36	47	53	31	24	37	34	857	222	106	115	128	85	48	87
90	72	80	69	36	34	44	36	75	91	113	52	27	16	31	29		38	55	132	158	123	140	80	59	74
100	285	48	48	50	47	38	54	81	81	110	39	63	16	15	4	35	42	69	136	161	139	105	66	74	88
110	79	56	53	43	51	43	49	96	102	47	55	62	49	31	11	10	119	166	48	165	149	110	75	76	76
120	60	69	56	48	36	40	56	70	105	91	75	28	127	34	115	32	23	410	62	175	132	103	91	75	73
130	75	76	52	47	37	31	48	69	111	58	45	39	20	30	25	7	57	103	124	113	121	91	86	80	67
140	65	63	50	40	43	36	45	63	106	59	46	33	28	35	38	32	54	83	98	203	103	110	88	78	65
150	68	54	41	36	32	32	49	58	82	73	62	26	55	23	24	16	188	66	36	175	108	129	77	90	62
160	73	55	48	35	35	35	36	64	92	84	52	35	44	20	38	57	17	125	141	85	146	113	100	68	63
170	56	52	41	37	36	32	39	66	86	69	60	38	51	20	56	25	25	48	127	140	108	118	89	71	61
180	60	50	36	33	36	38	36	63	66	110	72	52	85	66	141	181	46	47	83	192	147	210	102	78	80
190	62	53	44	61	48	45	54	70	102	77	50	53	30	62	32	143	297	205	122	144	101	162	80	86	82
200	58	58	45	36	40	39	44	66	79	75	54	71	48	86	106	160	129	180	363	164	133	80	103	80	91
210	64	47	40	38	41	44	55	69	97	80	57	64	105	66	116	115	124	92	87	83	124	98	75	99	84
220	68	49	43	43	31	44	40	54	91	66	54	43	29	54	48	80	164	76	77	82	91	124	118	92	73
230	56	34	54	59	42	35	30	87	77	90	67	58	51	41	45	107	51	94	73	92	120	106	100	66	71
240	71	27	27	41	56	56	39	63	109	75	57	45	36	49	48	52	94	91	72	107	120	138	217	70	76
250	93	74	20	40	52	34	47	127	72	107	62	52	49	40	49	64	80	47	84	150	180	154	109	73	79
260	40	40	39	43	28	20	45	90	83	119	80	55	49	63	64	67	52	52	75	270	98	102	109	15	74
270	69	22	32	32	40	27	49	67	93	115	76	87	50	39	40	52	60	53	66	88	213	88	79	74	67
280	86	43	27	58	53	45	78	95	105	120	83	83	46	35	37	34	44	53	69	122	106	76	62	55	61
290	27	59	30	41	20	45	54	84	151	80	68	69	63	84	33	34	37	53	71	95	232	68	29	42	63
300	59	37	32	44	31	32	59	67	97	85	101	61	53	41	32	33	39	59	91	127	94	116		61	60
310	46	44	40	47	23	64	44	48	99	81	71	54	39	37	41	34	32	79	80	62	149	56	64	55	55
320	28	24	30	36	37	37	41	88	62	111	87	58	43	34	28	44	32	41	112	155	93	127	43	75	58
330	31	55	14	17	38	32	43	75	106	92	80	43	53	27	48	38	43	57	91	124	328	128	30	24	71
340	65	69	27	40	32	36	48	97	126	135	88	46	61	39	28	30	35	46	120	110	110	61	35	42	68
350	25	39	53	40	52	47	43	65	109	86	117	55	43	46	29	26	23	37	66	134	109	76	40	23	60
360	37	30	50	30	28	41	54	110	109	178	113	44	56	31	40	36	33	53	54	77	106	63	51	56	63
Averag	**71**	**57**	**47**	**41**	**38**	**38**	**47**	**74**	**96**	**89**	**74**	**63**	**60**	**52**	**53**	**61**	**62**	**79**	**103**	**127**	**129**	**111**	**90**	**76**	**72**

Color Scale:	0	50	100	150	200	250	300

Figure 2-25
Pinal County Housing Hourly PM10 Averages by Wind Speed (m/sec) and Hour of Day, All Data (No Outliers)

Pinal County Housing Hourly PM10 Averages by Wind Speed (m/sec) and Hour of Day, All Data

Averag	Colu																								
Row	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**Averag**
0	68	57	45	43	38	39	50	82	110	106	81	73	60	37	47	44	46	75	134	141	132	118	96	77	79
1	65	61	48	42	40	40	48	76	102	92	71	52	42	35	30	28	30	45	78	107	118	103	84	73	65
2	54	42	38	32	33	31	41	63	80	71	52	42	40	34	30	29	32	42	55	71	122	79	63	61	49
3	46	60	34	22	27	25	30	49	68	54	48	45	39	35	37	55	53	51	54	69	96	86	65	71	52
4	55	45	171	33	38	33	49	53	83	79	50	57	64	41	50	65	64	73	86	134	152	180	191	86	77
5	170	42	25	94	58	34	38	64	82	77	142	85	65	109	111	106	119	344	324	203	289	144	406	121	144
6	91	79	83	50	56	28	17	98	42	141	271	285	185	257	263	253	336	295	834	679	225	508	140	1228	278
7	8449	301	23	96			25		137	325	309	372	931	294	269	565	412	598	208	716	1308	1190	335	181	521
8	95		40							289	450	784	593	395	794	586	822		543	3875	946		39	87	631
9									749			447		1398	412	1660		456	2471	3300	14				1229
10																	1328	3141		570		108			1287
11										740	0														370
Averag	**71**	**57**	**47**	**41**	**38**	**38**	**47**	**74**	**96**	**89**	**74**	**63**	**60**	**52**	**53**	**61**	**62**	**79**	**103**	**127**	**129**	**111**	**90**	**76**	**72**
Color Scale:		0	50	100	150	200	250	300																	

Summary – Mechanical dust sources within one mile of and surrounding the Pinal County Housing monitor appear to daily produce moderate PM10 concentrations, between 45 and 100 $\mu g/m^3$ at the monitor. Information on candidate sources fitting this profile should be collected at this site, possibly through interviews of residents or employees typically situated at or near the housing complex during daylight hours. Hours of maximum PM10 concentrations in excess of 1000 $\mu g/m^3$ should be investigated with respect to wind speed and direction to determine which of these continuous sources has the potential to generate high PM10 hourly values during episodic events. High wind events also appear to be responsible for high PM10 hours at the monitor. Back-trajectories of high wind hours on design days should be computed and the disturbance status of lands along these back-trajectories should be determined on these days through interviews of property owners or leasees. Land uses within 4 miles of the monitor in an arc from 90 to 230 degrees should be compared to those in the complementary arc to identify any differences that may contribute to the cumulatively higher impacts being generated in the former range of directions. Finally, the cause of nocturnal mitigation of emissions during wind speeds of 6 to 8 m/sec should be probed.

Inventory Focus – Mechanical source activity in areas immediately surrounding the Pinal County Housing monitor should be the focus of inventory data collection and analysis for the low wind day modeling inventory. On the high wind design day of January 1, 2008, the disturbance status of lands along the high wind hour back-trajectories should be assessed through interviews of property owners or lessees.

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3. DESIGN DAY SELECTION

3.1 Introduction

On February 3, 2011, the U.S. Environmental Protection Agency (U.S. EPA) designated the central portion of Pinal County as nonattainment for the 24-hour PM2.5 National Ambient Air Quality Standard (NAAQS), and designated the same area as attainment or unclassified for the annual PM2.5 NAAQS.[16] The rationale for the latter designation was based on the finding that the single monitoring site exceeding the annual standard, Cowtown, was a population-oriented microscale (i.e., localized hot spot) monitor that was not eligible for designation as a nonattainment site for the annual standard. On May 31, 2012, U.S. EPA designated a somewhat larger portion of central Pinal County as nonattainment for the 24-hour PM10 NAAQS.[17] The annual PM10 NAAQS was revoked by U.S. EPA on October 17, 2006. As a result of these decisions, the attainment demonstration for both PM2.5 and PM10 in Pinal County must be based on ambient air quality conditions and contributing emissions on specific design days.

Through discussions between U.S. EPA, ADEQ, and PCAQCD, a base year of 2008 was selected for the preparation of an emission inventory and an attainment demonstration. This is the year of the most recent triennial National Emission Inventory prepared by ADEQ and PCAQCD and approved by U.S. EPA. During 2008, exceedances of the 24-hour PM2.5 NAAQS were recorded at Cowtown, and exceedances of the 24-hour PM10 NAAQS were recorded at Maricopa, Cowtown, Stanfield, Casa Grande, Combs School, and Pinal County Housing. At each of these latter sites, continuously recording TEOMs are used to record hourly averaged PM10 ambient concentrations. At the Cowtown site, a filter-based instrument is used to record 24-hour average PM2.5 concentrations.

In an analysis of the relationship between PM2.5 and PM10 concentrations at Cowtown, ADEQ concluded that any control measures that will achieve attainment of the PM10 NAAQS will also yield attainment of the PM2.5 NAAQS.[18] This conclusion was based on the predominance of local source emissions, primarily from four nearby feedlots and disturbed soil surfaces, on elevated concentrations of both PM2.5 and PM10 measured at the Cowtown monitor. The monitoring data upon which this analysis was based were collected at the Cowtown station between 2006 and 2008.

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[16] Federal Register, Vol. 76, No. 23, Thursday, February 3, 2011
[17] Federal Register, Vol. 77, No. 105, Thursday
[18] Analysis of PM2.5 Exceedances in Pinal County Arizona: Demonstration that PM2.5 Concentrations are Driven by Local Sources of PM10 Near the Cowtown Monitor, Arizona Department of Environmental Quality, March 15, 2010

3.2 PM10 Exceedance Days

Each of the six monitoring sites deemed to be nonattainment for the 24-hour PM10 NAAQS recorded several exceedances of the 150 $\mu g/m^3$ standard. The numbers of exceedances recorded at each site in 2008 are presented in Table 3-1. The 24-hour average PM10 concentrations measured at each site on each monitoring day in 2008 are tabulated in Appendix A.

Table 3-1
Exceedances of 24-Hour Average PM10 and PM2.5 NAAQS at Pinal County Monitoring Sites in 2008

Monitoring Site	Number of Exceedances	
	PM10	PM2.5
Casa Grande	3	0
Combs School	4	N/A
Cowtown	173	7
Maricopa	6	N/A
Pinal County Housing	10	N/A
Stanfield	14	N/A

Initial evaluation of the relationships of hourly wind speed and PM10 concentration at the four sites with longer PM10 monitoring records indicated the presence of two primary meteorological scenarios that produced hourly PM10 concentrations in excess of the 24-hour NAAQS of 150 $\mu g/m^3$: high wind conditions, and stagnation conditions. The sources responsible for high PM10 concentrations are fundamentally different under these two scenarios. During high wind conditions, disturbed soil surfaces typically dominate the emission inventory and, because of the tendency of wind trajectories to remain somewhat constant during these periods, sources within a narrow band along the upwind trajectory and within one hour's transport distance of a monitor tend to significantly contribute to recorded PM10 concentrations. Conversely, during stagnation conditions, when wind speeds are typically below 3 mph, wind entrainment of loose soil particles is virtually nonexistent, and mechanical sources that lift particles into the air through combustion, vehicle movement, and other anthropogenic activities are primarily responsible for recorded PM10 concentrations. Additionally, because transport distances are relatively short under low wind conditions, only those sources within one mile in any direction of a monitor contribute to high hourly PM10 concentrations during stagnation conditions. Because of these differences in source mix and the need to demonstrate attainment under the range of meteorological conditions found at Pinal County monitors, a committee providing technical assistance to the development of the Pinal County PM2.5/PM10 State Implementation Plan (SIP) advised that at least one stagnation and

one high wind design day be selected for each nonattainment monitor ultimately selected for emission inventory and attainment demonstration development.

3.3 Stagnation Design Days

Table 3-1 shows that Cowtown is unique among the Pinal County monitoring stations with respect to PM10 exceedances. The proximity of stationary sources under permit to PCAQCD and transportation corridors to the Cowtown monitor in 2008 caused or significantly contributed to the very high number of PM10 exceedances recorded there in that year. While high wind conditions occurred on some of these exceedance days, a substantial number of exceedances occurred on stagnation days with little to no wind entrainment of loose soil particles nor wind transport of suspended PM10 over extended distances. Instead, mechanical sources caused the elevated PM10 impacts at the Cowtown monitor on stagnation days.

Some of these mechanical sources are common to most of the nonattainment PM10 monitoring sites. A control program that reduces emissions from these sources sufficient to attain the PM10 24-hour NAAQS at the stations other than Cowtown will provide air quality benefits to Cowtown and help define the reductions needed from sources that uniquely impact the Cowtown site. When this approach was endorsed by the SIP advisory committee, a list of PM10 exceedances occurring on stagnation days for stations other than Cowtown was assembled. This list is provided in Table 3-2.

Table 3-2 indicates that two monitoring sites—Pinal County Housing and Stanfield—exceeded the 24-hour PM10 NAAQS on one of the stagnation days, October 29, 2008. Table A3 in Appendix A shows that the Cowtown site also exceeded the 24-hour PM10 NAAQS on this date, and analysis of the meteorological data shows that October 29, 2008, was also a stagnation day at this site. Plots of hourly PM10 concentration, wind speed, wind direction, and mixing height recorded or modeled at each of these three monitoring sites on October 29, 2008, are presented in Appendix B. As each of the PM10 vs. Wind Speed plots show, wind speeds were low (typically less than 4 mph) and fluctuations in PM10 concentration did not correlate well with fluctuations in wind speed.

Table 3-2
PM10 Exceedances on Stagnation Days in 2008 at Monitoring Sites Other Than Cowtown

Date	Site	24-Hour Average PM10 Concentration ($\mu g/m^3$)
4/26/08	Stanfield	207.5
5/10/08	Stanfield	161.7
10/29/08	PCH	178.0
	Stanfield	162.1

These conditions are representative of stagnation conditions. Additionally, there were no high wind speed hours recorded at any of the three sites on this day. Because of these factors, October 29, 2008, was selected by the SIP advisory committee as the design day for the attainment demonstration under stagnation conditions at each of these three monitoring sites. Because no PM10 exceedances occurred on stagnation days at the Maricopa, Casa Grande, or Combs School monitoring sites, these sites were not included in the list of low wind speed attainment demonstrations to be addressed in the SIP.

3.4 High Wind Design Days

The control strategies needed to reduce emissions from high wind sources are different from those applicable to stagnation sources. High wind sources typically consist of disturbed soil surfaces that require shielding from the wind, covering of soil surfaces, or the consolidation of wind-entrainable surface particles into wind-resistant matrices in order to reduce PM10 emissions. High wind source emission strength is directly related to the magnitudes of wind velocity and disturbed surface area, and the soil texture. Stagnation sources typically involve mechanical or combustion processes from which PM10 emissions can be controlled through either pre-treatment of emission-generating materials or the capture of PM10 released by these processes. In sum, PM10 concentrations from wind events are primarily proportional to the areas of wind-affected soils, while concentrations from stagnation events are proportional to activity rates of mechanical sources.

Control strategies for high wind sources are best developed from the analysis and modeling of design days during which only these sources are contributing to ambient PM10 concentrations. To identify days on which these conditions existed, the PM10 exceedance days recorded at each of the six nonattainment monitoring sites were screened for hourly average wind speeds during hours of high PM10 concentrations. From limited analysis of the relationships between hourly wind speeds and PM10 concentrations over the 2008 baseline year at the monitoring stations continuously sampling these parameters, an average wind speed of 12 mph was estimated to be the threshold velocity for the generation of significant PM10 emissions from disturbed soil surfaces and was chosen as the definitional cut point for the identification of high wind hours in the 2008 meteorological record.

3.5 Cowtown

Several criteria were used to select the high wind day at the Cowtown monitoring site. These included the 24-hour average PM10 concentration for the day, the number of hours during which the hourly average wind speed exceeded 12 mph, the number of hours during which the high winds blew from areas other than the directions of the nearby stationary and transportation sources, and the correlation between hourly wind speeds and PM10 concentrations. These statistics are tabulated for the candidate high wind days at Cowtown in 2008 in Table C1 in Appendix C. The initial list of high wind days shown in the table represents those days on which the hourly wind speed exceeded 12 mph for at least one hour during the day.

The high wind PM10 exceedance days in the Appendix C table are ranked by 24-hour PM10 concentration. The screening criteria enumerated above were used sequentially to eliminate days from consideration, starting at the top of the table and working down. The average number of high wind hours per day was calculated to be 4.03 on PM10 exceedances days. Days reporting 4 or fewer high wind hours were removed from consideration as these days either included hourly PM10 concentrations in excess of 150 $\mu g/m^3$ during low wind hours (suggesting the influence of stagnation day sources), or resulted from very high PM10 concentrations for four or fewer hours in a day, such as result from passage of monsoon winds, which would normally qualify as an exceptional event because of the overpowering of emission controls qualifying as best available control measures. This screen reduced the number of candidate days from 36 to 11, but retained the top two highest PM10 days: May 21 and November 9, 2008.

Emission reductions at the stationary sources and transportation corridors south and west of the Cowtown monitor are expected to be critical to the attainment of the 24-hour PM10 NAAQS on stagnation days. The controls developed to achieve these reductions are also expected to significantly reduce windblown PM10 emissions from these facilities. In order to develop a control strategy that will be effective on all high wind days, a high wind design day during which high winds blow from sources other than those to the south and west is desirable. In the second screening of candidate days, the number of high wind hours during which the wind blew from sources other than those to the south and west—i.e., when the wind was blowing from a direction greater than 303 degrees or less than 134 degrees—were tabulated and days with 0 high wind hours meeting this condition were eliminated from consideration. As the table in Appendix C shows, this condition reduced the candidate days from 11 to 4: October 27, September 29, April 27, and November 21, 2008.

Review of hourly plots of wind speed and PM10 concentration for stagnation days in Appendix B demonstrated that a final criterion for screening high wind days should be the correlation of hourly PM10 concentration to wind speed. This was deemed to be useful since, in view of the many elevated PM10 concentrations recorded during low wind conditions at Cowtown, the recording of a high PM10 concentration during a low wind hour could be due to emissions from mechanical sources observed frequently by PCAQCD inspectors at Cowtown that would adversely skew the analysis of high wind source impacts at the monitoring site. The correlation between hourly wind speed and PM10 concentration was computed for each day at Cowtown in 2008, and the resulting values were included in Table C1 in Appendix C. Review of these values shows negative correlations on October 27 and September 29, and positive correlations on April 27 and November 21, 2008. Of these latter two days, April 27 has the higher correlation value and the higher 24-hour PM10 concentration. On this basis, April 27, 2008 was selected by the SIP advisory committee as the high wind design day for the Cowtown monitoring site. The hourly profiles of PM10 concentrations, wind speed, wind direction, and mixing height for this date are shown in the plots contained in Appendix C.

3.6 Stanfield

During 2008, exceedances of the PM10 24-hour standard were recorded at Stanfield on 11 days on which the hourly wind speeds exceeded 12 mph for at least one hour. These dates, together with PM10 and wind speed statistics, are presented in Table D1 in Appendix D. The dates are ranked by highest-to-lowest 24-hour average PM10 concentration measured at the Stanfield monitor.

In the first screening of these data, days with fewer than the average number of high wind hours for the days listed were eliminated from consideration as the design day should include a greater-than-average number of high wind hours. The average number of high wind hours calculated for these exceedances is 6.2 hours per day. This initial screen reduced the candidate exceedances days from 11 to 6. The remaining candidate days, having at least 7 high wind hours each, were November 9, May 21, January 1, November 15, November 21, and December 13, 2008.

These remaining days were further screened by the correlation of hourly PM10 concentration to wind speed. The date with the highest correlation, May 21, 2008, was further evaluated by reviewing the hourly plots of PM10 concentration, wind speed, wind direction, and mixing height. These plots are also presented in Appendix D. The plot of PM10 concentration and wind speed, Figure D1, shows a significant drop in PM10 concentration at 1400 hours and then a return to previous hourly values without any corresponding drop in wind speed. It is unclear what might have caused this anomalous fluctuation in PM10 concentration, but the lack of a change in wind speed causes this day to be questionable as a high wind design day candidate.

The day with the next-highest correlation between PM10 concentration and wind speed was November 9, 2008. Plots of hourly PM concentrations, wind speeds, wind directions, and mixing heights for this day appear in Figures D4 through D6. Like May 21, this candidate design day also shows a significant decline in PM10 concentration at 1200 hours and a slow return while wind speeds steadily increase. This precipitous drop in hourly PM10 concentration and later return similarly cannot be explained. The use of these data to calculate and model windblown dust emission rates, however, would lead to both errors in the emission rates and the lack of good correlation between modeled and monitored PM10 concentrations at the Stanfield monitor. For this reason, November 9, 2008, was questioned as a design day candidate.

The day with the third-highest correlation between hourly PM10 concentrations and wind speeds was December 13, 2008. Plots of hourly PM10 concentrations, wind speeds, wind directions, and mixing heights for this day are presented in Figures D7 through D9. Figured D7 shows a short-term drop and return in PM10 concentration commencing at 1200 hours without any decline, and in fact an increase, in hourly wind speed, which raises the same questions of modeling accuracy discussed above for May 21 and November 9, 2008. Like these two latter candidate days, December 13, 2008, was questioned as a candidate for the high wind design day for the Stanfield site.

The day with the fourth-highest correlation between hourly PM10 concentrations and wind speeds was November 21, 2008. Plots of hourly PM10 concentrations, wind

speeds, wind directions, and mixing heights for this day are presented in Figures D10 through D12. Although this day shows a small decline in PM10 concentration at 0800 hours, the drop is far less dramatic than is evidenced in the three candidate days with higher PM10 concentration-to-wind speed correlations. As a result of this smoother hourly PM10 profile and the relatively good statistics in the categories evaluated, November 21, 2008 was chosen as the high wind design for the Stanfield site.

3.7 Pinal County Housing

The monitoring station at Pinal County Housing recorded seven exceedances of the PM10 24-hour standard on high wind days in 2008. These dates, together with PM10 and wind speed statistics, are presented in Table E1 in Appendix E.

The process of choosing a high wind design day for the Pinal County Housing site followed a process similar to that used at the Cowtown site. First, high wind days were sorted into those that recorded more than 4 hours of hourly average wind speeds greater than 12 mph. This had the effect of excluding short duration, monsoonal-related, high wind days from the analysis, and reduced the list from seven candidate days to three: June 21, January 1, and October 27, 2008. The correlation values of hourly wind speed to PM10 concentration were then compared for these three days. Although October 27, 2008, recorded the highest correlation, this date had the lowest 24-hour average PM10 concentration and the lowest number of high wind hours of the three candidate days. January 1, 2008, recorded the second-highest correlation between hourly wind speeds and PM10 concentrations, and had the second-highest 24-hour average PM10 concentration. The 24-hour average PM10 concentration on June 21, 2008, was only 4% higher than that of January 1 (271 vs. 260 $\mu g/m^3$), but the wind speed/PM10 concentration correlation for June 21 was 27% lower than that of January 1. Based on these considerations for the two top candidate days, January 1, 2008, was selected as the high wind design day for Pinal County Housing. Plots of hourly PM10 concentration, wind speed, wind direction, and mixing height for January 1 are also presented in Appendix E.

3.8 Maricopa

In 2008, six exceedances of the PM10 24-hour standard were recorded at the Maricopa monitor. All of these exceedances occurred on high wind days. Wind and PM10 statistics for each of these days are presented in Table F1 in Appendix F.

Until the modeling domains for low wind and high wind days at the Cowtown monitoring site were established, the working assumption of the SIP steering committee was that the emission control strategies demonstrating attainment at this site would simultaneously demonstrate attainment at the Maricopa site. When the Cowtown modeling domains were selected, the committee realized that the Maricopa site was sufficiently distant from these study areas as to invalidate this working assumption. Upon that realization, the committee agreed to develop a separate emission inventory focus and attainment demonstration based on a modeling domain specific to the Maricopa site.

The selection of a high wind design day for the Maricopa site was based primarily on the number of high PM10 hours recorded on each candidate day. On May 21, 2008, hourly PM10 concentrations spiked at 1300 hours at an hourly average value of 1704 $\mu g/m^3$, but levels in both the preceding and succeeding hours were below 920 $\mu g/m^3$. During the same hours, hourly average wind speeds remained fairly constant, suggesting a poor correlation between wind speed and PM10 concentration during 1200 to 1400 hours. Because of this lack of good correlation, this date was not considered to be a good candidate for a design day.

On August 7, 2008, hourly PM10 concentrations also spiked for a three-hour period in the late evening. Hourly wind speeds followed a similar trend, suggesting the presence of a thunderstorm outflow on this day. Because hourly PM10 concentrations exceeded the 24-hour standard for only three hours, this day was also deemed not to be a good candidate for a design day.

Another three-hour PM10 spike was recorded on September 11, 2008. Although this spike corresponded to a similar rise and fall in hourly average wind speed, the very limited number of hours of high PM10 concentrations also eliminated this day from consideration as a design day.

Hourly PM10 concentrations exceeded the 24-hour standard for a period of seven non-contiguous hours on October 11, 2008. Although hourly wind speeds were close to or exceeded 12 mph during these hours, there is little correlation between wind speed and PM10 concentration during the high PM10 hours. As a result, this day was also not considered to be a good candidate for a design day.

The 24-hour PM10 standard was exceeded on six successive hours on October 27, 2008. The rise of hourly PM10 concentrations between 0700 and 0900 hours on that day closely followed the rise in hourly wind speeds. Although hourly average wind speeds remained elevated through 1600 hours, hourly PM10 concentrations fell between 0900 and 1200 hours back to the level of the 24-hour standard and continued to decline slowly through the remainder of the day. This relationship suggests that contributing windblown dust sources contained limited reservoirs of abradable material, and that these reservoirs were exhausted by hourly wind speeds peaking at 18 mph at 0900 hours. The good correlation between hourly wind speed and PM10 concentration during the rise in PM10 and the continuing decline in hourly PM10 concentration after the daily peak make this day a reasonable candidate for a high wind design day.

On the last PM10 exceedance day in 2008 at the Maricopa monitor, which occurred on November 9, 2008, hourly PM10 concentrations rose and fell in two spikes of two hours duration each, while hourly wind speeds gradually rose from the beginning of the first spike at 1,000 hours to the peak for the second hourly PM10 spike at 1600 hours. The poor correlation between hourly wind speed and PM10 concentrations during this interval makes this day a poor candidate for a design day.

Based on the analyses of each PM10 exceedance day recorded in 2008 at the Maricopa monitor, the advisory committee selected October 27, 2008, as the high wind design for

this monitoring site. Hourly plots of wind speed, wind direction, mixing height, and PM10 concentration for this day are shown in Figures F-1 through F-3 in Appendix F.

3.9 Combs School and Casa Grande

All of the PM10 exceedances recorded at the Combs School and Casa Grande sites in 2008 occurred on high wind days. Like the Maricopa site, the SIP steering committee assumed that a high wind day attainment demonstration developed for the Casa Grande site would also demonstrate PM10 attainment at the Combs School site due to proximity and a similar set of disturbed soil land uses impacting each site. The Casa Grande site was subsequently determined to be impacted not by local emission sources, but only by regional windblown dust sources that would be subject to control under the attainment strategies developed for the Cowtown, Stanfield, Maricopa, and Pinal County Housing sites. At this point, the committee conducted a limited analysis of hourly PM10 and wind relationships on exceedance days, and concluded that the high wind control strategies that would bring the Casa Grande site into attainment would also provide the same benefit at the Combs School site. As a result, these sites were not chosen for development of modeling domain emission inventories or attainment demonstrations.

3.10 PM2.5 Exceedance Days

The national 24-hour ambient air quality standard for PM2.5 of 35 $\mu g/m^3$ was exceeded at only the Cowtown monitoring station during 2008. A tabulation of the 24-hour average PM2.5 concentrations, PM10 concentrations, and wind speed statistics for these days is shown in Table G1 in Appendix G. The exceedance days are ranked in the table from highest to lowest 24-hour average PM2.5 concentration for each day.

PM2.5 is collected by a filter-based sampler that produces only 24-hour average concentrations at the Cowtown station. Hourly average values of PM2.5 are not available from this type of monitoring. As a result, fluctuations in hourly PM10 concentrations were evaluated as a surrogate for hourly PM2.5 values, based on the close correlation between PM10 and PM2.5 concentrations reported in an analysis conducted by ADEQ.

At the Cowtown monitoring site, PM10 concentrations are dominated by emissions from south and west of the monitor. Because of the close correlation between 24-hour average PM10 and PM2.5 concentrations recorded at this site, it is logical that PM2.5 concentrations are also heavily influenced by emissions from the stationary sources and transportation corridors in these directions. As a result, the PM2.5 design day should not be a high wind day, but rather a day in which wind directions are from the south or west to the monitor at wind speeds less than 12 mph. The hourly PM10 concentrations, wind speeds, wind directions, and mixing heights of the days listed in Table G1 were plotted and reviewed using these criteria in selecting a PM2.5 design day. These plots are presented in Figures G1 through G21 in Appendix G.

The day with the highest PM2.5 concentration—March 25, 2008—has a single hour with a very high PM10 concentration that represents approximately 40% of the 24-hour

average for that day. Because of the very small number of high PM10 concentration hours, this date was not considered to be a good candidate for the PM2.5 design day.

The day with the second-highest PM2.5 concentration—April 12, 2008—contains a similar evening PM10 spike spanning three hours. This spike represents approximately 79% of the 24-hour average for this day. Again, because of the small number of high PM10 hours, this date was not considered to be a good candidate for the PM2.5 design day.

The day with the third-highest PM2.5 concentration—May 6, 2008—includes two hours with the highest PM10 concentrations when wind speeds exceeded 12 mph. Because of the desire to avoid days when high winds caused high PM10 concentrations that dominated the 24-hour average, this day was not considered to be a good candidate for the PM2.5 design day.

The day with the fourth-highest PM2.5 concentration—April 30, 2008—also contains a single high PM10 hour during which the wind speed exceeded 12 mph. Because of this high wind contribution, and the significant contribution made by this single hour to the 24-hour average concentration, this day was also not considered to be a good candidate for the PM2.5 design day.

The day with the fifth-highest PM2.5 concentration—November 20, 2008—includes a major PM10 peak spanning four hours in the evening and a minor PM10 peak in the early morning spanning two hours. None of the hours spanned by these peaks exceeded the assumed high wind speed threshold of 12 mph. In the absence of concerns raised in the days with higher PM2.5 24-hour concentrations, this day was considered to be a reasonable candidate for the PM2.5 design day.

The day with the sixth-highest PM2.5 concentration—June 23, 2008—contains several PM10 peaks spread throughout the day. The most significant of these peaks, spanning two hours in the late evening, occurs when hourly average wind speeds are between 10 and 12 mph, approaching the high wind threshold. Because of the presence of these two hours with elevated wind speeds, this day was considered to be a marginal candidate for the PM2.5 design day.

The day with the seventh-highest PM2.5 concentration—April 18, 2008, has an evening PM10 spike spanning three hours and a missing hour of PM10 data at 0900 hours. The evening PM10 spike represents approximately 40% of the 24-hour average PM10 concentration for this day. Because of the missing PM10 hour and the significant contribution of the evening PM10 spike, this day was not considered to be a good candidate for the PM2.5 design day.

As a result of the screening analysis summarized above, November 20, 2008 was selected as the PM2.5 design day for the Cowtown site.

<u>Summary</u> – For the purpose of demonstrating attainment with the national 24-hour PM10 ambient air quality in central Pinal County, emission inventories will be prepared for modeling use in the source areas surrounding each of the Cowtown, Maricopa, Pinal

County Housing, and Stanfield air quality monitoring stations. Separate modeling domains for stagnant design days and high wind design days will serve as the basis for modeling inventory preparation at each of the Cowtown, Pinal County Housing, and Stanfield monitoring sites. For the Maricopa site, only a high wind design day modeling domain will be developed. Finally, a PM2.5 design day modeling domain will be prescribed for the Cowtown site. Table 3-3 lists the design days for which inventory preparation will also focus at each attainment demonstration site.

Table 3-3
Summary of Selected Design Days

Design Day Character	Site	Date	24-Hour Average PM10 Concentration ($\mu g/m^3$)
High Wind Days	Cowtown	April 27, 2008	168.3
	Pinal County Housing	January 1, 2008	264.9
	Stanfield	November 21, 2008	178.6
	Maricopa	October 27, 2008	159.4
Stagnant Days	Cowtown	October 29, 2008	188.8
	Pinal County Housing	October 29, 2008	178.0
	Stanfield	October 29, 2008	162.1
$PM_{2.5}$ Day	Cowtown	November 20, 2008	345.0

3.11 Modeling Domains

Emission inventory preparation will focus on emissions generated within the attainment demonstration modeling domain surrounding each PM10 monitor for which a design day was selected. For the central Pinal County PM10 nonattainment area, these monitoring sites include Cowtown, Maricopa, Pinal County Housing, and Stanfield. Because separate stagnation, high wind, and PM2.5 design days were selected for each affected site, separate modeling domains were also developed to correspond to each design day.

Different modeling domains were developed for stagnation and high wind design days because the source categories significantly impacting monitors under each of these of meteorological conditions are quite different. On stagnation days, PM10 is entrained into the air only through the action of mechanical sources—such as motor vehicles, farm equipment, and industrial machinery—either releasing quantities of fine particulate matter through production processes or dislodging fine particulate lying on soil surfaces, with sufficient force to discharge the particulate into the air. Once suspended in the air, these particles travel limited distances—because of the lack of lateral air movement during stagnation conditions—before settling out the air again within an hour or so. This

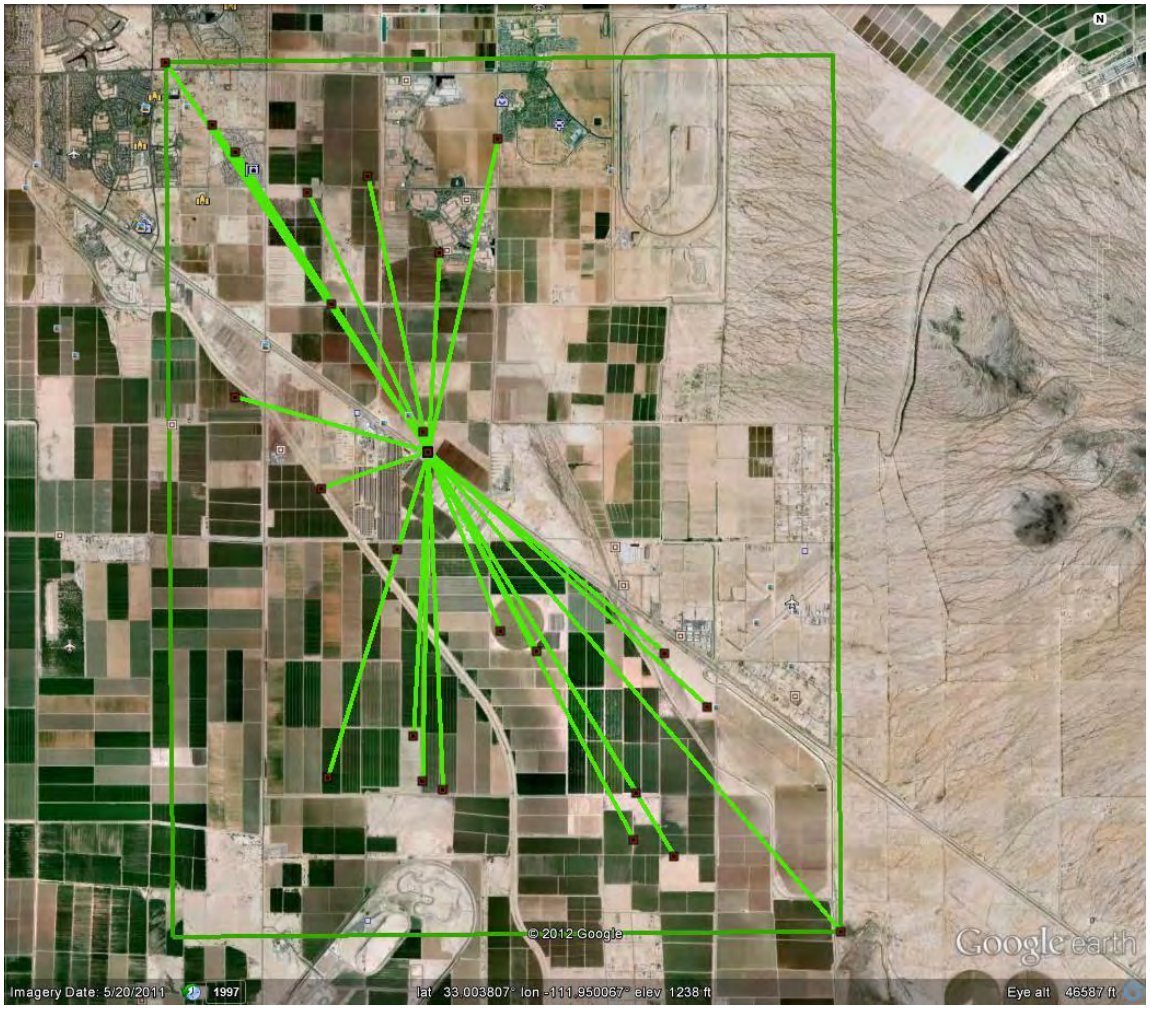
condition of limited travel means that sources whose emissions impact a monitoring site on such a day are typically located quite close to the monitor.

The types and locations of sources whose emissions significantly impact PM10 monitors on high wind days are considerably different from significant stagnation day sources. During high wind hours, when hourly average wind speeds nominally exceed 12 mph, windblown dust sources—most of which are disturbed soil surfaces—produce high concentrations of ambient PM10 that significantly exceed concentrations produced by mechanical sources in the same area. Research has demonstrated that the flux of PM10 in the vertical direction above disturbed soil surfaces is proportional to the speed of the wind, above a certain threshold velocity, blowing horizontally over the soil. This research has also demonstrated that below this threshold wind speed, windblown dust emissions from disturbed soil surfaces are much lower.[19] This condition is explained by the fact that the saltation (bouncing) of sand particles over soil surfaces is the primary cause of fine particles being dislodged from surface matrices and lifted into the air by turbulent eddies to produce airborne PM10 concentrations. Below the threshold wind speed, sand particles remain at rest on soil surfaces and no significant PM10 emissions are generated. Once entrained in the air, PM10 particles can be blown considerable distances depending on the velocity of the wind during transport. With time, however, suspended PM10 particles settle out of the moving air mass and are also widely dispersed laterally and, to a less extent, vertically due to increased groundlevel turbulence at higher wind speeds. As a result, windblown dust sources located a number of miles upwind can contribute to measured concentrations at a monitor, but those that significantly impact a PM10 monitor during a high wind hour are more typically within a few miles upwind of the monitor.

The settling velocities of PM10 particles cause a majority of particles entrained from soil surfaces to settle out of the air within an hour after initial entrainment. This characteristic of PM10 facilitated the process by which modeling domains for stagnation and high wind days were selected. On stagnation days, when wind velocities were typically less than 4 mph throughout the day, particles arriving at the monitor were assumed to have traveled no more than one hour at the average wind velocity recorded at the monitoring station for that hour. The starting point for each hourly trajectory of emissions from windblown dust sources to the monitor was determined by plotting the back-trajectory of the hourly wind parcel from the monitor to the emission source on the basis of that hour's wind speed and direction. The starting points of each hourly wind trajectory ending at the monitor were plotted on an aerial photograph of the area surrounding each stagnation design day, and rectangles with sides aligned with the cardinal compass directions were drawn to bound all of the trajectory origin points. A diagram showing each hourly wind trajectories and the rectangular boundary enclosing all of the origin points for the Cowtown monitor on the stagnation design day of October 29, 2008, is presented in Figure 3-1.

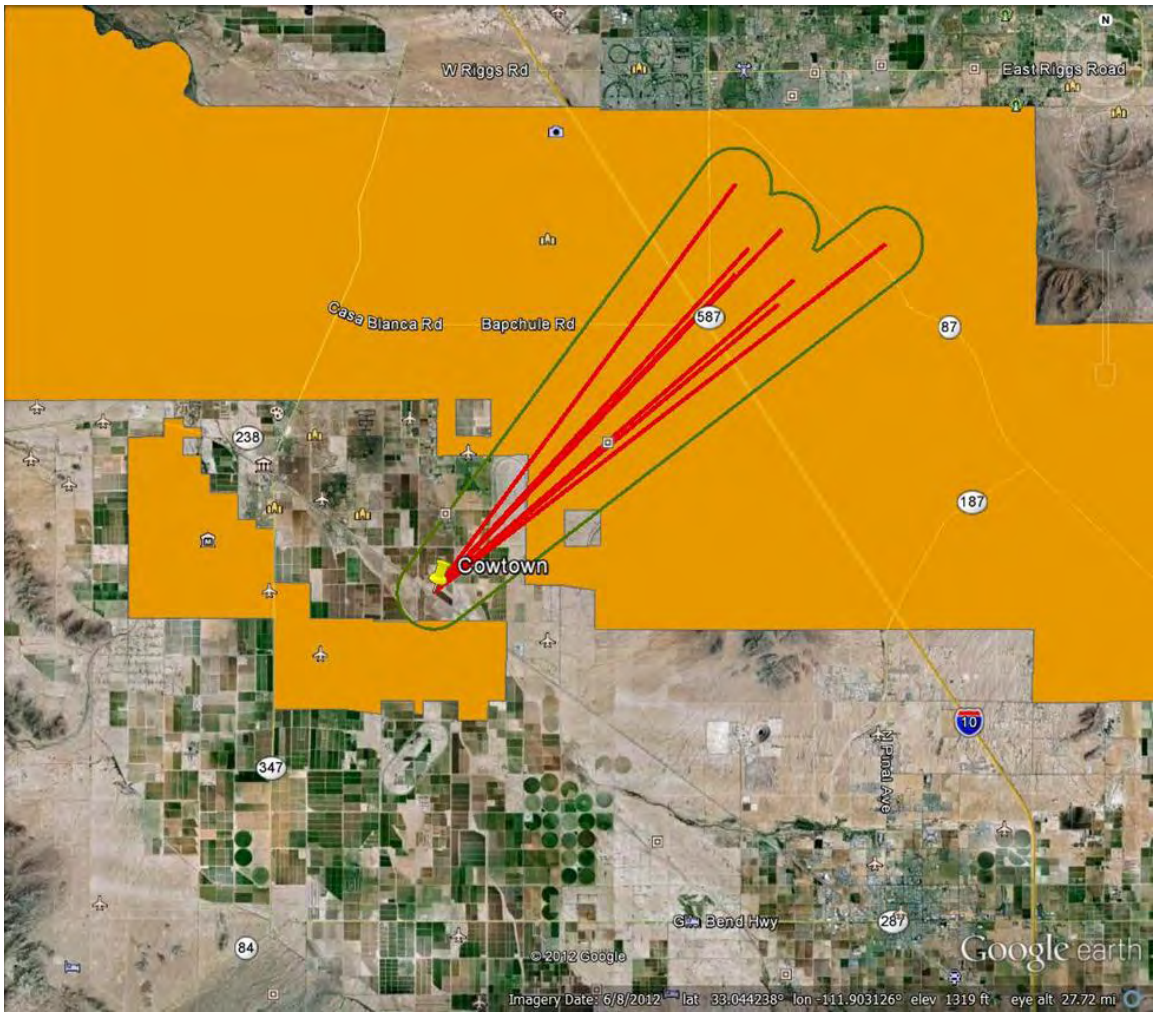
[19] The Physics of Blown Sand and Sand Dunes, Bagnold, Ralph A., Dover Publications, Mineola, New York, 2005

Figure 3-1
Cowtown Stagnant Design Day Modeling Domain



During high wind hours, wind directions tend to be less variable than those recorded hourly on stagnation days. Analyses of area source plume behavior contained in technical support documents of earlier PM10 attainment planning in Arizona, indicated that windblown dust sources lying more than one mile laterally from the centerline of the one hour wind back-trajectory centerline contributed less than 1% to the PM10 concentrations measured at a monitor, assuming that windblown dust emission factors were uniform across all upwind disturbed soil surfaces. This finding guided the design of high wind hour modeling domains that were centered over one-hour wind back-trajectories and extended one mile laterally from each centerline. An example of this type of modeling domain for high wind hours on April 27, 2008, at the Cowtown monitor is shown in Figure 3-2.

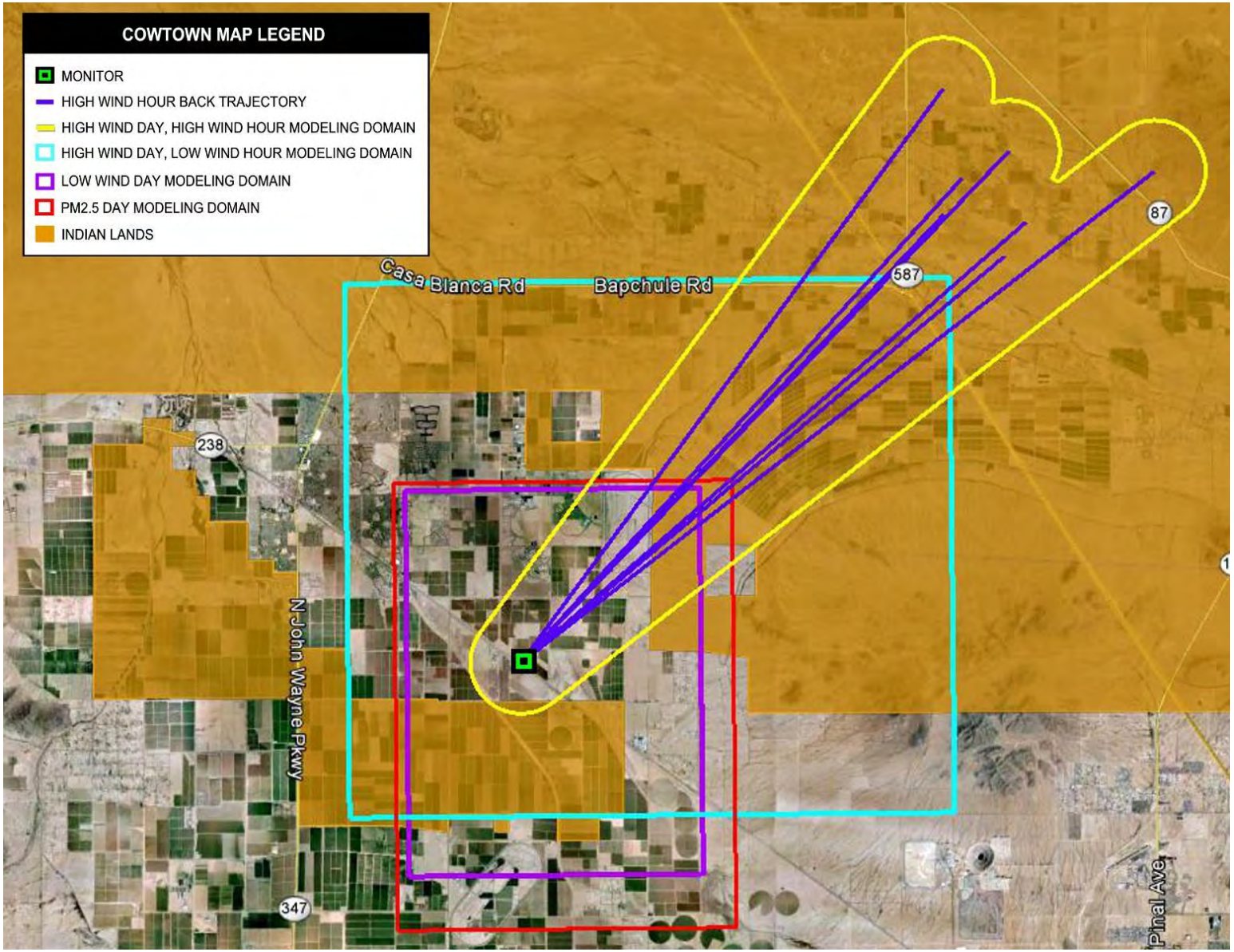
Figure 3-2
Cowtown High Wind Hour Modeling Domain During the High Wind Design Day



Cowtown – The Cowtown monitor will be the subject of three attainment demonstrations in the Pinal County PM SIP: a stagnation day PM10 demonstration, a high wind day PM10 demonstration, and a peak day PM2.5 demonstration. Each of these attainment demonstrations will be based on the modeling of controlled emissions within modeling domains whose boundaries will be set using the protocols described above. A map of the various modeling domains proposed for the Cowtown demonstrations is presented in Figure 3-3.

In Figure 3-3, the modeling domains for the stagnation day, October 29, 2008, and the PM2.5 peak day, November 20, 2008, are very similar. As a result, the larger modeling domain for the PM2.5 peak day will be used for both attainment demonstrations, and emission data from sources of both PM10 and PM2.5 will be collected simultaneously in this domain to serve both modeling efforts.

Figure 3-3
Cowtown



Maricopa – A map of the high and low wind hour modeling domains for the high wind day (October 27, 2008) attainment demonstration is provided in Figure 3-4. Because a substantial portion of the high wind hour modeling domain for the Maricopa demonstration overlays the high wind hour modeling domain for the Cowtown monitor, a single data collection effort will be undertaken to quantify windblown PM10 emissions from exposed soil surfaces common to both domains.

Pinal County Housing – The modeling domains for the Pinal County Housing (PCH) attainment demonstration do not overlay those of any other PM10 monitoring site. The location of these domains in relation to the PCH site is displayed in Figure 3-5. Emissions data will be collected in these domains following the same protocols used for the other design day monitoring sites.

Stanfield – The high and low wind modeling domains to be used in the Stanfield attainment demonstration lie just to the south of those to be used for the Cowtown modeling. As a result, the modeling domains share similar emission source mixes, and may well share similar emission factors for significant source categories. A map showing the location of the Stanfield modeling domains is presented in Figure 3-6.

Figure 3-4
Maricopa Modeling Domains

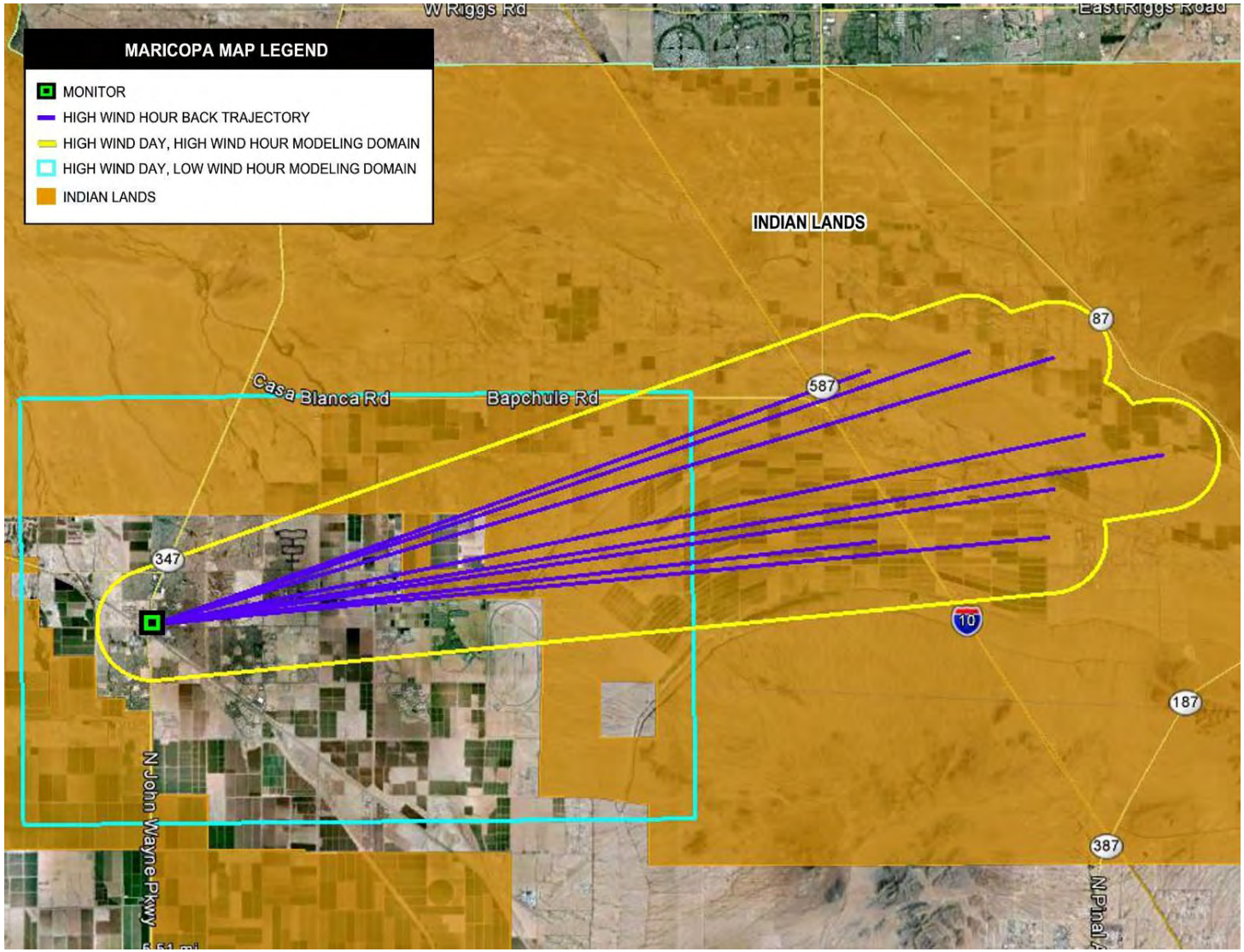


Figure 3-5
Pinal County Housing Modeling Domains

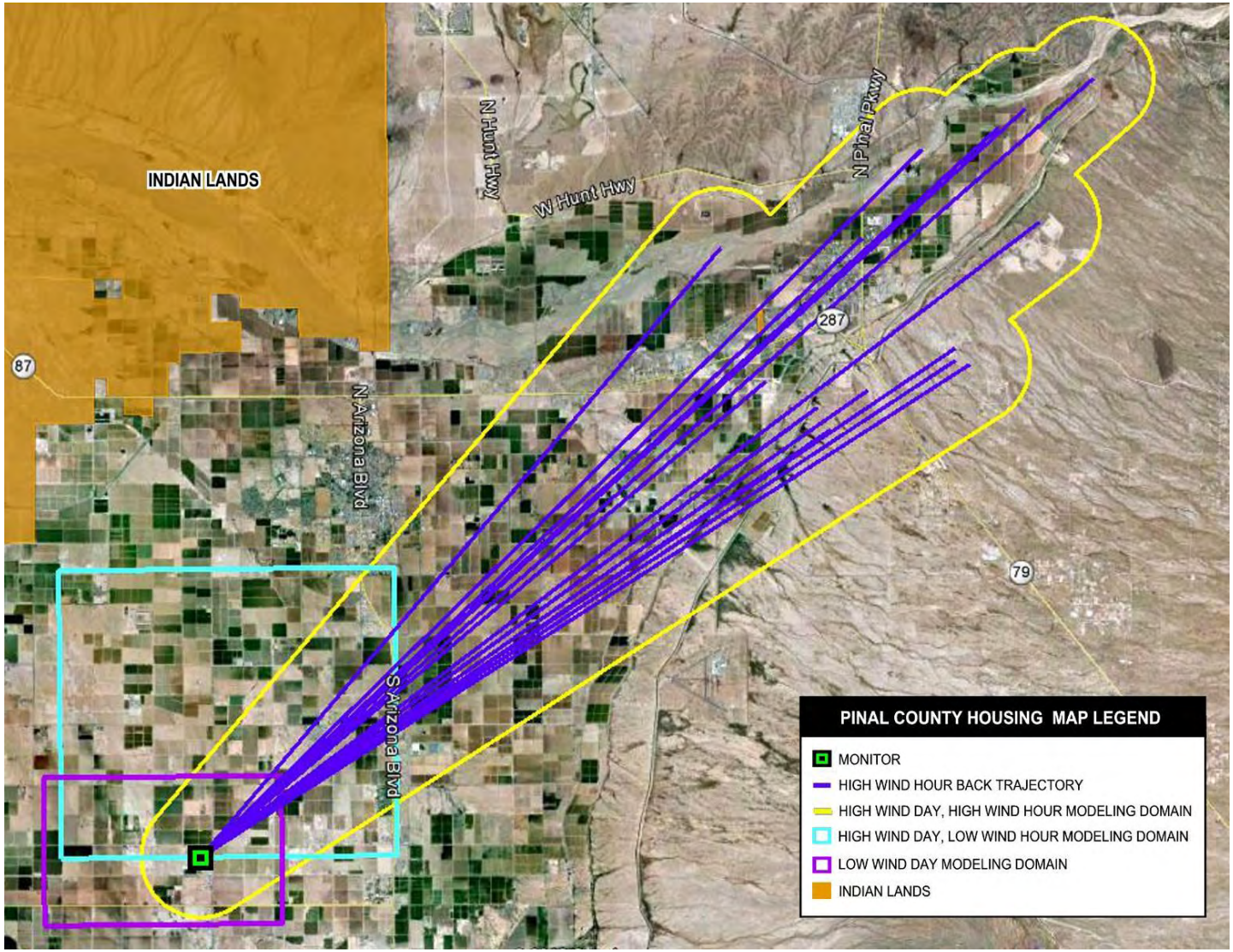
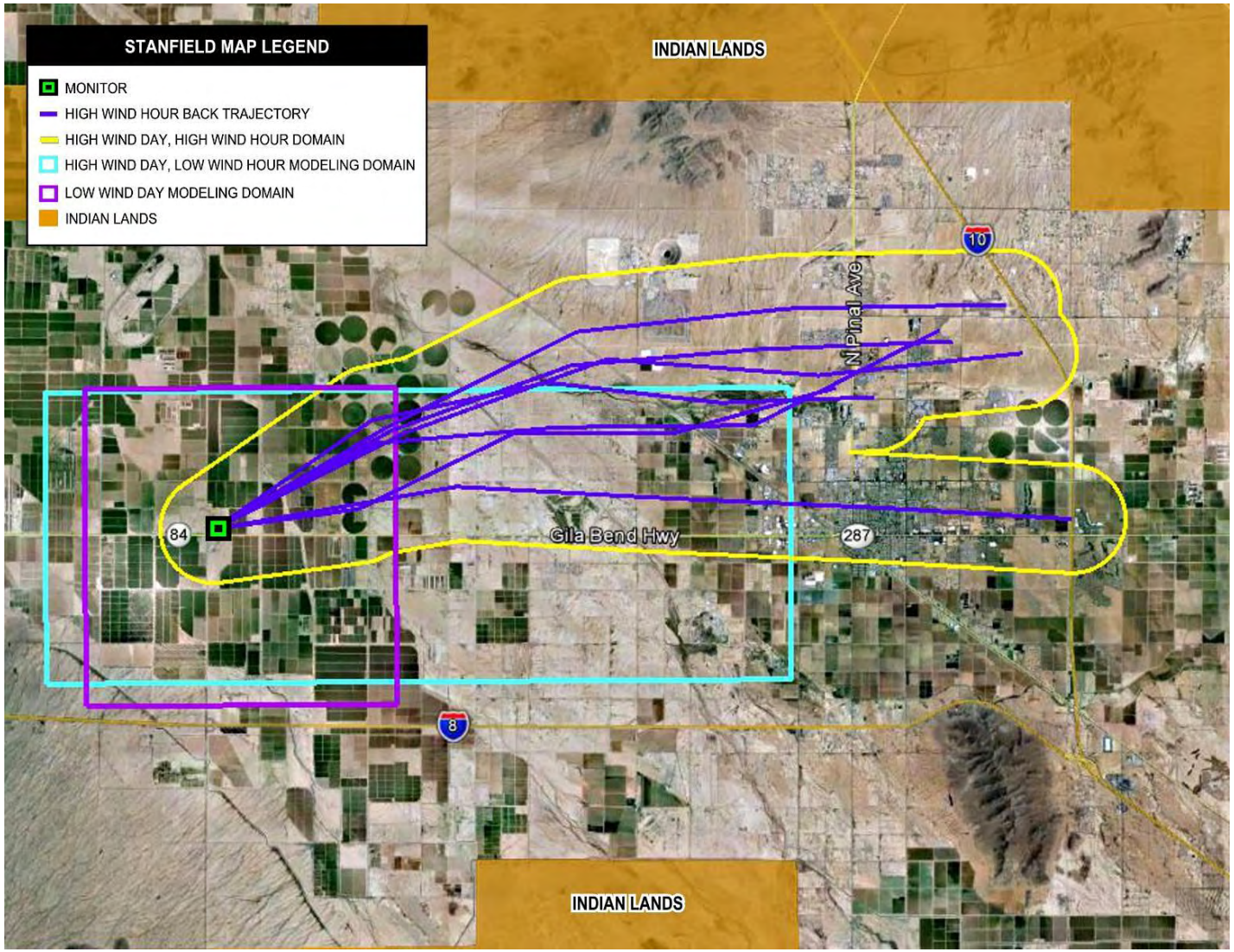


Figure 3-6
Stanfield Modeling Domains



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4. EMISSION INVENTORY PROCEDURES AND DATA SOURCES

As discussed in Section 3, for the purpose of design day selection, PM10 exceedance days in 2008 were divided into separate low and high wind event categories based on the 12 mph threshold velocity for generation of windblown dust. This threshold was estimated from limited analysis of the relationships between hourly wind speeds and PM10 concentrations over the 2008 baseline year at the monitoring stations continuously sampling these parameters. Low wind or stagnation event sources typically involve mechanical or combustion processes from which PM10 emissions can be controlled through either pre-treatment of emission-generating materials or the capture of PM10 released by these processes. High wind sources typically consist of disturbed soil surfaces that require shielding from the wind, covering of soil surfaces, or the consolidation of wind-entrainable surface particles into wind-resistant matrices in order to reduce PM10 emissions. Separate discussions of methods and data sources available to quantify emissions under low and high wind conditions are presented below. These discussions presented in this section provide a greater emphasis on area sources as previous studies[20] indicate that the crustal component of area source emissions comprise a significant portion of the overall inventory. As a result, available resources will be more heavily focused on these area source emissions calculations, whereas point and mobile source emissions calculations will utilize more standard methodologies that require less discussion.

4.1 Low Wind Emissions

Point Sources – Point sources refer to stationary facilities that release emissions to the air primarily through stacks or flues. Such facilities may also release "fugitive" emissions to the air from non-stack sources (e.g., evaporative emissions from leaks in pump seals, valves, and flanges), but the presence of emitting stacks places such facilities in the "point" source category. (Facilities with stack sources and facility-wide emissions below a certain limit or "cutoff" are treated as area sources. This section of the IPP discusses the key issues, available data, and procedures for the development of a point source emissions inventory.)

[20] Summary of Findings Report for the RARE Pinal County Source Apportionment Study. *http://www.pinalcountyaz.gov/Departments/AirQuality/Documents/Monitoring%20Network/RARE_Report_v4_1.pdf*

Land use files supplied by the Pinal County Air Quality Control Department (PCAQCD) identified a total of 44 industrial point sources within the nonattainment area in 2008 (see the land use discussion later in this section). All facilities emitting 5.5 lbs/day or 1 ton per year from stacks or vents are required to obtain permits. Annual and typical daily emission estimates for these facilities can be determined from annual source emission reports, PCAQCD investigation reports, permit files and logs, or telephone contacts with sources. For most of the sources, material balance methods will be used to determine activity rates for vented sources. Emissions will be calculated using the emission factors from AP–42, source tests, engineering calculations, or manufacturers' specifications.

PCAQCD distributes annual emissions survey forms to nearly all facilities to which operating permits have been issued. Facilities are required to report detailed information on stacks, control devices, operating schedules, and process-level information concerning their annual activities. These instructions include examples and explanations on how to complete the annual emissions reporting forms that facilities must submit to PCAQCD.

Annual emission inventory reports include calculated process-level emissions for PM10, NOx, SOx, and NH_3 from each vented source at each facility. Actual emissions for these pollutants are calculated using cited emission factors (from AP–42 or source test results) and estimated efficiencies of any control devices installed. PM2.5 emissions are typically calculated as a fraction of PM10 emissions, depending on the Source Classification Code (SCC) of the process reported, as outlined below.

- For those SCCs and control device combinations included in EPA's *WebFIRE*, this database will be used to calculate PM2.5 on the basis of EPA-recommended emission factors and typical control efficiencies.

- For processes with no PM10 controls, emission factors for PM2.5 published by the California Air Resources Board (CARB, 2004) will be used where available.

- For all other processes (where neither of the above resources provided guidance), PM2.5 will be assumed equal to PM10 as a conservative estimate.

Air quality planners are required to check inventory accuracy and reasonableness, and assure that all point sources have been identified and that the methodology applied to calculate emissions is appropriate and that the calculations are correct. Other reasonableness checks include recalculating emissions using methods other than those used to make the initial emissions calculations and comparing results. QA needs to be conducted by checking all emissions reports submitted to PCAQD for the year 2008 for missing and questionable data and by checking the accuracy and reasonableness of all emissions calculations made for such reports. Notes concerning follow-up calls and corrections to calculations need to be documented on each 2008 annual emissions report.

The QA point source coordinator should review and check calculations, identify errors, and perform completeness, reasonableness and accuracy checks.

Area Sources – Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively can release significant amounts of a pollutant. Emissions from stationary sources that were not identified as point sources in this report have been included in the area source inventory. Examples of area source categories include agricultural operations, such as tillage, harvesting, and cotton ginning; offroad recreational vehicle use; construction activities; and windblown dust from disturbed soil areas.

Tillage – The use of mechanical operations such as discing, digging, ripping, overturning and land planing is generally referred to as tillage, which produces fugitive dust. Several methods are available to estimate tillage emissions. The first was used in the 2008 Periodic Emission Inventory PEI for Maricopa County. Tillage emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). The agricultural tillage emission factor was calculated as follows:

$$EF = k\,(4.8)\,s^{0.6}$$

where:

EF = Agricultural emission tillage factor (lbs PM10/acre-pass)
k = Particle size multiplier (value of 0.15 for PM10)
s = Silt content of soil (%) = 35.2% (URS and ERG, 2001)

Thus: $EF = 0.15 \times 4.8 \times (35.2)0.6 = 6.10$ lbs PM10/acre-pass. This estimate does not take into account reductions for agricultural best management practices.

According to the 2008 PEI documentation, data on the majority of planted acres were obtained from the 2008 Arizona Agricultural Statistics Bulletin (AASS, 2009). Planted acres for potatoes and sorghum for grain were obtained from the USDA National Agricultural Statistics Service for 2008 (USDA, 2008b) and vegetables and citrus acreage were obtained from the 2007 Census of Agriculture (USDA, 2007a). Crop-specific annual land preparation operations data were obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001).

The key uncertainty in this emissions calculation is the estimate of activity that occurred on the design day. Since date-specific field operations data are extremely difficult to obtain, the approach used to estimate activity necessarily assumes that tilling operations can occur on any of the days during a crop's tilling season. This has the effect of producing an estimate of activity that, while statistically correct, significantly underestimates the level of activity on days when the activity occurs (i.e., since on many days no activity occurs). Thus, estimates developed using this methodology have the potential to significantly underestimate agricultural emissions when tilling occurs.

The second method uses tilling activity-specific emission factors from CARB[21] for Agricultural Land Preparation. Those values are summarized in Table 4-1.

Table 4-1
CARB Land Preparation Emission Factors Used to Prepare Agricultural Estimate of Agricultural Fugitive Dust Emissions

Land Preparation Operation	Emission Factor (lbs/acre pass)
Discing, Tilling, Chiseling	1.2
Ripping, Subsoiling	4.6
Land Planing & Floating	12.5
Forming/Planting[a]	0.8
Average	4.8

a. Discussions with CARB staff indicated that the weeding emission factor would be appropriate for this activity.

Additional information on plow-down speeds is needed to determine the acre passes per operation (e.g., disc implement width and speed can be used to determine the number of acres tilled per hour). The number of operations and the time of year in which they occur vary by crop type; therefore it is necessary to determine not only the acres of crop under cultivation, but the mix of crops being farmed on the selected design days.

MAG's 2007 Five Percent Plan[22] contrasted emission estimates using the two methods and found the above method produced an estimate of emissions for corn tillage that was an order of magnitude higher than produced by the first methodology. AERMOD performance evaluations determined that the lower values provided a better fit with concentration measurements. This indicates that care should be taken in determining which methodology to employ.

Data Sources – The following data are needed:

- Acreage under cultivation within modeling domains selected for low and high wind design days;
- The distribution of crops being cultivated within the selected modeling domains, either on average or within finer spatial domains; and
- The number of operations being conducted by crop type on the design days.

Information on the first two categories should be available from responsible government agencies, including the Arizona Department of Agriculture and USDA. The results

[21] *http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-4.pdf*
[22] Air Quality Modeling for the Salt River Area in Support of the Five Percent Plan for PM-10, prepared for Maricopa Association of Governments, by Sierra Research, November 2007

should be reviewed by the County Agricultural Agent to confirm their representativeness. Data on the number of operations are available only from farmers who were active on the design days. It is recommended that the results of the above analysis be shared with the local farm organizations to determine representativeness and to request additional information on activities that took place on selected design days.

Harvesting – The 2008 PEI used crop-specific emission factors (CARB, 2003) to estimate harvest emissions. Table 4-2 lists the crop types and associated PM10 emission factors used to calculate emissions from agricultural harvesting.

Table 4-2
CARB Harvest PM10 Emission Factors
(lb/acre-yr)

Crop Type	PM10 Emission Factor
Cotton	3.4
Wheat	5.8
Barley	5.8
Alfalfa Hay	0.0
Other Hay	1.68
Corn	1.68
Sorghum for Grain[a]	5.8
Potatoes	2.7
Vegetables[b]	0.08
Citrus	0.08

a. Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.
b. Includes melons, excludes potatoes.

Annual PM10 emissions from agricultural harvesting were calculated using the following equation:

Uncontrolled annual harvestCrop emissions = *EFcrop* × *ACrop* × ton / 2,000 lb

where:

harvestCrop = harvest emissions for each crop type (tons PM10/yr)
EFCrop = harvest emission factor (lbs PM10/acre)
ACrop = number of harvested acres for each crop type per year

Example:

EFCotton = 3.4 lbs PM10/acre for cotton
ACotton = 18,800 acres of cotton

Uncontrolled annual harvestCotton emissions =
3.4 lbs PM10/acre ×18,800 acres × 1 ton/2,000 lbs
= 31.96 tons PM10/yr

Key issues to be resolved in estimating harvest emissions are the control efficiency produced by applicable agricultural BMPs and whether fields located within the selected modeling domains were harvested on the selected design days.

Data Sources – Maricopa County obtained the majority of crop-specific harvest acreage from the 2008 Arizona Agricultural Statistics Bulletin. Harvest acres for potatoes were obtained from the USDA National Agricultural Statistics Service for 2008, and vegetables and citrus were obtained from the 2007 Census of Agriculture. These sources should be reviewed to determine if similar information is available for Pinal County. The data will be available only at a county level of disaggregation; if possible, more detailed data should be pursued to address the distribution of crops being cultivated within the selected modeling domains. It is suggested that the County Agricultural Agent be contacted to determine if a finer spatial resolution of cultivation is available.

Cotton Ginning – Annual emission reports are available from all permitted cotton gins in Pinal County. Daily emission levels can be calculated from facility-specific operating schedules. A review of the coordinates determined that seven cotton gins are located within the nonattainment area.

Data Sources – Each of the seven cotton gins should be contacted to determine their daily operating schedules.

Offroad Recreational Vehicle Fugitive Dust – EPA's NONROAD model estimates exhaust emissions for offroad recreational vehicles. Since particulate emissions are also generated by recreational vehicles traveling on unpaved surfaces, estimates of fleet size and activity are needed to support fugitive dust calculations. NONROAD provides estimates of annual mileage and number of vehicles by county for all-terrain vehicles (ATVs), offroad motorcycles (ORMs), and specialty vehicles/carts (SVCs). Daily estimates of travel can be calculated from the annual mileage and number of vehicles by category. These estimates of travel can be combined with emission factors for unpaved industrial roads, discussed in the section addressing fugitive dust from unpaved roads. The Maricopa County PEI assumed the average vehicle weight for offroad recreational vehicles was one half of a ton. ORMs (two wheeled vehicles) are assumed to emit at half the level of ATVs and SVCs (both four wheeled vehicles).

Data Sources – In addition to the variables required for estimating unpaved road fugitive dust emissions, estimates of vehicle activity in both the nonattainment area and within the modeling domains will be needed. Several options are available to allocate NONROAD estimates of vehicle class activity for the county to the nonattainment area and the individual modeling domains, including allocation by population, allocation by share of acreage, consideration of where offroad activity parks are located, etc. Contacts should be established with knowledgeable park and law enforcement officials to determine the best method for allocating activity.

Construction – Unlike most emission sources, the locations of construction activities and emissions move within modeling domains from year to year. Therefore, it is necessary to obtain information on dust control permits issued during the years of interest. Permits provide information on the project type, acreage, date issued, permit period (one year) and project location. Project types are listed below.

- Sand & Gravel
- Construction
- Unknown
- Commercial Construction
- Site Development
- Vacant
- Low Density Residential

To estimate emissions for each permit for the 2008 PEI, Maricopa County multiplied the number of acres by an emission factor that varied by project type (in units of tons/acre-month) by the number of months of construction duration, which also varied by project type.

Estimates for the duration of house and apartment construction were obtained from EIIP guidance (U.S. EPA, 2002). Estimates for the duration of nonresidential construction and road construction were obtained from the WRAP Fugitive Dust Handbook (WRAP, 2006a). No estimates for the duration of trenching, demolition, weed control, site prep/land development, and temporary storage yard activities were available; thus, the following activity periods are assumed, as previously cited in the MCAQD PEI:

- 1-month duration for trenching, demolition, and weed control;

- 8-month duration for site prep/land development activities (weighted average of residential and commercial duration) because the duration depends on the project type and size; and

- 12-month duration for temporary storage yard activities because these activities are frequently associated with road construction.

Emission estimates for residential (single-family and multi-family), nonresidential, road and general construction were obtained from the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook. Estimates for road construction were obtained from Clark County and general construction emission factors from the WRAP Handbook were used for trenching, demolition, weed control, and temporary storage yard activities. The average duration of construction activity and emission factors for each project type are shown below in Table 4-3.

Table 4-3 Average Project Duration and Emission Factor Employed in 2008 Maricopa County PEI		
Project Type	Duration (months)	Emission Factor (tons PM10/acre-month)
Residential: single-family	6	0.032
Residential: multi-family	12	0.11
Commercial	11	0.19
Road Construction	12	0.265
Trenching	1	0.11
Demolition	1	0.11
Trenching	1	0.11
Weed Control	1	0.11
Site prep/land development	8	0.11
Temp. Storage Yard	12	0.11

Two key assumptions employed in calculating emissions are described below.

- *Acreage* – No permits were included unless the area of disturbance was equal to or greater than an acre.

- *Dates* – The County estimates of project duration (e.g., road construction, 12 months; residential single family, 6 months; commercial, 11 months) were used to count backwards from the design date and determine if a permitted site would have been active on the design day. Thus, for example, any road construction project started more than 11 months prior to the day to be modeled was excluded from the inventory of sources that impacted that date.

Data Sources – Since the county issues permits for a 12-month period and many projects have durations that are shorter than 12 months, assumptions will need to be developed about when projects start so that it can be determined whether those projects are active on the selected design days. Similarly, assumptions about whether projects are active on weekends, holidays, etc. will also be needed. Discussions with Pinal County staff indicate that there are few multi-family projects, so a decision will be needed as to whether separate estimates of single- versus multi-family construction emissions are warranted. Similarly, estimates of the duration of the construction period on active days will also need to be developed (e.g., 10-hour days, 8-hour days, etc.), along with start and ending times.

On-Road Mobile Sources – On-road mobile sources are defined as those vehicles that are licensed for and operated on public roads (i.e., on highways, arterials, and other local

roads) and include cars, motorcycles, trucks, and buses. For the purpose of this IPP, on-road mobile sources consist of the following types of emissions:

- Exhaust, tire, and brake wear;
- Fugitive dust from vehicles operating on paved roads;
- Fugitive dust from vehicles operating on unpaved roads; and
- Fugitive dust from unpaved shoulders.

EPA's most recent motor vehicle emission factor model, MOVES (Motor Vehicle Emissions Simulator), is required to characterize emissions for the first category. AP-42, which is EPA's Compilation of Air Pollutant Emission Factors, provides specific methodologies for quantifying fugitive dust emissions for the second and third categories.

The general approach for computing on-road mobile source emissions consists of multiplying vehicle activity expressed as vehicle miles traveled (VMT) by vehicle emission factors (in units of grams/mile) obtained from the methods noted above. In large urban areas, VMT data are generally available at the roadway link level from travel demand model outputs. Outside urban areas, VMT is typically compiled at the county or regional level from sources such as the Highway Performance Monitoring System (HPMS) maintained by the Federal Highway Administration or fuel consumption and sales data (although use of fuel sales data at the county level can be problematic in regions of heavy inter-county travel). An outline of the methods, inputs required to characterize conditions within the nonattainment area and data sources for preparing inputs is outlined below.

Exhaust, Tire & Brake Wear – EPA's MOVES model requires the collection of local data to characterize the vehicle fleet operating in the nonattainment area. This is accomplished by preparing input fields to represent vehicle population, activity, road types, inspection and maintenance, fuel supply, and meteorology for the region and time period being simulated through MOVES. Each of the individual inputs once obtained must then be properly formatted and imported through the provided MOVES importer tools into a MYSQL database.

Described below are the inputs needed to represent the nonattainment area.

- <u>Vehicle Population</u> – The vehicle population field represents the regional fleet of vehicles for each of the 13 MOVES vehicle types; these data can typically be obtained from vehicle registration information. Using a VIN decoder software tool, the raw registration information can then be parsed into the appropriate MOVES vehicle type fields.

- <u>Age Distribution</u> – A separate input field that also relates to the vehicle population is the age distribution. Each of the 13 vehicle types in MOVES must also have the age of the vehicles defined; again, the vehicle registration information can be used as the source of that information.

- Alternative Vehicle Fuels and Technologies (AVFT) – The Alternative Vehicle Fuels and Technologies input defines the fraction of each vehicle type belonging to separate fuel and engine technology groups such as diesel, gasoline, natural gas and electric vehicles. VIN-decoded DMV data are one source for deriving these data.

- VMT by HPMS Vehicle Type – Annual Vehicle Miles Traveled organized by HPMS vehicle types are required inputs for the MOVES model. Where available the output from a travel demand model for a given region is used as the source of this information.

- VMT Fraction – In order to resolve the annual VMT by HPMS into finer temporal resolution three temporal breakdowns of VMT by each MOVES vehicle type are developed. These fields represent VMT fractions by month, day, and hour. At present, MOVES differentiates only between weekdays and weekends for daily VMT breakdowns. Traffic counter data are commonly used as the source of data for the VMT fraction fields.

- Road Type Distribution – Each of the vehicle types has VMT further resolved into the 5 distinct MOVES road types. A source for this data can be the outputs from a regional travel demand model.

- Ramp Fraction – The fraction of vehicle hours traveled on ramps is calculated using VHT data from a regional travel demand model. MOVES defines two distinct ramp categories: rural restricted and urban restricted roads.

- Speed Distribution – Average speed distribution can be calculated using VHT outputs from a regional travel demand model. Speed distributions are broken into 16 different bins in MOVES and distributed across vehicle type, road type, day, and hour.

- Inspection and Maintenance Programs – I/M data tables should reflect the vehicles in the region that are required to comply with the local I/M programs along with an estimate of the compliance fractions. The table is organized by pollutant process, state, county, vehicle types, fuel types, and model year.

- Fuel Data – The fuel supply and fuel formulation should be specified as MOVES inputs reflecting the local blend of fuels available. These inputs can be derived from local fuel inspection results where available. Additionally, MOVES does provide a default set of values that may be sufficient in the absence of local data.

- Meteorology – Average hourly temperature and relative humidity by month should be obtained from local meteorology stations and used in place of the MOVES default values.

Data Sources – Inputs for characterizing the vehicle fleet can be obtained from Arizona Department of Transportation (ADOT) registration files; fuels information can be obtained from the Arizona Department of Weights and Measures; I/M program data can be obtained from the Arizona Department of Environmental Quality (ADEQ); and vehicle activity data can be obtained from several sources, including ADOT, 2008 Highway Performance Monitoring System (HPMS) records (which can be obtained from ADOT), and MAG's travel demand model, which characterizes travel on portions of Pinal County. An alternate option for configuring MOVES to represent the nonattainment area is to use inputs developed by MAG to quantify Pinal County emissions for the ozone plan.

Fugitive Dust, Paved Roads – The AP-42 methodology computes paved road emissions as a function of silt loading values and the average weight of vehicles traveling on paved road surfaces. Maricopa County classifies roads as freeways, high-traffic arterials, and low-traffic arterials to reflect different silt loading assumptions. An arterial carrying a traffic volume of less than 10,000 vehicles per average weekday is classified as low-traffic; all other roads that are not freeways are classified as high-traffic arterials. The AP-42 equation for calculating paved road fugitive dust emission factors is as follows:

$$E = k \times sL0.91 \times W1.02 \times (1 - P/4N)$$

where: E = annual average particulate emission factor (g/mile),
k = particle size multiplier for particle size range (1.0 g/mile for PM10 and 0.25 g/mile for PM2.5),
sL = road surface silt loading (g/m^2),
W = average weight of the vehicles traveling on the roads (tons),
P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation, and
N = annual number of days (366 days in 2008).

Data Sources – Silt loadings are available from multiple sources. Maricopa County derived them from samples collected by an EPA contractor in 1993. The values, in grams per meter squared, derived from those samples are 0.02 for freeways, 0.067 for high-traffic arterials, and 0.23 for low-traffic arterials. Alternately, measurements can be obtained for selected roads from ADOT or those values can be augmented with measurements collected by ADEQ and/or Pinal County staff from a representative sample of roadways. Average vehicle weights can be derived from ADOT vehicle registration data for Pinal County.

Fugitive Dust, Unpaved Roads – The emission equations for calculating fugitive dust from unpaved road travel developed by EPA are published in AP-42.2. The equation used in this analysis is designed to estimate particulate matter emissions from light-duty vehicle travel on unpaved roads. This equation has the following form:

$$E = [(k)(s/12)^a(S/30)^d/(M/0.5)^c - C][(365 - P)/365]$$

where: E = particulate matter emission rate, pound per vehicle miles traveled (lb/VMT),
k = particulate size factor (dimensionless) = 1.8 for PM10,
s = surface material silt content (%),
S = mean vehicle speed, miles per hour (mph),
M = surface material moisture content (%),
a = empirical constant = 0.2 for PM10,
d = empirical constant = 0.5 for PM10,
C = PM10 emissions from vehicle exhaust, brake wear, and tire wear (lb/VMT), and
P = number of precipitation days per year on which 0.01 inches or more rain falls (days/yr).

Data Sources – The three variables in this equation—silt content, moisture content, and vehicle speed—vary significantly from one unpaved road to another. Because of this variability, measurements of these parameters are needed to increase the accuracy of the representation of roads within the nonattainment area. Options to collect these values include use of values employed by Maricopa County in the 2008 PEI (silt content, 11.9%; moisture content, 0.5%; and vehicle speed, 25 mph on unpaved roads and 10 mph on alleys). Another source of information on silt content and moisture content is an ADOT report entitled *Identification of Emissions Sources for Pinal County ADOT*, which provides values for five separate unpaved roads along with information on average vehicle speed and average daily traffic counts collected in 2005. This information was used to prepare separate PM emission factors for each of these roads. Lacking any other data sources, these values could be extrapolated to similar roads located within the nonattainment area and modeling domains. Alternately, ADEQ and/or Pinal County staff can collect measurements from a representative sample of roadways following AP-42 data collection and measurement procedures.

With regard to vehicle activity, PCAQCD collected daily counts of selected roads between October 2001 and August 2011. Counts were generally collected to respond to complaints and employed a single tube counter for a seven-day period. Road surface distinctions include dirt, dirt w/soil stabilizer, paved and dirt/gravel. Most of the roads counted were dirt roads. Some roads were sampled multiple times and could provide a basis from tracking trends in growth. A copy of the road counts is presented in Appendix H.

Fugitive Dust, Unpaved Shoulders – The 2006 field study in the Salt River Area of Maricopa County observed blowing dust emissions on unpaved arterial road and secondary road shoulders as a result of bow wake passage. Because emissions from this source can be controlled through programs that pave or stabilize shoulders and were found to be significant in the MAG PM SIP plans, they should be addressed in both the nonattainment area and modeling PM emissions inventories.

Although the literature reports very few truck bow wake emission studies, MAG used one good study from the San Joaquin Valley to estimate bow wake emissions in the Salt

River Area. The San Joaquin Valley study measured wind energy levels and particulate flux away from a paved road on which trucks were traveling at an average speed of 60 miles per hour.[23] The PM10 emission factor was computed to be 7.75 grams per vehicle kilometer traveled, or 12.47 g/mi. This emission factor cannot be directly applied to Pinal County traffic because of the lower truck speeds on arterial roads found in the nonattainment area.

Truck bow wake emissions were assumed in this study to vary with the square of the truck speed, very much as aerodynamic drag and bow wake energy vary with the square of vehicle speed. From the MAG travel demand model, Salt River Area truck speed was estimated to average 35 miles per hour. At this speed, the bow wake emission factor was computed to be 4.24 g/mi (= 12.47 g/mi x $\{35 \text{ mph}/65 \text{ mph}\}^2$) at 35 miles per hour.

MAG also computed windblown PM10 emissions from unpaved shoulders for modeling purposes. For this calculation, MAG used the "All Sites" wind erosion equation published in the 1986 Nickling and Gillies study.[24] Because the emission factor predicted by this equation is a function of the wind speed raised to the 4.355 power, it was concluded that the average hourly emission factor based on the average hourly wind speed would be less than the factor based on wind speeds measured during sub-hour increments. Because five-minute average wind speed data were available from MCAQD for the two monitors during the December 2006 field study period, a statistical analysis of this relationship found the use of five-minute wind data produced an hourly emission factor that was roughly 10% higher than the factor calculated on the basis of the hourly average wind speed. As a result, the statistical model developed from the December 2006 high wind data was used to adjust the Nickling and Gillies equation to account for this phenomenon. The adjusted equation was then used to compute the windblown emission factor for each high wind hour on the high wind design day.

Emission estimates require information on the fraction of travel generated by heavy trucks, and location and extent of unpaved shoulders within the nonattainment area and within the low wind modeling domains. Unpaved shoulder lengths can be multiplied by hourly truck counts to determine bow wake vehicle miles traveled for individual road segments. These estimates can be combined with g/mi bow wake emission factors to produce estimates of fugitive dust emissions.

Data Sources – Visual analysis of aerial photographs and Google Earth images can be used to determine the extent of unpaved shoulders on arterial and secondary roads within the nonattainment area and the modeling domains. Vehicle class count data will be needed for a representative sample of arterial and secondary roads within the nonattainment area and modeling domains. If not available, these data can be collected by either visual observation or through size-specific tube counts. Alternately, the values employed in the MAG analysis can be used.

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[23] "Effectiveness Demonstration of Fugitive Dust Control Measures on Public Unpaved Roads and Unpaved Shoulders on Paved Roads," prepared for the San Joaquin Valley Unified Air Pollution Control District by Desert Research Institute, 1996.

[24] "Evaluation of Aerosol Production Potential of Type Surfaces in Arizona," prepared for Engineering-Science by W.G. Nickling and J.A. Gillies, 1986.

Open Burning – Open burning is a waste disposal tool on central Pinal County lands used for agricultural production, residential occupancy, and commercial activities. Open burning is also used with less frequency to provide fire protection training, building demolition, and destruction of certain hazardous materials. Because of the very small quantity of daily or annual emissions generated by these latter uses, the open burning portion of the emission inventory will focus exclusively on the more frequent, higher emission activities that occur on agricultural, residential, and commercial property.

Data Sources – Emission factors for open burning by activity type will be derived from AP-42 and from research studies conducted in field experiments and burn chamber tests in the western United States over the past 30 years. Activity and location data for each open burning event in 2008 will be extracted from the open burning permit database maintained by PCAQCD.

4.2 High Wind Emissions

As discussed in Section 3, high wind sources typically consist of disturbed soil surfaces that require shielding from the wind, covering of soil surfaces, or the consolidation of wind-entrainable surface particles into wind-resistant matrices in order to reduce PM10 emissions. Control strategies for high wind sources are best developed from the analysis and modeling of design days during which only these sources are contributing to ambient PM10 concentrations. For the purpose of selecting high wind design days, high wind hours were defined as those exceeding a threshold velocity of 12 mph. Additional analyses may be warranted to determine a more precise wind speed threshold velocity for the purpose of determining high wind emissions.

At this point, ADEQ is considering two completely different methods for quantifying emissions under high wind conditions. The first back calculates emission factors for upwind lands by establishing a relationship between monitored concentrations and lands located within footprints determined to be impacting the monitors, based on an analysis of meteorological conditions for specific days and conditions; this method is summarized in a report entitled "A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM_{10} Emissions," which is presented in Appendix I.

The second method replicates the approach MAG employed in quantifying high wind emissions for the Maricopa County's 2008 Periodic Emission Inventory (PEI) for PM10 and MAG's 2012 Five Percent Plan; a copy of MAG's methodology is presented in Appendix J. Effort will be required to adjust the methodology to represent conditions in the Pinal County nonattainment area (e.g., meteorology, land use, precipitation, silt content, soil texture, agricultural activity, etc.). Maricopa County's 2008 PEI cited local conditions that did not reconcile with the certain underlying wind tunnel studies, and relied upon a long-established low-wind inventory to justify a "standardization" to reduce the calculated annual windblown PM10 inventory. Prevailing conditions in Pinal County may not justify such "standardization" of wind-generated emissions. In general, activity rates and emission factors for a number of areally dispersed fugitive dust sources are

extremely difficult to quantify.[25] As such, EPA has requested that a modeling analysis be prepared to assess how well the two methods represent monitored concentrations.

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[25] Air Quality Criteria for Particulate Matter, Vol. 1, EPA/600/P-99/002aF, U.S. Environmental Protection Agency, October 2004

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5. QUALITY ASSURANCE

This section presents a review of the QA procedures to be employed during the development of the emission inventories. It includes all of the critical elements recommended in the U.S. EPA documents cited in the Introduction, as well as guidance provided through the Emission Inventory Improvement Program (EIIP). It also provides written instructions for the technical and quality aspects associated with development of the new emission inventories. It is designed so that QA and quality control (QC) procedures are implemented throughout the entire inventory development process. This will ensure that the inventories are as complete, accurate, comparable, and representative as possible.

Inventory tasks and QC procedures will include data checking by the inventory development team (IDT) throughout the development of the inventory and final emission report. These procedures include, but are not limited to, the following:

- The development and implementation of written procedures for data collection, data assessment, data handling, calculation of emissions, and reporting;
- Adequate management and supervision of the work;
- Review of all calculations for technical soundness and accuracy, including verification that the appropriate emission factors were used and the impacts of controls were correctly addressed;
- Correct assignment of Source Category Codes;
- Assignment of DARS scores;
- Use of technically sound approaches when developing results based on engineering judgment;
- Documentation of the data in a manner that will allow reconstruction of all inventory development activities; and
- Maintenance of an orderly master file of all the data gathered and a copy-ready version of the final inventory submitted to the U.S. EPA.

The emission inventories developed in accordance with this plan are for SIP development and are considered Level II inventories, based on guidance provided by the 1996 EIIP. The estimates contained in the inventories will be used to make decisions about the need for and types of control strategies required to ensure short-term attainment and long-term compliance with the NAAQS. As a result, they must satisfy applicable QA requirements.

The first step in this process is establishing the data quality objectives (DQO) for the new inventories. Table 5-1 summarizes the procedures to be employed in meeting the DQOs, showing that considerable effort will be focused on meeting accuracy, completeness, representativeness, and comparability objectives.

Table 5-1
Data Quality Objectives

DQO	Procedure for Achieving Objective
Accuracy	For point and onroad mobile sources, the data generator will check 100% of the calculations, and another equally qualified inventory development team (IDT) member will check 20% of the calculations. For area and nonroad mobile sources, the data generator will check 100% of the calculations, and another equally qualified IDT member will check 10% of the calculations. In all cases, the data validator will develop a written summary of his or her activities, and will conduct follow-up activities to ensure that data are corrected as needed. If more than 5% of the calculations checked by the data validator need to be revised, then 100% of the calculations will be checked.
Completeness	Extensive planning will be conducted prior to data collection to identify all applicable emission sources. After identifying these sources, the goal will be to determine 100% of the emissions from the largest emitting sources from each source category and as many of the minor sources as possible within the time frame allotted for the work. Those sources identified but not included in the inventory will be identified in the data file and final report.
Representativeness	Technical personnel will review all of the primary source data and compare them to previous emission results and similar results from comparable regions to determine the reasonableness of the emissions estimates and representativeness of the data.
Comparability	To ensure that the data are comparable, standard procedures will be followed and results for the NAA will be presented in the same units that were used in the NEI inventories.

Table 5-2 shows the data quality indicators (DQIs) that will be used to measure progress towards the DQOs. The Data Attribute Rating System (DARS)[26] will be used to verify the desired inventory accuracy.

Table 5-2
Data Quality Indicators

DQO	Inventory DQI Target Values
Accuracy	Achieve DARS score >= 0.7 for all area sources contributing >10% of total emissions Achieve DARS score >=0.8 for all point sources >=100 tons per year (TPY) Achieve DARS score >=0.7 for onroad mobile source inventory Achieve DARS score <=0.5 for nonroad mobile source inventory.
Completeness	100% of all point sources >=100 tpy 90% of all other point sources
Representativeness	Monitor specific low and high wind source characterization
Comparability	Results for the NAA will be compared to NEI pollutant inventories.

5.1 Managerial Responsibilities

ADEQ will lead the preparation of the nonattainment area emission inventories. Key assignments shall include those outlined below.

State Inventory Coordinator – The State Inventory Coordinator will be responsible for planning and managing all inventory development activities, including the development of the QAP and the final emissions report.

Source Inventory Development Managers – Source Inventory Development Managers will be responsible for planning and leading source-specific inventory development activities.

QA/QC Coordinator – The QA/QC Coordinator will be responsible for ensuring that adequate QA/QC procedures are incorporated into the inventory development process. The Coordinator will conduct QA training and revise the audit schedule as needed so that all critical phases of the inventory development process are audited prior to generation of the emission report. The QA Coordinator will attend status meetings (by teleconference if necessary) held by the Inventory Development Managers and use the information from

[26] Beck, L.L., R.L Peer, L.A. Bravo, and Y. Yan, "A Data Attribute Rating System," presented at the Air & Waste Management Association Specialty Conference on Emission Inventory Issues, Raleigh, North Carolina, November 1994

these meetings to revise the audit schedule, when appropriate, to ensure that the audit objectives are met.

The QA Coordinator will categorize and use the audit findings to evaluate the effectiveness of QC measures and QA audits. The QA/QC program will be revised to address trends that suggest that the technical and data quality objectives are not being achieved.

The QA Coordinator's responsibilities and activities are as follows:

- Help develop the QAP;
- Develop the audit checklist and audit schedule;
- Provide QA training to inventory development and QA personnel;
- Attend inventory status meetings;
- Schedule audits, conduct audits, and report findings;
- Evaluate audit findings to determine if trends exist, and keep management informed of results;
- Follow up on recommendation for corrective actions;
- Keep the Inventory Development Manager informed of audit results;
- Work with the SIP Program Manager to resolve any quality concerns that cannot be resolved at the inventory management level; and
- Maintain a file of audit findings and corresponding corrective actions.

The QA Coordinator reports directly to the State Inventory Coordinator and indirectly to the managers overseeing the development of the inventory. These reporting lines help provide an objective approach to the implementation of the QA program and reporting of quality issues.

5.2 Schedule

The schedule includes the following tasks/completion dates:

- Data collection, including field measurements – January 31, 2013

- Inventory development, including source specific emission estimates and selection of high wind estimation method – March 29, 2013

5.3 General QA/QC Procedures

QA/QC procedures described in this QAP were developed to help ensure data accuracy, completeness, representativeness, and comparability. These procedures have been incorporated in the technical procedures, where applicable, and will be implemented by the IDT throughout the planning, data collection, emission estimation, and reporting phases of the inventory development program.

QC procedures will be implemented by the IDT during inventory development to meet the technical objectives and DQOs. These activities will be conducted at the following steps in the inventory development process:

- Data collection;
- Data documentation;
- Calculation of emissions;
- Data checking and DARS scoring;
- Reporting; and
- Maintenance of the master file.

Data collection will be conducted according to U.S. EPA-approved procedures. The approach and supporting documents or references will be thoroughly documented and included in the emissions report. The documents identified in Table 5-3 will be used to determine the best data-collection approach for each emission source type. Some data sources identified in these documents are also listed in Table 5-3. All data sources will be thoroughly documented by the IDT. The IDT will also document when required data needed for specific source categories cannot be obtained or do not apply. The reason for not including a source or source category in the inventory will be clearly explained in the documentation.

All activities conducted by the IDT will be documented. The traditional approach is to use bound notebooks with indices to facilitate the retrieval of recorded information. An alternate approach is to record activities electronically and make this information available to team members located in different parts of the state. To enhance communication and productivity, team members will be allowed to employ either approach but will be encouraged to track information relative to the development of the inventory electronically. This daily log of activities will help another IDT member reproduce the emission results and allow an evaluation of data accuracy and completeness.

Table 5-3 Data Collection Guidance Documents		
Source Type	Guidance Document	Suggested Data Sources
Point	EPA-450/4-91-016[a] AP-42[b] EIIP Volume II	Existing inventories, state permit files, facility surveys, county business directories, telephone directory
Area	EPA-45-/4-91-016[a] EIIP Volume III	Existing inventories, example cases and data sources
Nonroad Mobile	EPA-450/4-81-026d[c]	Existing inventories, example cases, and data sources
Onroad Mobile	EPA-45-/4-91-010[d] EPA-450/4-91-011[e] EIIP Volume IV	Transportation or planning agency data

a."Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources," U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1991.
b. "Compilation of Air Pollutant Emission Factors, 5th Edition and Supplements, AP-42," U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina,1995.
c. "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," U.S. EPA, Office of Mobile Sources, Ann Arbor, Michigan, 1992.
d. "Emission Inventory Requirements for Ozone State Implementation Plans," U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1991.
e. "Emission Inventory Requirements for Carbon Monoxide State Implementation Plans, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1992.

The following procedures are to be followed when documenting data in notebooks:

- Data will recorded legibly and in black ink;
- Entries will be corrected by drawing a single line through the data and writing the correct data above or below the correction (with initials, date, and explanation of corrections to allow reconstruction of the work);
- Complete descriptions of all data sources will be included (references to be included in final inventory report);
- Units of measurements will provided for emission sources that are omitted from the final inventory (justification required in report);
- The procedures used to calculate emission will be described and example calculations will be provided;
- The approach used to determine completeness for each source type will be described;

- Documents from which emission factors are taken will be identified and referenced; and

- The source, agency, group, or company providing information by telephone will be identified (include telephone number and date information was provided).

Worksheets and contact reports may also be used to maintain records of data sources or calculations; however, the same guidelines must be followed when recording information on them. A file will be developed specifically for these forms to ensure that they are retained and are easily located when the data are needed to calculate emissions. A contact report should include the date of contact; originator name, title, organization, and address of person contacted; and a summary. All worksheets, electronic spreadsheets, and notebooks will be reviewed periodically by the inventory development task leaders to determine whether the procedures described above are being followed. This review should be evidenced by a dated signature on the notebook pages or worksheets reviewed (i.e., reviewed by _____ on _____).

Data used in calculation emissions should be checked for data accuracy, reasonableness, and completeness. The results from data checking will be documented to further qualify the emission estimates. In addition to the DARS scores assigned, the number of data points checked assists reviewers in evaluating the accuracy of the completed emissions report. Documentation of DARS scoring and data checking should include descriptions of the rationale for scoring, the data checked, and the dated signature of the reviewer. An example area source form that will be used to document the data checked and the findings can be found in EIIP Volume VI, Chapter 5, Section 5, Figure 5.2.

QA activities are not directly involved in the development of the inventory. These include assessments of the effectiveness and appropriateness of the systems established by management to control data quality. This includes evaluations of the management and supervision of the work.

QA activities will include QA training and the conduct of a series of independent audits to assess the effectiveness of the QC system and management of inventory development activities. The QA coordinator and other trained personnel who are not involved in the inventory development process will conduct these activities.

Training/Education – Initial training sessions for the ADEC IDT will be conducted to discuss the items on the audit checklist and QA/QC requirements specified in this document. The QA Coordinator will conduct additional training when audits reveal the need for more QC measures or revision of existing procedures.

Occurrences that may lead to additional QA training include those listed below.

- An audit reveals a lack of understanding of QA/QC requirements or the need to develop additional QC measures.

- An audit reveals the need to provide guidance on acceptable data handling procedures because data are not maintained in a manner that allows easy verification of the accuracy of emission results and source of the supporting data.

- An audit reveals unacceptable data documentation practices that lead to entry errors or an inability to recreate emission results.

- An audit reveals that the internal data reviews do not adequately control data entry and calculation errors.

- The Inventory Development Manager requests QA training for new IDT member.

The QA coordinator will conduct the training and maintain records of each training session.

Audits – Audits will be conducted at key points in the inventory development process. These will include assessments as the inventory development process is being planned, during data collection, as emissions are being calculated, and when the results are reported. The primary goal of the audit program is to prevent quality concerns. Opportunities to incorporate preventative measures will be included during each audit.

Prior to announced audits, the auditor will inform the persons to be interviewed of the date and time of the audit and data systems to be reviewed. All of the personnel involved in inventory activities being audited will be asked to be available to respond to questions about their duties. The responses will then be compared to the requirements specified in this document and other referenced documents to determine compliance with approved procedures.

Questions that will be asked by the auditor and data to be evaluated during the audits vary by source type. The QA Coordinator will use the results of previous audits and work with the Inventory Development Manager to develop source-specific audit checklists. Example checklists for technical systems and data audits are provided in EIIP, Volume VI, Chapter 5, Appendices A, B, and C. After developing the checklists, QA training will be held to inform the IDT of the steps in the inventory development process that are considered to be of concern. These meetings will be used to increase the team's awareness of the points in the inventory development process that may require more QC and managerial oversight.

Data audits will be conducted after major data transcriptions and calculations. The auditor will evaluate consistency in data entry and manipulation between IDT members. The results from the audits will be immediately shared with the data generator and the Inventory Development Manager. IDT members involved in the audit will be asked to respond immediately to the findings that will be informally discussed after the audit.

Audit findings will be documented on the audit checklist. The audit checklist and notes will be used to summarize the preliminary findings for the IDT and Inventory Development Manager after the audit. The checklist and notes will also be used to

develop the audit report, which will be included in the QA documentation section in the inventory report.

The audit report will describe each deviation from approved procedures or finding that could compromise the successful outcome of the inventory. Documentation of each finding will include a description of the action or data reviewed that led to the quality concern and recommendation for corrective action.

At a minimum, the audit report will include the following:

- Name of auditor, Inventory Development Manager, and IDT members audited;
- Audit date;
- Audit type;
- Audit objectives;
- Audit findings; and
- Recommendations for corrective actions.

Audit reports will be distributed within two weeks of the completion of each audit to the persons interviewed and the Inventory Development Manager. A summary of the types of quality concerns found will be periodically forwarded to the Section Manager to keep her informed of the quality issues found and actions being taken to resolve them. Audit reports will be retained in a QA file and used to conduct subsequent audits and plan follow-up activities.

Recommendations for corrective actions will be presented in the audit report. Findings and actions implemented in response to each recommendation should be documented and included in the audit file on a response form. The response form should include the date, originator, problem identification, priority of problem, recommended action, problem resolution, and QA verification (a sample form is included in EIIP Volume VI, Chapter 5, Figure 2-3). The auditor will use the information on the response form to monitor the types of problems found and the phases of the inventory development process that may need additional QC to eliminate recurring quality concerns.

The urgency of the response is determined by the category of the finding, as listed below.

Priority 1: Potential for major revisions needed
Priority 2: Potential for failure to achieve DQOs
Priority 3: Suggested improvements.

Priority 1 and 2 will be immediately brought to the attention of upper management and the planned implementation dates for the corrective actions will be as soon as possible after the audit. The planned implementation date for Priority 3 findings may be later than the dates proposed for implementing actions taken in response to Priority 1 and 2 findings.

Follow-up activities will be conducted as frequently as required by the Inventory Development Manager and auditors to determine whether the recommended actions are taken. Each effort to assess the implementation of the corrective action will be documented and maintained by the QA Coordinator in an audit file established for these records.

Follow-up activities could include the conduct of additional audits or informal assessments of the data or system of concern. The type of reevaluation will be determined by considering the impact that the quality concern could have on the technical objectives and DQOs.

5.4 Data Reporting

Reporting will be accomplished by submitting written documentation and emissions summaries to the U.S. EPA. All supporting documentation, project notebooks, data sheets, and calculations shall be submitted for review.

The report will include summary tables, raw listings of equipment, activity levels and emissions from individual sources, and a QA documentation section. A detailed inventory report allows baseline inventories to be compared between one area and another and the impact of control strategies to be evaluated, and also facilitates updates to the inventory and development of projection inventories.

In addition to EIIP guidance, the U.S. EPA reports cited in the introduction will be followed. These documents provide guidance for presenting and documenting SIP emissions inventories, and contain examples of how to present and verify inventory development efforts. The QA documentation section of the emissions inventory will provide enough detail so that the inventory development described in the report can be compared to the information provided in this QAP. Any discrepancies will be identified and explained.

At a minimum, documentation should describe in general terms how the inventory data were collected and where they came from. Specific details for documentation requirements should be negotiated with the EPA regional office. The report will include the components listed below.

- A description of the geographic area included in the inventory, including documentation for any adjustments made to the original designated area. Documentation shall reference all sources of current or projected data, and include maps of boundaries for excluded areas.

- The base year of the emissions inventory.

- The population of the area, and the source of the population data.

- Efforts taken as part of QA program.

- Procedures used to temporally allocate each source category (e.g., selection of the months comprising the seasons, seasonal variations in activity levels at sources, daily variation in activity levels, etc.).

- Procedures used to spatially allocate the emissions inventory. If a dispersion model will be used for control strategy demonstrations, a map of the geographic area with the modeling domain and grid squares overlaid shall be included. The grid square sizes need to be indicated on the map.

The QA documentation section of the inventory report will also include the audit report. As discussed previously, the audit report will describe each deviation from approved procedures or findings that could compromise the successful outcome of the inventory. Documentation of each finding will include a description of the action or data reviewed that led to the quality concern, along with a recommendation for corrective action. The QA documentation section of the inventory report will then discuss how the recommended corrective actions were implemented.

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Appendix A

2008 24-Hour Average PM10 Concentrations Recorded at Six Pinal County TEOM Monitoring Sites

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CASA GRANDE PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	120.0	29.4	41.3	69.3	60.9	50.1	42.4	50.0	12.3	58.9	78.3	37.4
2	35.6	23.6	65.2	46.4	47.9	57.7	53.3	36.3	30.5	75.0	52.4	36.8
3	51.8	26.1	21.6	46.2	50.6	59.1	70.2	37.5	25.8	52.3	54.0	44.2
4	33.9	10.5	46.3	41.0	39.5	61.8	42.9	26.1	34.7	48.5	44.3	53.6
5	24.1	15.0	56.0	51.8	58.7	63.6	44.4	49.6	46.8	70.0	52.4	46.7
6	8.4	19.6	38.2	27.5	41.7	42.1	55.7	19.6	50.5	46.6	48.9	59.0
7	9.7	26.6	43.9	54.1	28.9	54.3	25.5	115.3	40.7	45.2	66.2	54.3
8	12.9	32.7	47.6	49.9	38.9	43.0	55.2	44.0	64.6	51.5	78.7	26.8
9	18.6	30.9	34.5	58.8	65.3	52.3	27.4	27.8	32.1	48.8	**182.9**	24.8
10	25.8	28.9	38.6	62.8	57.1	53.7	25.1	31.9	25.4	55.7	85.2	25.3
11	31.4	39.5	51.8	46.4	58.5	44.0	24.2	38.6	**202.5**	99.5	55.1	55.1
12	23.1	39.5	53.9	39.8	53.6	39.5	17.9	42.9	49.0	46.4	43.4	53.6
13	16.7	32.3	20.8	38.7	46.8	66.7	17.1	43.4	32.4	51.1	61.5	64.3
14	13.9	37.6	61.4	56.1	37.1	71.8	23.5	23.7	35.9	57.2	70.1	36.5
15	49.5	13.3	47.0	47.3	62.4	61.8	29.2	31.2	49.0	58.0	103.7	25.3
16	34.5	10.6	25.5	64.1	26.1	71.2	31.9	51.1	**AN**	40.7	39.9	9.9
17	24.7	16.2	16.2	38.2	28.7	57.4	39.4	24.6	**AN**	53.3	61.1	11.4
18	41.5	22.5	35.8	55.4	29.7	74.3	38.7	29.1	53.8	52.8	58.3	9.4
19	37.7	28.4	43.2	62.6	57.3	53.0	59.0	29.3	56.3	45.4	94.8	23.4
20	40.4	30.1	47.0	29.2	47.9	65.5	10.7	28.8	35.7	53.6	96.3	21.0
21	30.8	33.2	54.9	40.4	**164.2**	67.5	23.4	34.7	25.4	55.3	113.2	22.5
22	39.2	23.7	50.6	59.4	78.8	103.2	31.6	34.6	44.9	62.0	94.8	22.7
23	42.6	19.4	42.1	75.6	29.4	75.6	27.9	72.2	50.3	77.2	86.8	14.5
24	22.0	20.8	53.3	62.1	26.2	57.3	46.2	40.0	56.4	98.6	77.3	18.9
25	36.3	39.9	55.7	58.6	17.0	63.5	43.9	39.5	44.1	86.6	136.9	11.4
26	32.6	34.3	48.2	66.4	14.6	34.3	20.1	16.4	49.3	74.7	49.7	9.4
27	13.4	26.7	49.7	74.7	27.2	24.5	21.5	24.2	31.5	125.7	7.8	13.3
28	11.9	48.3	49.9	55.7	27.6	34.9	28.4	18.2	31.1	49.5	16.7	16.2
29	27.4	51.9	37.6	62.6	30.6	49.2	28.9	24.3	48.0	74.3	16.3	26.3
30	23.7		51.3	55.4	40.5	37.2	30.9	23.0	47.0	89.5	19.0	30.6
31	13.1		51.0		39.4		54.8	10.6		78.0		60.0

1st quarter average	34.5	2nd quarter average	51.9	3rd quarter average	39.1	4th quarter average	54.3
# of valid samples	91	# of valid samples	91	# of valid samples	90	# of valid samples	92
% of samples collected	100.0%	% of samples collected	100.0%	% of samples collected	97.8%	% of samples collected	100.0%
# of 24 hr exceedances	0	# of 24 hr exceedances	1	# of 24 hr exceedances	1	# of 24 hr exceedances	1

COMBS PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	39.6	53.6	40.9	69.7	67.5	49.8	73.4	89.8	17.4	91.1	69.2	24.0
2	68.5	25.8	31.7	85.4	59.4	60.5	60.7	49.2	29.5	106.2	44.2	26.6
3	66.7	31.1	77.4	62.7	50.1	66.5	74.1	48.8	54.7	78.1	66.6	33.7
4	39.3	8.9	58.0	65.5	40.1	79.6	51.2	54.3	63.0	61.8	64.3	34.8
5	29.4	10.6	58.4	63.4	76.5	98.6	40.0	107.6	62.9	76.5	67.5	44.9
6	8.4	17.8	42.1	37.6	65.0	70.6	67.2	27.9	52.7	71.7	61.3	32.5
7	9.9	26.1	68.2	55.2	65.1	56.5	41.7	85.4	35.0	78.3	61.9	30.4
8	15.9	39.7	35.4	77.5	82.5	62.4	42.9	74.4	94.7	92.5	64.6	22.7
9	18.8	43.5	28.1	75.8	86.4	73.3	44.5	26.2	55.4	61.2	270.0	27.8
10	27.7	29.4	70.3	68.7	83.1	63.6	23.6	27.9	79.5	97.7	105.0	39.3
11	32.6	38.1	63.7	54.4	62.4	46.4	18.5	60.5	194.7	88.0	45.2	52.2
12	28.7	48.8	54.3	46.1	84.2	85.3	17.1	92.2	75.3	51.7	44.1	73.3
13	16.0	86.6	60.3	48.0	62.7	92.4	20.2	97.5	71.2	56.3	70.7	59.6
14	54.6	57.6	79.4	80.0	47.2	65.0	25.6	32.1	39.9	65.2	53.6	39.3
15	60.1	12.4	55.4	79.7	121.1	51.6	42.8	35.9	101.9	70.4	89.9	31.3
16	52.2	7.5	28.3	93.4	56.9	84.0	54.4	34.9	75.2	69.9	40.8	14.4
17	54.2	12.1	32.6	53.5	42.9	81.8	54.9	33.1	76.6	81.1	77.7	11.0
18	57.5	26.3	61.9	81.9	45.2	73.1	59.4	41.5	70.4	62.4	65.9	13.1
19	33.5	40.2	72.9	64.8	59.0	77.7	81.6	54.0	87.3	44.8	75.1	17.8
20	27.9	28.6	76.0	44.0	52.5	97.9	12.7	61.8	41.1	79.0	65.6	17.7
21	41.6	21.8	75.6	65.5	170.7	85.8	30.4	51.3	28.2	86.1	92.2	14.2
22	70.2	27.6	40.1	78.6	72.6	75.9	32.8	77.4	67.0	68.6	63.7	16.5
23	81.4	17.6	43.3	83.5	19.6	73.0	43.4	55.6	70.8	71.1	56.2	13.7
24	49.2	18.0	90.7	72.1	24.5	70.9	48.4	41.1	109.5	82.4	80.0	17.1
25	37.0	36.0	101.4	69.4	19.9	101.0	59.0	67.9	148.2	90.6	113.9	8.5
26	37.7	55.8	94.5	53.5	16.6	54.8	40.9	13.4	59.9	68.7	38.8	8.2
27	12.4	50.0	73.4	93.0	28.8	37.3	36.0	14.4	52.9	121.5	7.3	11.0
28	6.7	60.2	87.8	87.8	34.3	40.9	69.4	23.6	45.5	93.1	10.8	12.1
29	27.3	74.3	51.4	73.2	43.9	61.9	74.0	24.2	192.1	87.2	14.1	24.3
30	16.1		57.7	84.3	54.2	47.1	81.0	33.9	104.5	93.3	16.0	21.1
31	40.5		80.5		52.7		66.1	15.0		101.9		28.4

1st quarter average	44.6	2nd quarter average	65.9	3rd quarter average	57.6	4th quarter average	57.2
# of valid samples	91	# of valid samples	91	# of valid samples	92	# of valid samples	92
% of samples collected	100.00%	% of samples collected	100.00%	% of samples collected	100.00%	% of samples collected	100.00%
# of 24 hr exceedances	0	# of 24 hr exceedances	1	# of 24 hr exceedances	2	# of 24 hr exceedances	1

CWTN 1400 PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	67.7	35.2	111.3	239.0	239.0	133.7	200.3	169.6	26.4	299.8	192.5	42.1
2	86.4	34.5	135.5	230.4	327.4	240.1	172.2	126.1	87.6	286.1	147.5	38.1
3	110.1	30.8	50.9	354.8	306.3	264.2	211.3	137.4	100.5	271.4	219.8	54.1
4	51.3	20.3	167.7	436.1	303.5	216.1	91.3	99.9	126.0	237.7	146.8	63.0
5	44.2	15.7	114.9	240.7	243.5	280.9	88.7	306.4	163.2	188.8	148.9	63.4
6	10.9	15.0	106.4	216.7	303.8	169.4	155.6	56.1	149.3	255.7	207.1	98.6
7	22.8	AN	182.6	323.7	199.7	174.2	77.3	336.4	174.0	153.9	283.7	62.1
8	14.5	AN	106.1	419.9	225.6	226.5	217.9	47.0	172.8	275.6	313.1	45.1
9	19.1	AN	127.8	276.9	272.1	226.0	131.9	41.9	64.2	204.6	527.8	44.2
10	22.5	AN	183.3	301.5	344.1	289.3	104.6	61.9	43.0	177.2	156.0	59.4
11	27.6	68.7	294.2	389.4	352.7	195.7	21.3	76.1	63.7	326.1	177.8	83.4
12	31.4	68.1	159.8	369.6	304.4	228.5	19.9	106.3	70.4	188.3	196.0	91.8
13	23.8	65.2	437.9	163.9	180.4	313.4	49.4	114.7	83.8	168.1	216.1	58.6
14	13.9	123.6	310.3	337.6	200.9	262.7	23.8	70.5	160.9	263.1	264.8	65.2
15	58.4	30.2	224.5	326.4	265.1	217.5	54.8	63.2	83.1	210.1	125.7	59.3
16	47.9	11.9	93.3	376.0	268.7	198.3	98.6	73.7	AN	191.8	45.7	38.8
17	31.8	13.5	206.8	327.4	363.8	195.4	100.3	82.0	AN	344.6	268.5	9.5
18	80.0	28.9	334.1	361.6	290.0	306.3	110.2	102.0	AN	207.6	209.4	21.4
19	63.9	37.8	123.3	306.1	224.1	363.8	128.0	185.0	216.8	218.1	400.5	21.8
20	61.4	75.3	228.7	162.8	375.2	367.8	25.4	199.3	133.7	223.7	345.0	18.4
21	50.7	48.0	539.3	266.6	608.6	250.9	51.9	237.1	173.9	256.3	174.5	19.9
22	88.7	27.6	406.0	213.6	167.8	293.5	64.6	126.4	262.8	172.0	379.7	18.7
23	59.3	55.3	237.7	226.5	27.9	249.4	92.0	239.6	136.4	337.2	268.7	18.9
24	35.5	AN	372.6	336.6	24.8	326.3	149.6	106.6	166.3	273.4	273.5	13.4
25	23.0	AN	496.8	404.6	21.3	196.9	147.3	142.8	75.4	288.2	274.5	9.8
26	57.6	58.4	335.7	246.2	30.8	114.2	21.3	69.4	218.6	367.6	85.9	19.9
27	20.8	54.8	252.9	168.3	58.8	143.8	47.3	53.6	155.9	279.7	13.1	14.9
28	11.4	79.4	273.7	238.0	77.0	165.4	83.4	31.5	104.4	247.9	18.2	17.7
29	26.5	64.0	225.3	334.6	84.8	135.3	121.0	29.1	210.1	188.8	19.1	20.0
30	33.0		267.9	285.0	113.5	242.5	105.5	37.5	241.2	244.5	17.6	43.7
31	14.1		134.7		117.2		143.5	17.0		176.7		54.6

1st quarter average	113.1	2nd quarter average	250.5	3rd quarter average	116.0	4th quarter average	162.3
# of valid samples	85	# of valid samples	91	# of valid samples	89	# of valid samples	92
% of samples collected	93.4%	% of samples collected	100.0%	% of samples collected	96.7%	% of samples collected	100.0%
# of 24 hr exceedances	21	# of 24 hr exceedances	78	# of 24 hr exceedances	24	# of 24 hr exceedances	50

MARICOPA PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	20.0	37.2	42.8	63.9	56.8	45.2	106.1	67.7	16.9	73.9	89.5	45.9
2	134.7	37.4	91.5	62.4	42.2	69.4	87.8	49.3	28.2	98.2	70.9	46.8
3	42.6	24.2	25.3	39.5	59.7	58.0	65.3	37.6	34.5	104.7	88.4	47.4
4	55.3	14.9	50.8	58.8	58.5	103.5	54.2	42.0	41.1	76.8	50.7	65.2
5	29.9	33.3	44.7	85.9	93.9	136.3	34.0	92.7	56.8	82.0	61.6	52.1
6	12.4	27.5	35.2	43.0	54.0	58.6	61.4	29.4	61.0	67.4	65.4	65.5
7	12.7	41.7	42.1	59.7	40.4	71.4	60.9	213.3	57.2	63.9	65.0	62.7
8	17.5	53.4	60.0	70.3	65.2	49.2	108.8	51.4	78.8	79.0	85.8	29.7
9	27.5	39.1	28.8	72.7	114.2	81.9	80.3	26.8	37.5	75.6	520.3	29.3
10	34.4	30.6	56.0	63.0	79.1	71.3	65.4	31.6	30.8	68.7	82.5	31.9
11	42.3	42.4	64.0	48.3	62.0	54.8	15.8	36.2	170.4	157.0	67.2	53.3
12	33.4	51.6	70.2	50.2	104.6	65.1	21.0	50.8	60.6	30.3	77.9	66.8
13	19.5	50.2	72.3	45.2	74.4	78.2	45.9	46.1	21.7	40.8	90.9	61.5
14	16.9	73.1	78.2	56.8	104.8	60.8	23.3	36.4	37.8	38.9	106.5	38.7
15	41.2	19.8	53.3	73.3	94.3	54.1	35.0	35.1	59.2	91.1	58.6	53.6
16	39.6	11.8	30.7	81.7	41.1	67.3	38.3	34.3	31.3	79.6	41.8	16.2
17	25.2	20.3	25.5	48.6	62.6	63.6	50.6	28.3	42.0	100.7	91.4	15.5
18	47.4	29.9	52.0	96.8	52.6	86.6	AN	32.4	61.2	79.3	110.7	25.3
19	34.9	34.1	74.3	75.6	74.3	63.8	AN	38.5	AN	61.3	116.5	37.5
20	35.6	34.7	61.9	38.8	84.2	76.6	AN	45.9	52.8	69.5	125.8	23.4
21	38.2	29.7	69.0	68.2	317.1	87.5	AN	46.8	43.1	73.1	153.2	21.7
22	53.2	27.4	55.3	81.1	86.5	123.1	42.2	49.1	71.7	61.6	93.8	26.5
23	47.7	20.8	46.3	72.5	27.8	106.5	53.7	51.7	63.8	65.4	108.3	21.0
24	36.9	24.6	65.8	61.3	26.0	108.2	61.3	43.1	87.4	136.6	81.1	18.5
25	23.8	39.2	91.2	47.8	18.8	98.6	70.9	99.2	59.3	113.9	129.6	10.5
26	32.9	37.3	63.9	62.5	20.0	68.5	21.1	21.1	67.5	84.0	62.8	14.3
27	15.2	33.6	68.7	54.5	34.3	43.3	23.3	38.2	55.3	159.4	9.6	17.4
28	16.5	51.5	76.4	73.6	34.4	47.5	32.1	AN	31.2	72.6	14.7	16.2
29	37.7	63.3	63.8	95.7	29.2	56.0	50.2	AN	75.8	106.5	18.1	23.3
30	30.7		91.2	75.4	49.8	80.0	52.4	27.2	51.4	103.2	22.5	32.8
31	20.1		39.9		43.4		64.1	13.6		114.0		33.7

1st quarter average	42.9	2nd quarter average	68.9	3rd quarter average	52.1	4th quarter average	70.6
# of valid samples	91	# of valid samples	91	# of valid samples	85	# of valid samples	92
% of samples collected	100.00%	% of samples collected	100.00%	% of samples collected	92.39%	% of samples collected	100.00%
# of 24 hr exceedances	0	# of 24 hr exceedances	1	# of 24 hr exceedances	2	# of 24 hr exceedances	3

PINAL COUNTY HOUSING PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	264.9	29.6	50.6	76.9	62.8	64.7	159.2	76.5	16.0	79.5	122.1	36.9
2	71.8	23.9	51.5	62.4	67.0	58.5	64.6	69.6	32.4	118.3	77.2	41.9
3	53.9	34.7	36.4	57.3	106.5	63.6	106.2	32.7	47.7	85.6	72.9	45.2
4	32.1	8.6	55.4	69.9	60.6	99.3	67.1	39.6	50.7	144.6	57.6	100.5
5	33.4	7.5	61.7	72.0	63.3	64.7	61.9	59.8	80.7	81.1	93.7	68.3
6	9.0	12.3	75.9	36.3	113.3	93.9	75.8	22.0	65.2	93.7	120.6	66.7
7	9.4	36.4	65.8	64.1	47.6	79.4	22.8	60.5	53.8	101.4	96.5	54.1
8	7.8	19.4	64.0	70.3	68.4	71.0	55.1	69.3	129.9	95.4	122.3	BJ
9	11.8	24.7	54.7	71.4	88.6	80.7	33.4	31.0	68.1	70.4	285.2	BJ
10	15.2	27.6	51.9	59.6	130.8	65.6	23.4	38.2	33.6	71.9	81.2	46.6
11	23.3	29.7	63.9	64.9	AN	62.2	22.4	50.4	217.1	97.5	47.3	77.9
12	18.1	32.6	56.7	116.5	AN	76.8	17.4	60.1	55.9	50.1	50.3	93.2
13	18.3	27.1	60.3	65.5	AN	100.4	24.0	58.7	40.1	85.9	86.4	141.0
14	17.1	50.6	66.1	77.2	52.4	110.2	27.2	25.4	70.3	88.5	83.5	30.8
15	23.5	12.3	54.8	64.9	221.1	64.0	37.3	204.1	92.3	78.3	81.3	20.3
16	38.4	8.1	37.5	78.8	36.9	75.5	55.3	89.1	46.7	90.8	47.7	14.7
17	44.0	12.1	29.7	67.7	AN	80.0	77.9	22.2	64.4	81.2	81.5	11.3
18	60.1	18.1	45.5	102.7	AN	105.6	61.0	42.0	80.0	62.5	79.5	10.1
19	43.7	24.4	83.1	102.3	AN	88.0	77.9	43.5	87.3	60.7	130.3	22.4
20	42.0	19.6	75.9	46.9	64.0	110.9	12.9	54.3	61.0	79.5	160.6	22.2
21	46.9	34.1	73.5	67.4	273.8	86.4	24.7	66.3	31.7	78.2	98.8	31.1
22	68.0	18.5	78.3	73.8	98.7	141.6	49.4	66.8	60.7	94.5	116.3	29.5
23	58.7	24.5	72.4	83.0	24.4	89.7	46.5	67.7	59.1	106.2	94.4	13.3
24	27.4	25.1	69.9	83.8	25.6	73.9	54.1	57.1	57.0	117.7	84.4	13.7
25	37.6	50.4	107.5	94.8	18.6	103.3	71.2	45.9	65.5	89.7	AN	36.3
26	53.0	42.1	80.2	75.1	17.6	71.0	27.5	15.1	56.4	85.3	AN	30.9
27	14.3	38.4	63.7	127.7	33.1	33.6	29.1	23.6	66.4	153.3	9.3	11.5
28	5.8	44.1	95.6	83.7	33.8	55.3	52.2	19.7	47.9	78.6	13.4	15.0
29	20.1	63.2	49.2	72.4	44.9	68.3	74.8	16.6	68.3	178.0	28.2	22.5
30	16.7		80.1	106.0	51.8	64.2	59.8	22.6	86.9	140.7	19.8	33.3
31	14.0		66.8		49.6		96.9	37.6		159.1		40.1

1st quarter average	43.7	2nd quarter average	77.1	3rd quarter average	57.1	4th quarter average	75.2
# of valid samples	91	# of valid samples	85	# of valid samples	92	# of valid samples	88
% of samples collected	100.00%	% of samples collected	93.41%	% of samples collected	100.00%	% of samples collected	95.65%
# of 24 hr exceedances	1	# of 24 hr exceedances	2	# of 24 hr exceedances	3	# of 24 hr exceedances	4

STANFIELD PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	255.3	24.2	52.3	57.4	57.3	52.6	127.5	74.8	20.8	96.6	137.8	34.1
2	61.8	23.8	141.9	50.3	72.2	71.6	116.4	60.9	33.1	105.8	64.8	46.0
3	58.9	45.2	49.3	67.5	106.3	79.5	157.8	54.5	34.3	56.2	70.2	49.5
4	40.0	14.5	45.3	55.2	43.0	114.4	43.4	52.5	48.8	74.0	63.0	51.8
5	21.5	12.3	44.7	75.9	125.2	76.2	57.0	115.3	43.9	76.1	83.0	50.0
6	10.1	19.7	49.6	44.9	43.2	59.4	44.3	35.2	59.1	118.3	108.6	70.0
7	10.6	22.7	58.5	76.0	43.4	69.7	67.1	364.3	65.2	105.3	112.5	52.8
8	10.0	34.7	54.4	46.3	81.8	54.5	86.6	58.3	264.2	86.3	82.5	18.3
9	9.7	31.6	62.4	66.6	79.7	111.4	41.8	31.2	36.5	49.6	375.1	24.5
10	13.8	26.3	66.8	104.9	161.7	60.6	29.5	40.7	31.4	98.6	92.3	31.0
11	22.2	33.0	60.3	68.9	56.9	54.4	24.4	67.7	178.2	103.6	57.8	62.7
12	21.3	38.0	75.2	144.2	83.9	102.3	20.4	90.7	55.1	83.0	99.3	70.9
13	20.4	40.9	49.1	152.9	89.0	115.0	44.2	53.4	42.0	104.7	73.3	178.2
14	36.5	57.3	74.0	97.1	56.2	146.6	29.5	37.4	51.8	94.5	89.7	46.7
15	39.3	18.4	69.9	58.2	89.6	134.3	26.5	33.8	65.4	119.6	240.7	41.7
16	30.4	10.2	25.3	95.3	65.7	107.7	36.4	63.3	35.9	115.1	75.8	69.9
17	29.7	14.9	18.6	49.6	55.2	89.1	49.2	32.0	36.1	131.6	141.9	8.8
18	40.0	18.2	49.0	82.1	46.9	83.7	52.0	46.8	75.3	91.2	153.7	8.5
19	40.5	28.8	56.8	88.3	115.4	84.2	101.2	42.1	52.8	67.2	117.0	16.1
20	30.4	24.7	65.7	49.0	61.6	126.8	13.6	41.1	47.8	107.5	123.9	16.9
21	27.5	28.2	64.6	AN	323.0	106.3	24.5	54.7	25.6	94.1	178.6	16.2
22	51.3	17.4	83.5	100.4	134.1	149.3	41.9	71.2	56.3	91.5	138.6	17.6
23	42.7	18.5	153.0	141.4	25.2	103.2	60.2	100.7	73.7	AV	102.1	11.9
24	19.7	26.2	112.5	67.8	24.4	79.4	145.5	99.8	74.6	AV	116.2	16.9
25	22.9	38.0	94.1	145.3	19.2	105.9	67.4	49.0	64.7	125.7	149.8	26.7
26	33.0	48.1	57.3	207.5	18.8	52.2	24.2	23.8	65.8	86.2	55.4	6.5
27	14.5	44.2	57.8	125.4	30.3	47.1	28.6	58.0	64.4	212.6	7.4	9.3
28	10.1	60.0	62.2	92.6	30.3	73.9	49.4	14.5	56.5	87.8	8.8	11.9
29	22.7	60.5	66.6	63.1	36.9	78.7	57.2	18.9	79.8	162.1	19.3	18.3
30	28.5		60.3	89.1	53.4	70.9	78.2	34.6	122.2	131.3	20.8	26.8
31	14.0		71.2		75.1		70.5	10.9		121.0		31.0

1st quarter average	44.2	2nd quarter average	83.7	3rd quarter average	62.1	4th quarter average	81.1
# of valid samples	91	# of valid samples	90	# of valid samples	92	# of valid samples	90
% of samples collected	100.00%	% of samples collected	98.90%	% of samples collected	100.00%	% of samples collected	97.83%
# of 24 hr exceedances	1	# of 24 hr exceedances	3	# of 24 hr exceedances	4	# of 24 hr exceedances	6

Corresponding Color Codings		AQS Codings
24 hour exceedances	any sample > 154.5 ug/m^3	
PCAQCD Exceptional Event	HIGH WIND EVENTS	
	HIGH WIND EVENTS - EPA CONCURRED.	###[A]
Noise excedences	when the noise on the monitor is greater than 1.0 for more than 1 hour	AN
Status flow out of range	flow out of range for more than 1 hour	AH
	status codes other than 0 for more than 1 hour	AN
General maintenance	monitor is down for general maintenance activities or filter exchanges for more than 1 hour	BA
Negative data readings	data readings > - 10.4 ug/m^3 or	AI
	Operator Error for more than 1 hour	BJ
Power failures	power outage for more than 1 hour	AV
CAL / VER / AUDIT	monitor is down to perform monthly verification or	AT
	annual system calibrations or	AT
	bi-weekly flow verification or	AX
	QC Audit (ADEQ) for more than 1 hour	AZ

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Appendix B

Plots of Hourly PM10 Concentration, Wind Speed, Wind Direction, and Mixing Height Recorded or Modeled at Cowtown, Pinal County Housing, and Stanfield Monitoring Sites on October 29, 2008

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STAGNATION DAY, 10/29/2008, COWTOWN

Figure B1. PM10 vs. Wind Speed

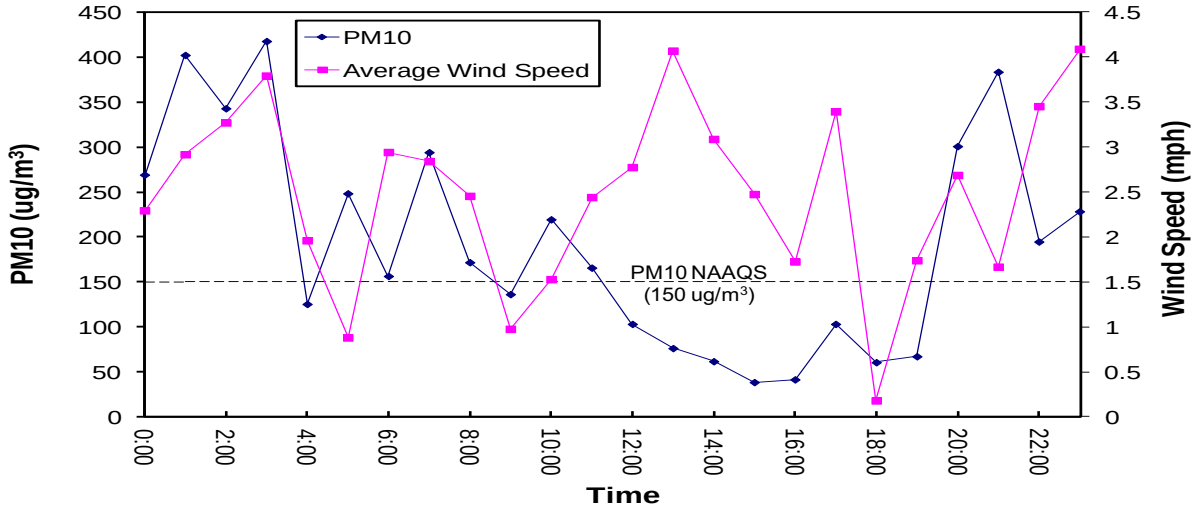


Figure B2. Wind Direction vs. Wind Speed

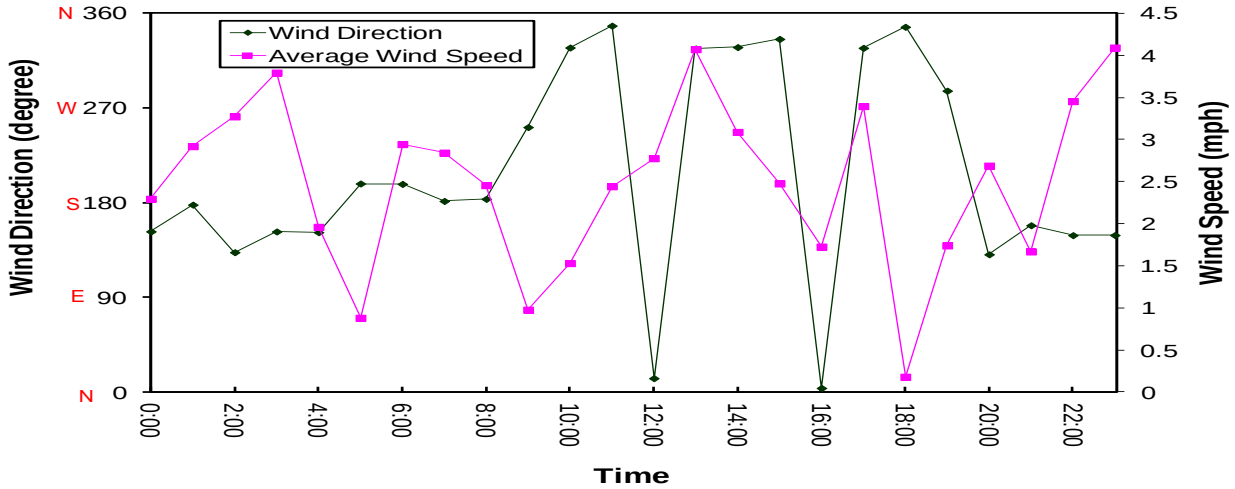
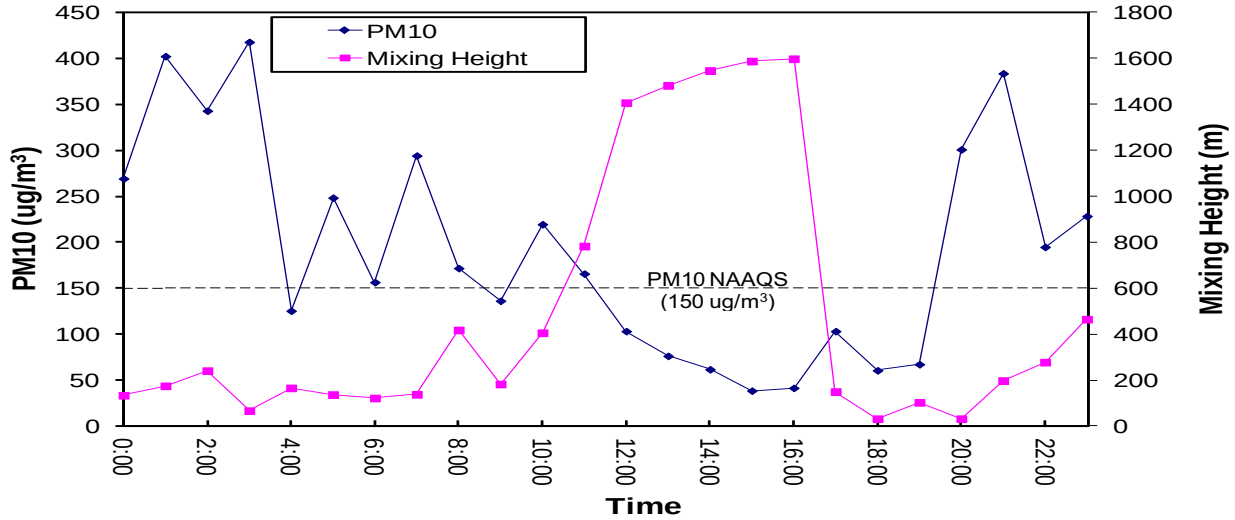


Figure B3. PM10 vs. Mixing Height



STAGNATION DAY, 10/29/2008, PINAL COUNTY HOUSING

Figure B4. PM10 vs. Wind Speed

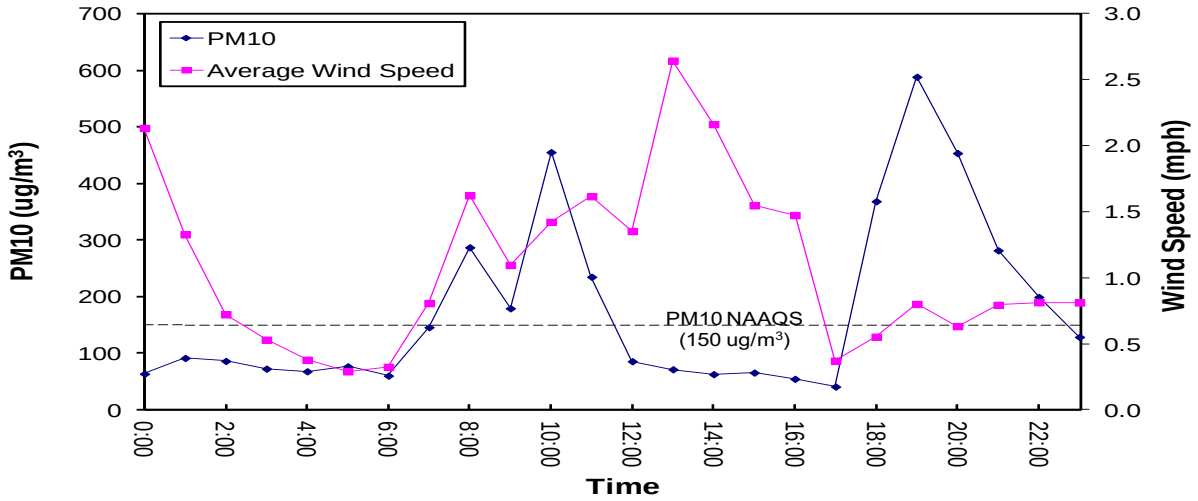


Figure B5. Wind Direction vs. Wind Speed

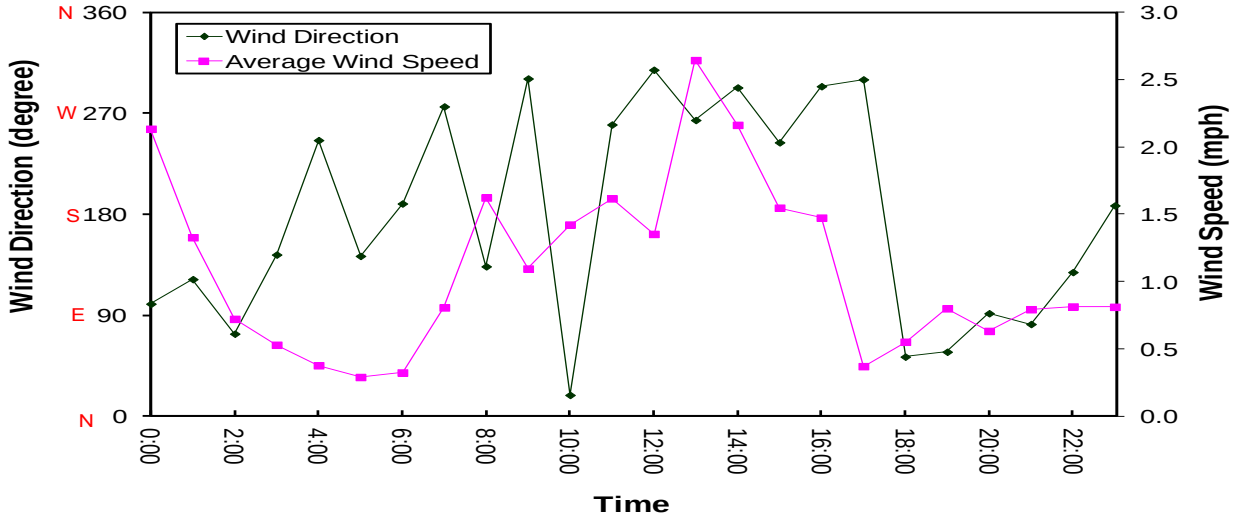
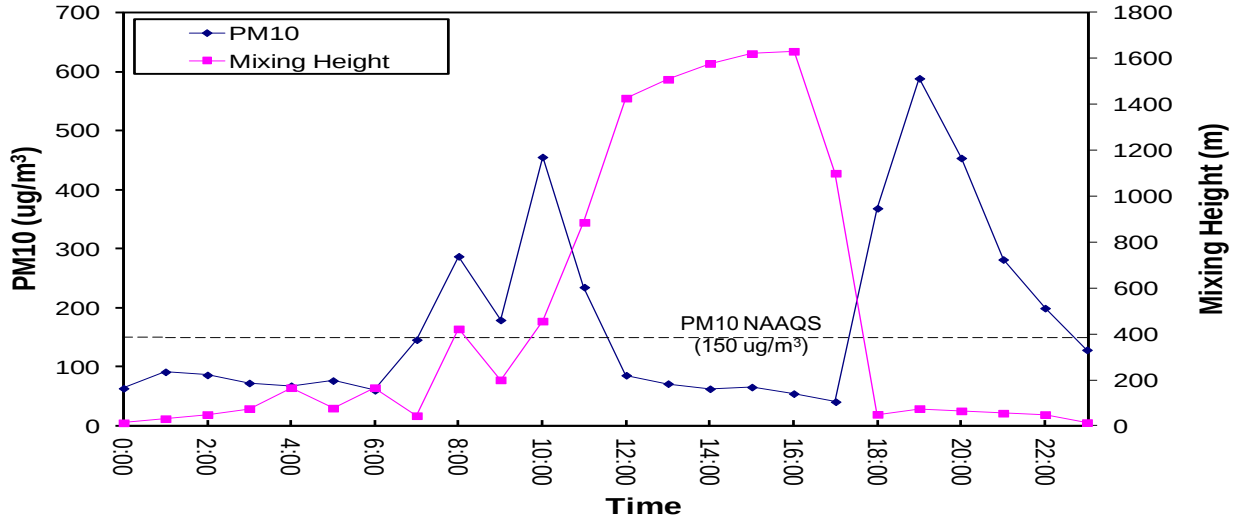


Figure B6. PM10 vs. Mixing Height



STAGNATION DAY, 10/29/2008, STANFIELD

Figure B7. PM10 vs. Wind Speed

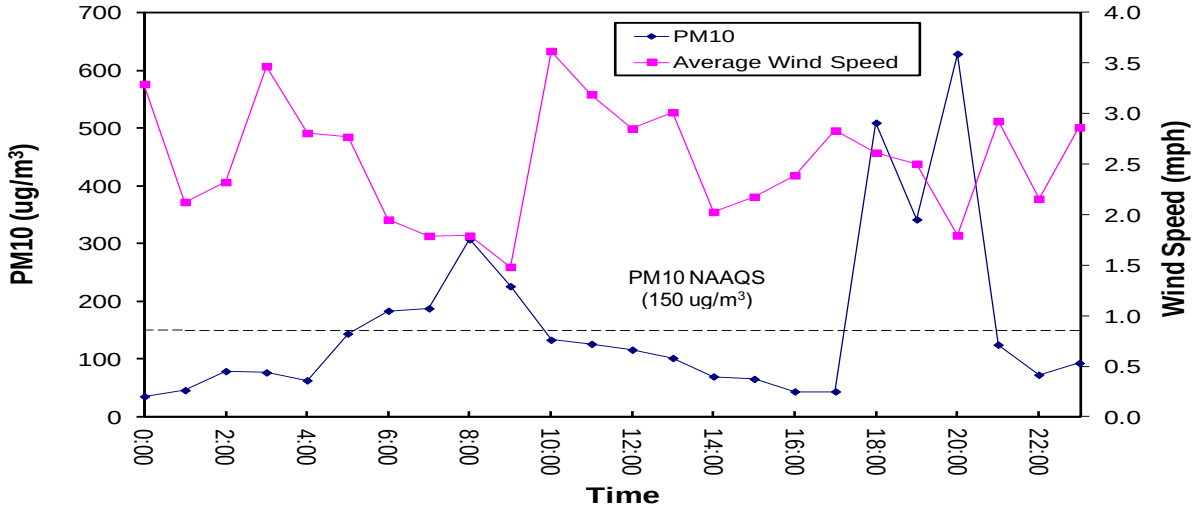


Figure B8. Wind Direction vs. Wind Speed

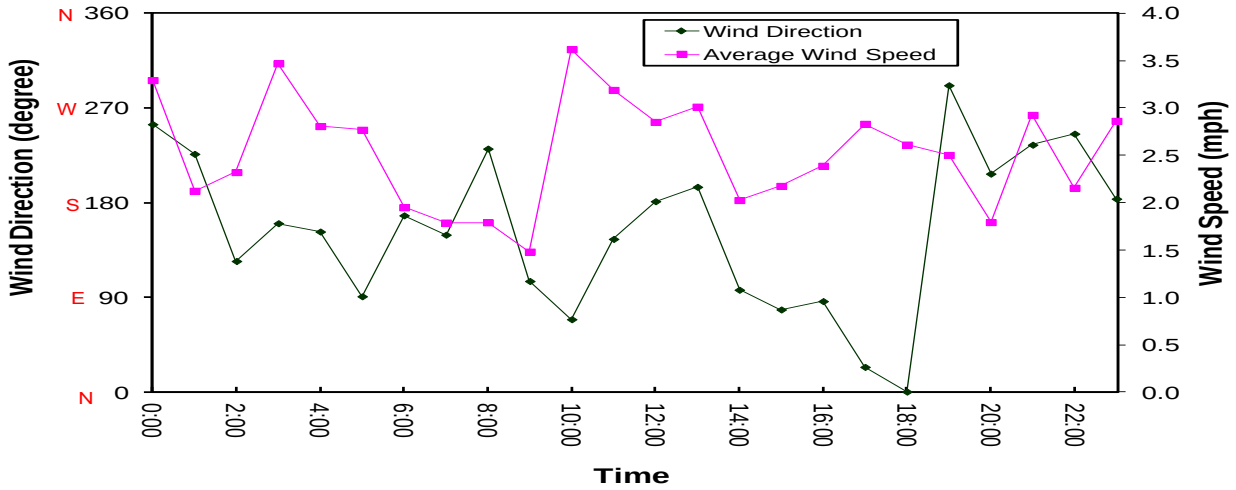
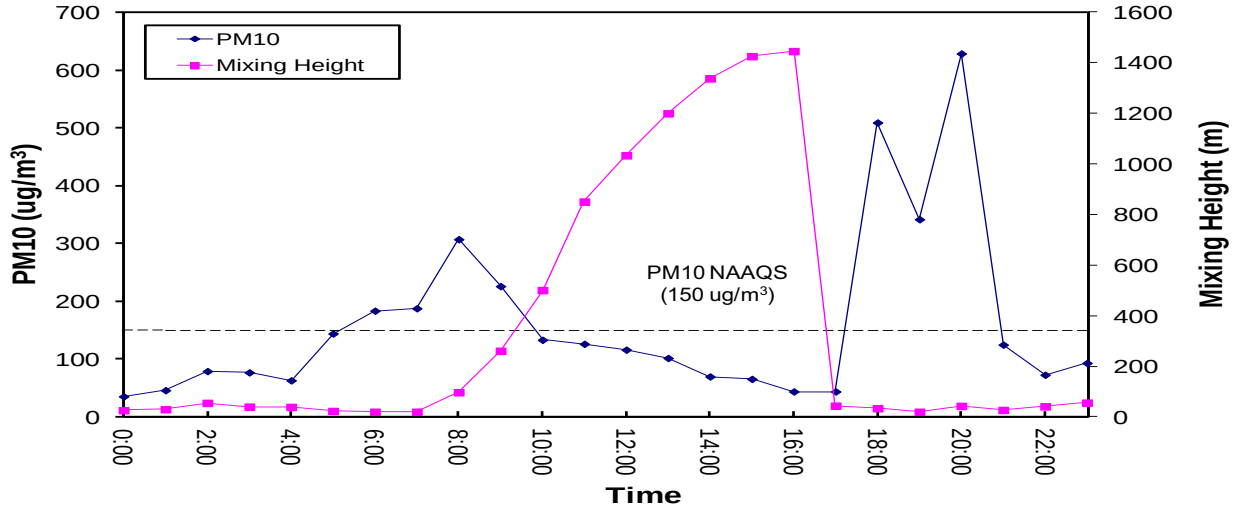


Figure B9. PM10 vs. Mixing Height



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Appendix C

Statistics of the High Wind PM10 Exceedance Days at Cowtown in 2008

Table C1. Statistics of the PM10 High Wind Exceedance Days at Cowtown in 2008

Date	Number of High Wind Hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10	Number of High Wind Non-feedlot Hours
5/21/2008	12	609	11	19	0.643	0
11/9/2008	10	528	12	22	0.540	0
4/8/2008	1	385	6	12	-0.118	0
4/16/2008	4	376	4	16	0.432	0
4/15/2008	2	326	7	14	-0.464	0
8/7/2008	3	336	6	22	0.498	0
10/11/2008	12	326	11	18	0.462	0
3/14/2008	5	310	8	13	-0.237	0
6/18/2008	2	306	6	13	-0.326	0
8/5/2008	1	306	5	16	0.384	1
5/6/2008	3	304	7	16	-0.034	0
5/12/2008	3	304	8	15	0.236	0
10/27/2008	9	280	10	20	-0.076	9
5/9/2008	1	272	7	13	-0.300	0
4/30/2008	6	285	10	18	0.110	0
4/9/2008	1	277	8	12	-0.401	0
5/15/2008	1	265	5	19	0.250	1
3/30/2008	2	268	7	15	0.309	0
5/16/2008	3	269	7	14	-0.427	3
10/4/2008	2	238	7	14	-0.098	0
5/5/2008	6	243	9	16	0.012	0
10/28/2008	3	248	6	17	-0.470	3
4/5/2008	2	241	7	13	-0.353	0
6/30/2008	1	242	5	13	-0.288	1
4/2/2008	2	230	6	13	0.217	0
6/4/2008	8	216	10	17	0.476	0
5/1/2008	4	219	8	14	-0.122	0
9/29/2008	5	210	8	18	-0.010	5
7/1/2008	2	200	6	15	0.125	2
7/8/2008	2	200	5	13	0.321	1
5/13/2008	2	180	8	17	-0.112	1
5/22/2008	4	168	9	14	0.577	0
10/10/2008	4	177	9	15	0.096	0
4/27/2008	7	168	7	16	0.191	7
11/21/2008	8	160	8	19	0.127	6
4/13/2008	2	164	5	13	0.038	2

HIGH WIND DAY, 04/27/2008, COWTOWN

Figure C1. PM10 vs. Wind Speed

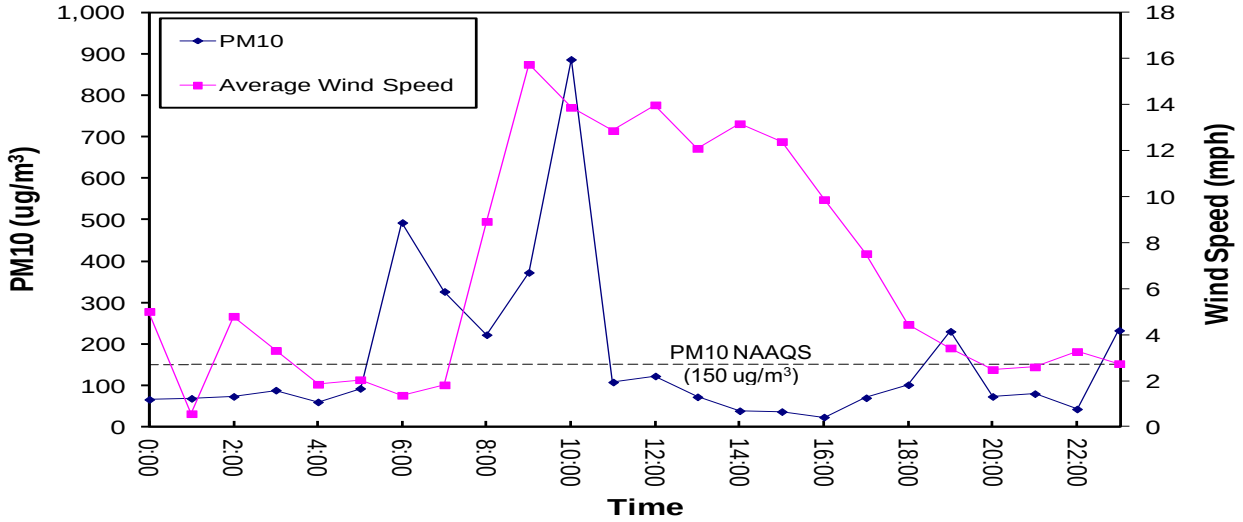


Figure C2. Wind Direction vs. Wind Speed

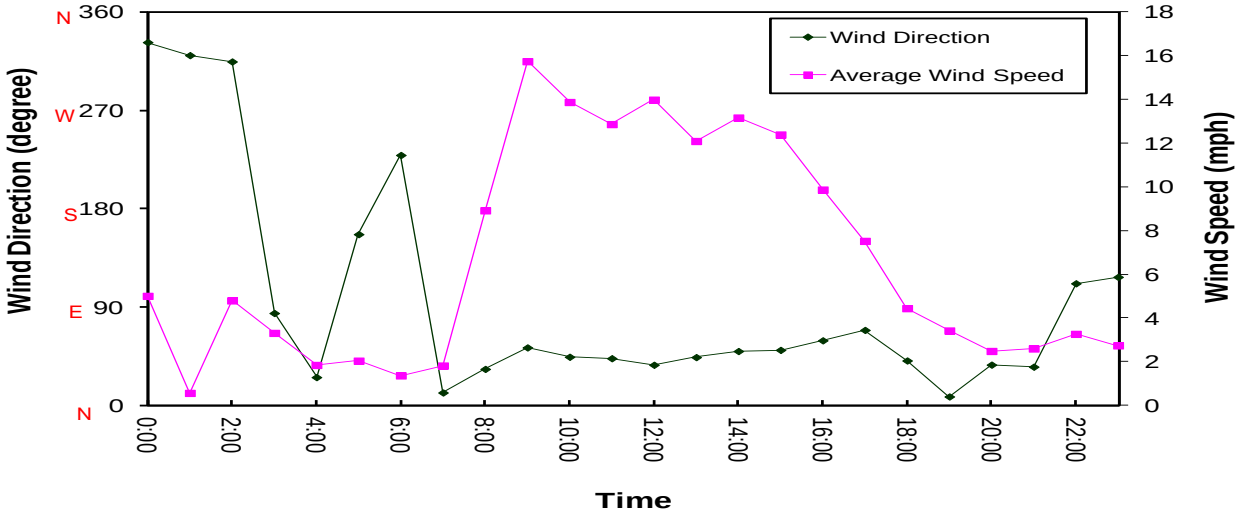
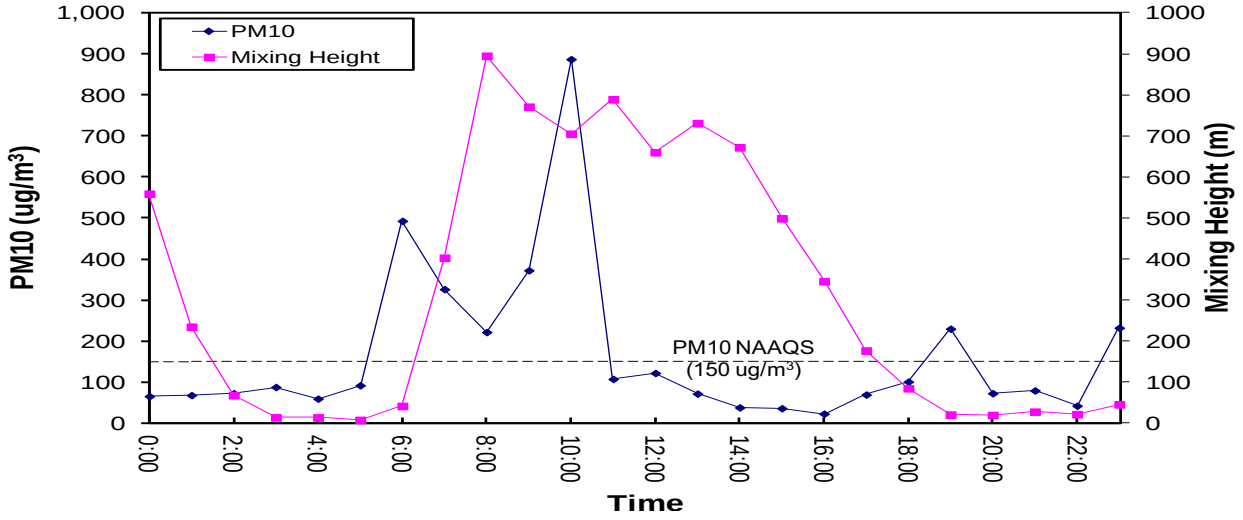


Figure C3. PM10 vs. Mixing Height



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Appendix D

Statistics of the High Wind PM10 Exceedance Days at Stanfield in 2008

Table D1. Statistics of the PM10 High Wind Exceedance Days at Stanfield in 2008

Date	Number of High wind hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10
11/9/2008	7	371	9	22	0.7494
8/7/2008	3	365	6	21	0.6961
5/21/2008	15	317	14	21	0.8545
1/1/2008	11	255	10	21	0.5550
11/15/2008	7	244	8	18	0.5942
10/27/2008	5	211	7	16	0.4814
11/21/2008	7	178	7	16	0.6289
9/11/2008	2	177	6	27	0.8111
12/13/2008	7	177	8	15	0.6429
7/3/2008	1	159	5	12	0.5470
4/13/2008	3	158	6	18	0.3838

HIGH WIND DAY, 05/21/2008, STANFIELD

Figure D1. PM10 vs. Wind Speed

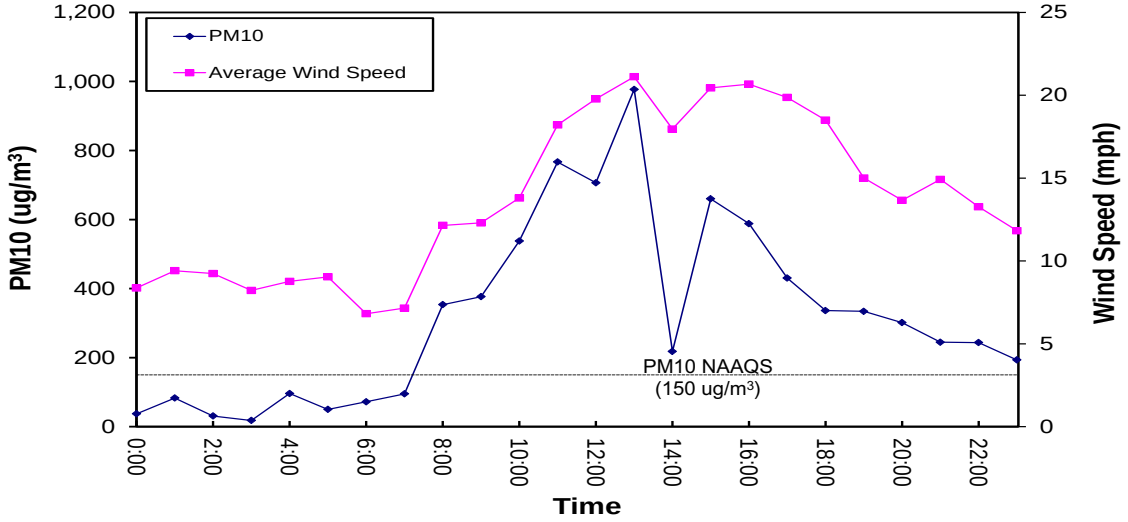


Figure D2. Wind Direction vs. Wind Speed

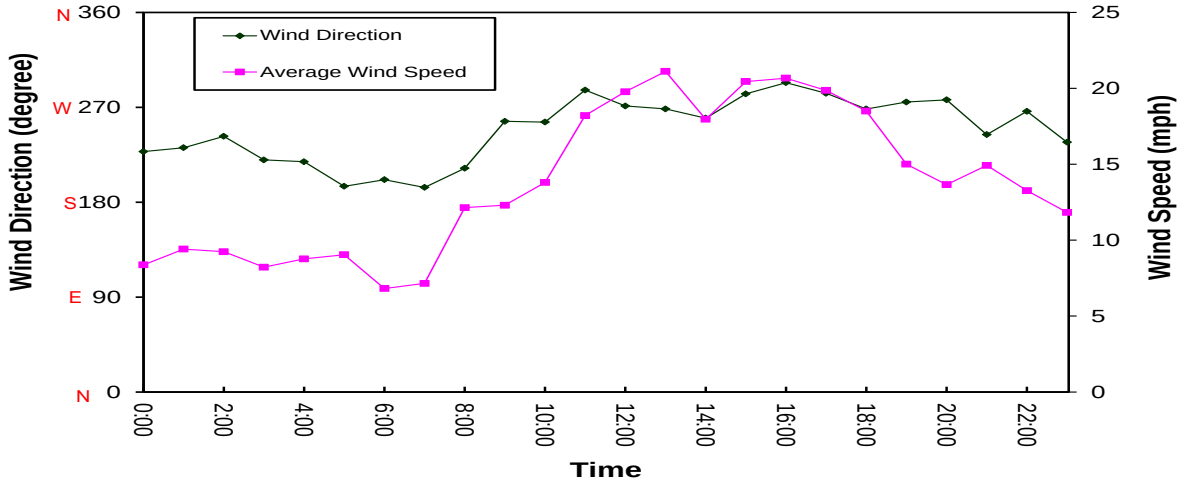
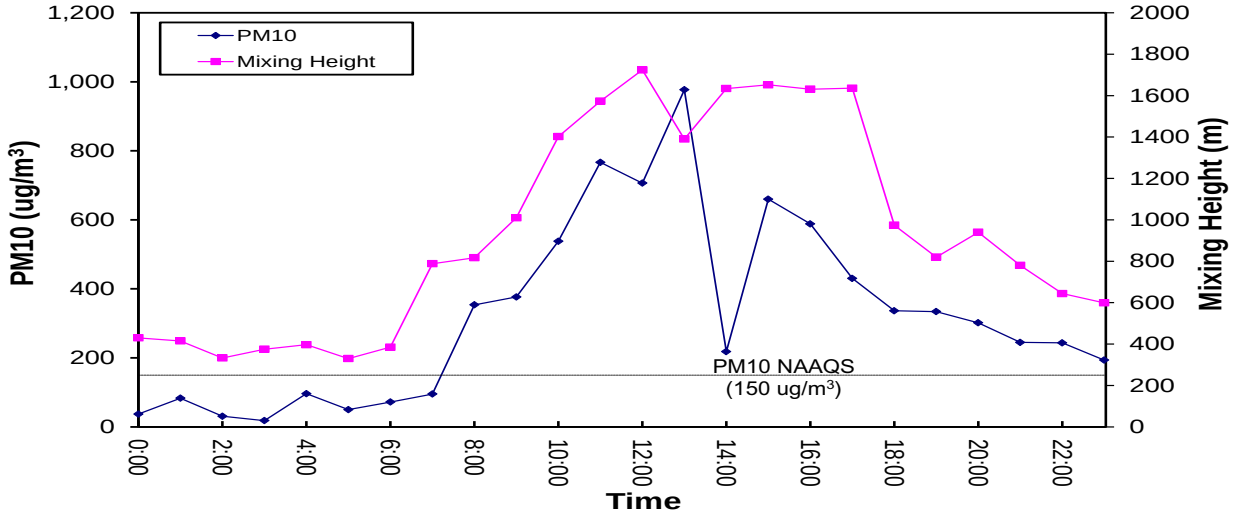


Figure D3. PM10 vs. Mixing Height



HIGH WIND DAY, 11/09/2008, STANFIELD

Figure D4. PM10 vs. Wind Speed

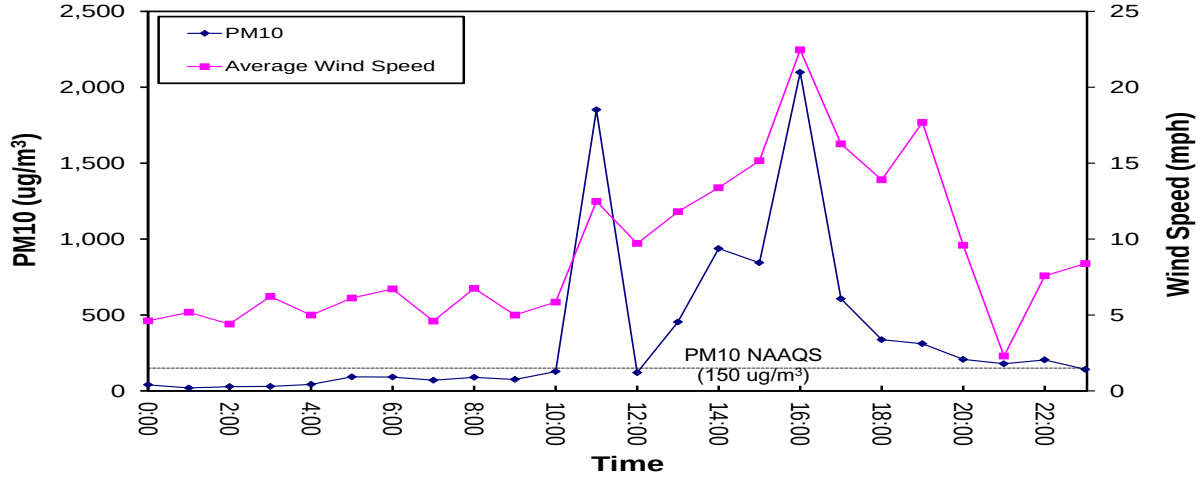


Figure D5. Wind Direction vs. Wind Speed

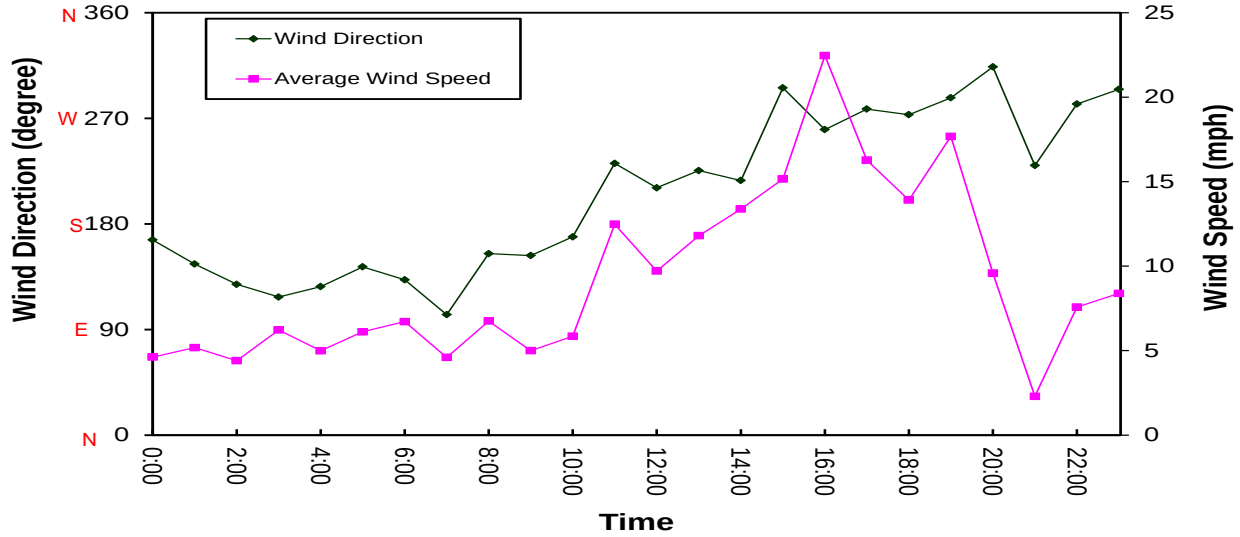
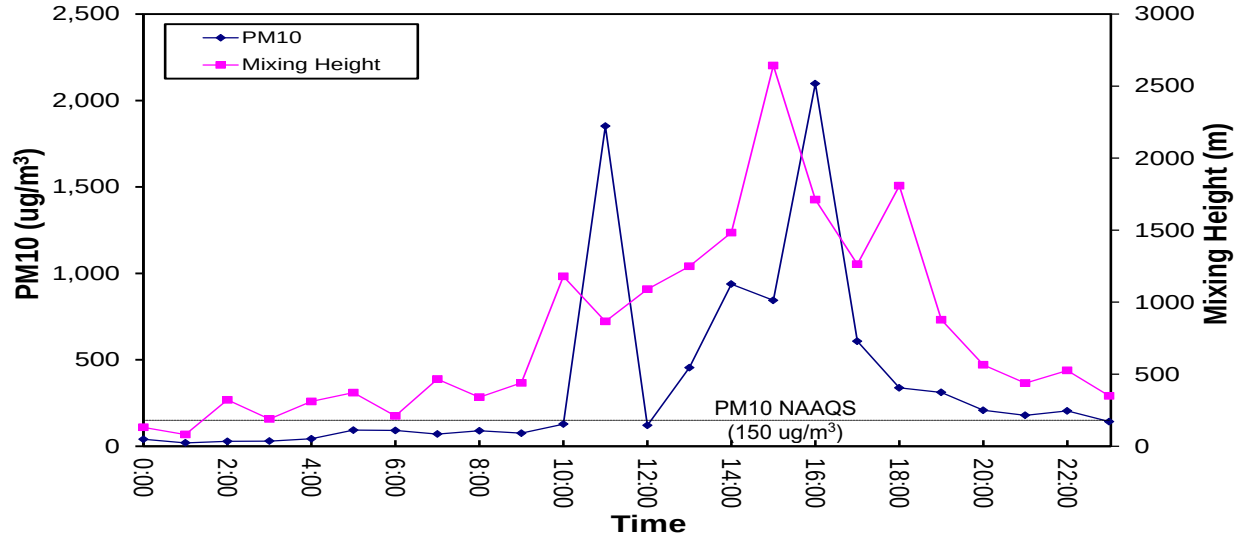


Figure D6. PM10 vs. Mixing Height



HIGH WIND DAY, 12/13/2008, STANFIELD

Figure D7. PM10 vs. Wind Speed

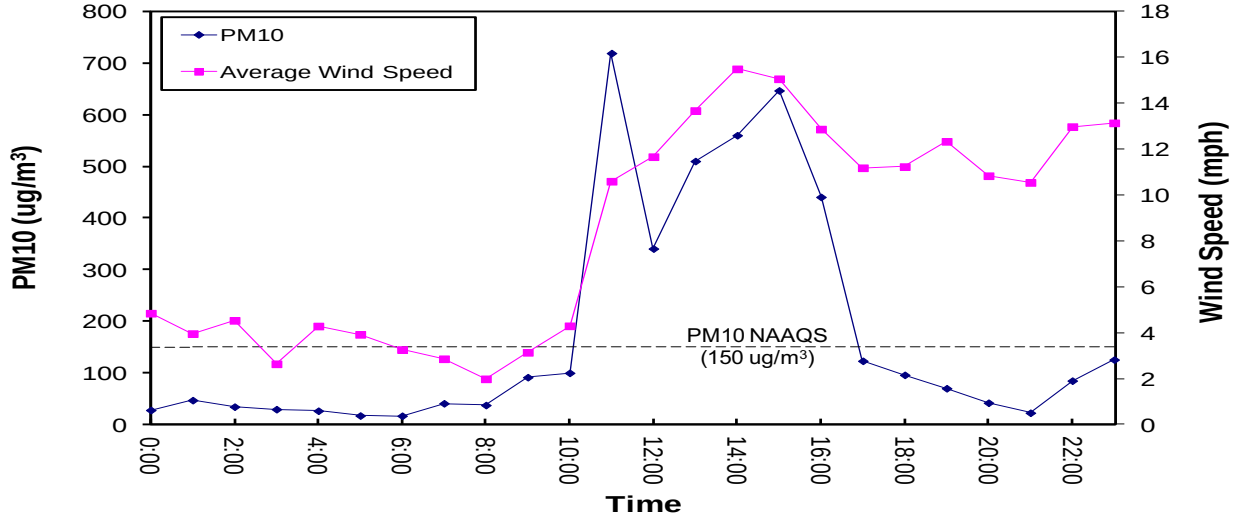


Figure D8. Wind Direction vs. Wind Speed

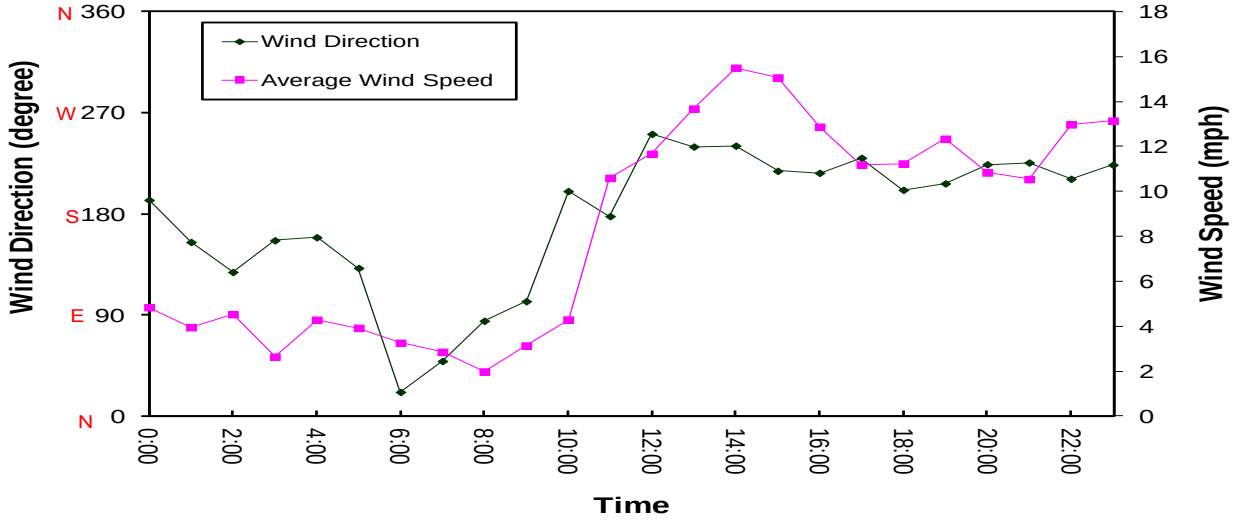
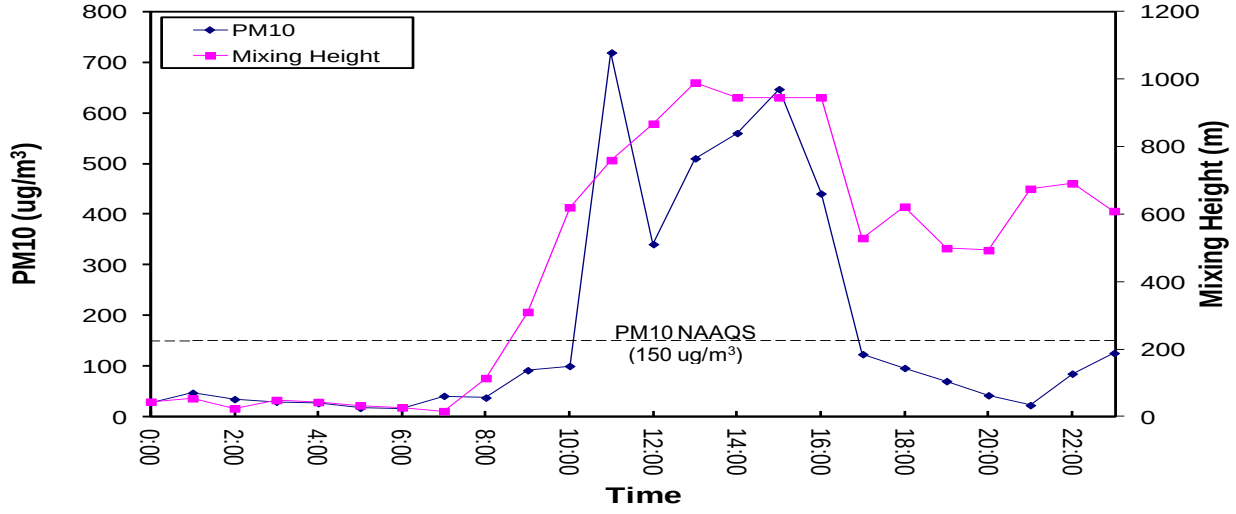


Figure D9. PM10 vs. Mixing Height



HIGH WIND DAY, 11/21/2008, STANFIELD

Figure D10. PM10 vs. Wind Speed

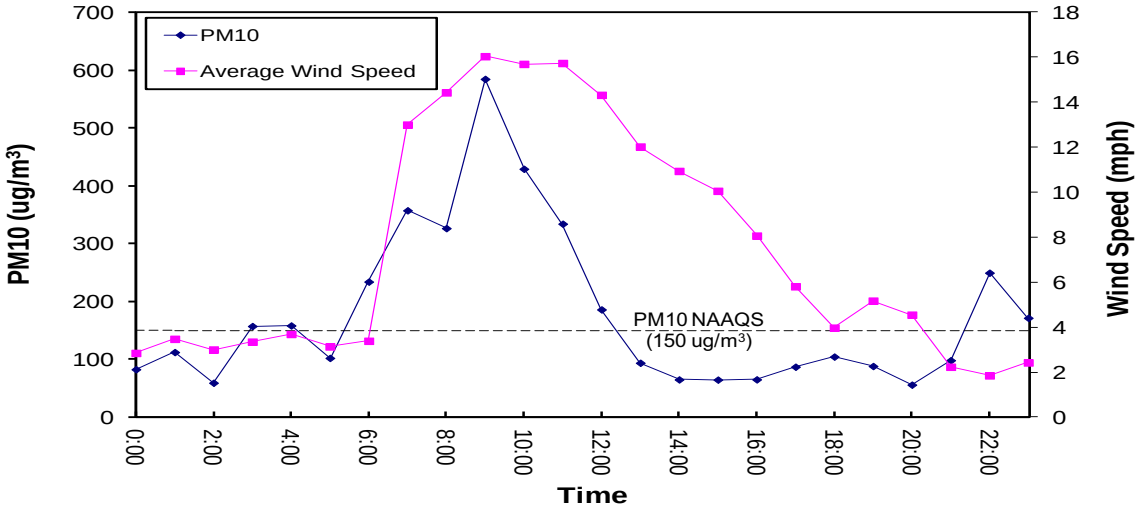


Figure D11. Wind Direction vs. Wind Speed

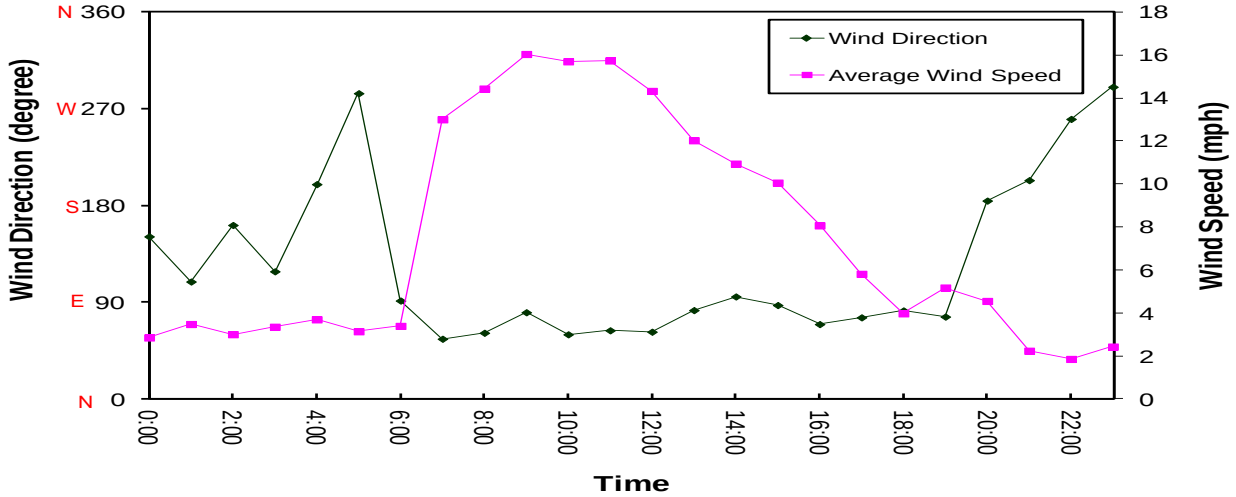
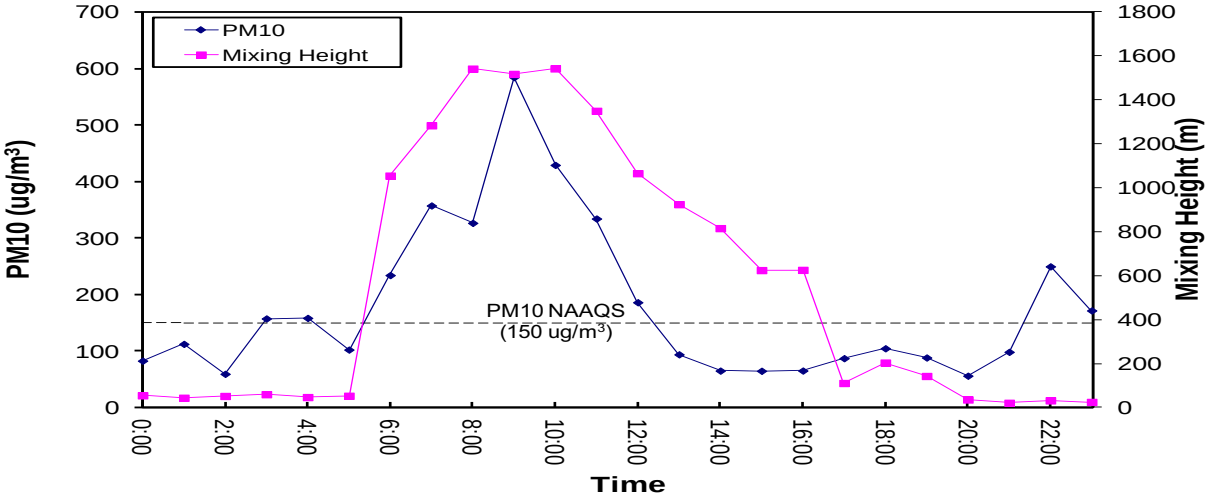


Figure D12. PM10 vs. Mixing Height



Appendix E

Statistics of the High Wind PM10 Exceedance Days at Pinal County Housing in 2008

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Table E1. Statistics of the PM10 High Wind Exceedance Days at Pinal County Housing in 2008

Date	Number of High wind hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10
11/9/2008	4	282	5	17	0.7954
5/21/2008	13	271	11	17	0.4827
1/1/2008	15	260	11	20	0.6639
5/15/2008	2	222	5	15	0.5432
9/11/2008	2	213	4	18	0.7246
8/15/2008	1	172	4	14	0.7661
10/27/2008	7	156	7	15	0.7750

HIGH WIND DAY, 01/01/2008, PINAL COUNTY HOUSING

Figure E1. PM10 vs. Wind Speed

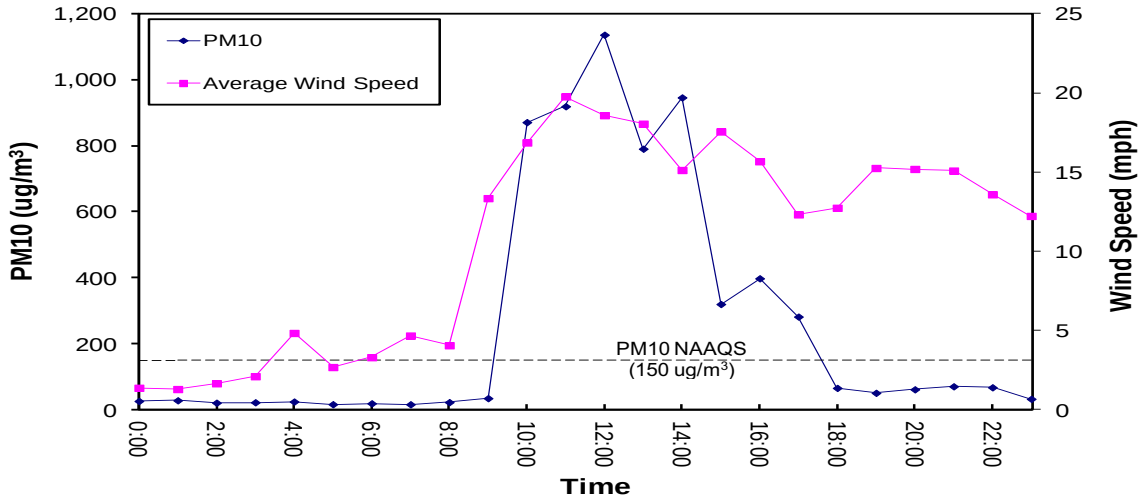


Figure E2. Wind Direction vs. Wind Speed

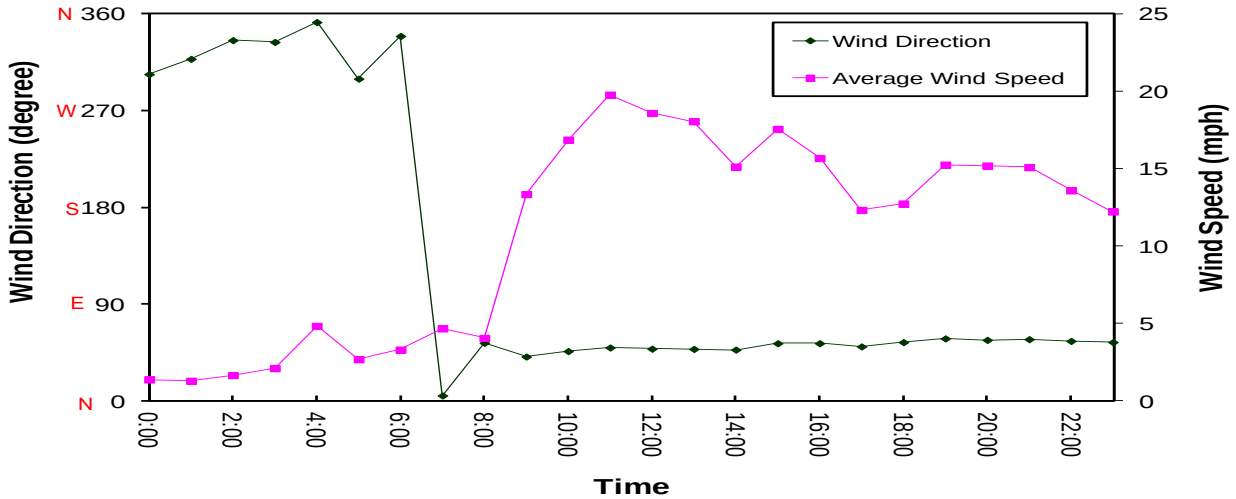
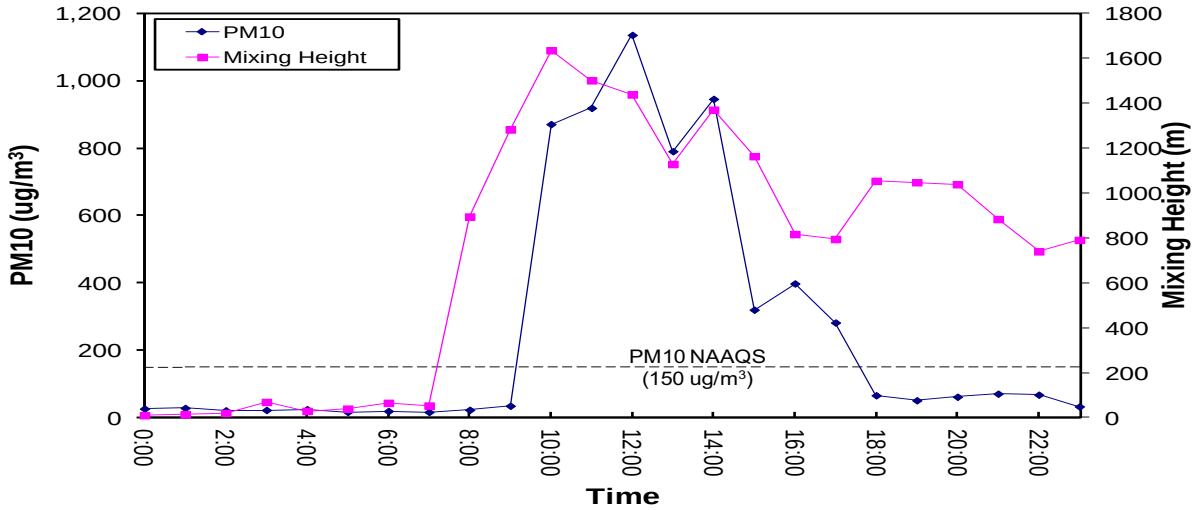


Figure E3. PM10 vs. Mixing Height



Appendix F

Statistics of the PM10 Exceedance Days at Maricopa in 2008

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Table F1. Statistics of the PM10 High Wind Exceedance Days at Maricopa in 2008

Date	Number of High wind hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10
1/1/2008	12	317	11	19	0.7112
8/7/2008	3	213	6	22	0.7717
9/11/2008	2	170	6	21	0.6398
10/11/2008	7	157	8	14	0.5433
10/27/2008	9	159	9	18	0.4384
11/9/2008	6	520	8	18	0.6795

HIGH WIND DAY, 10/27/2008, MARICOPA

Figure F-1. PM10 vs. Wind Speed

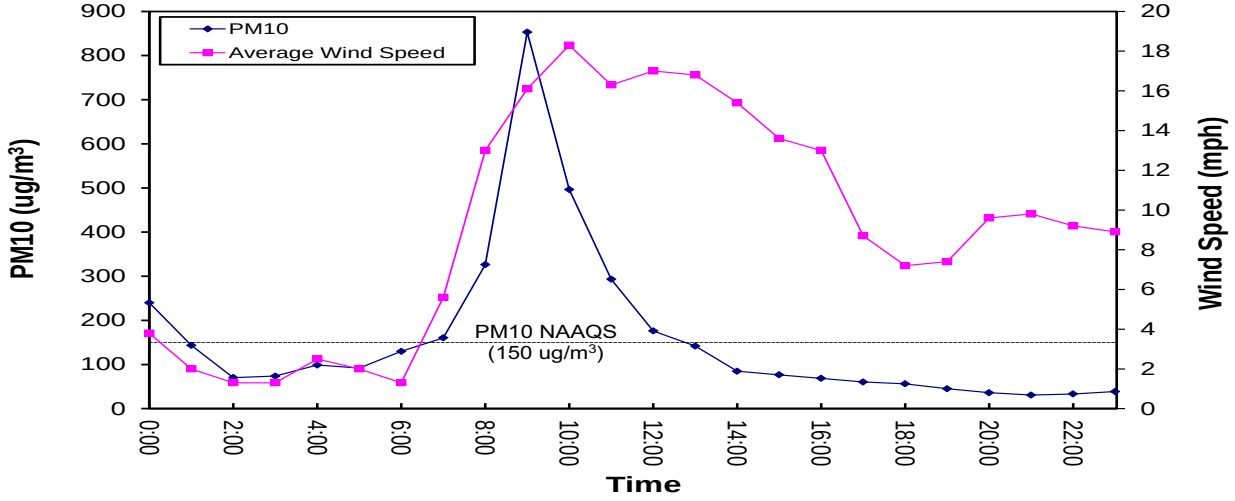


Figure F-2. Wind Direction vs. Wind Speed

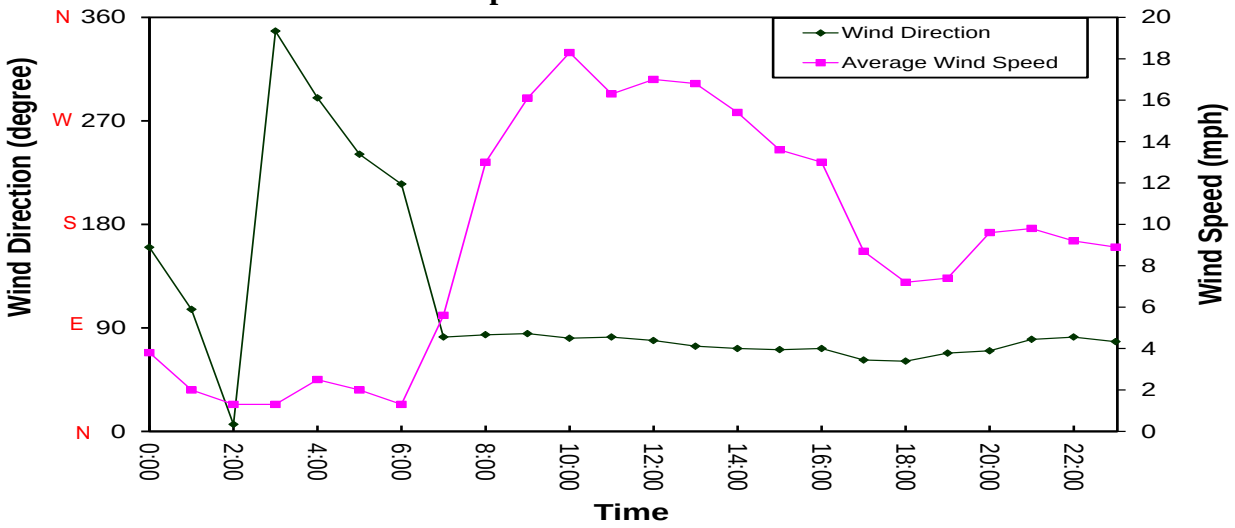
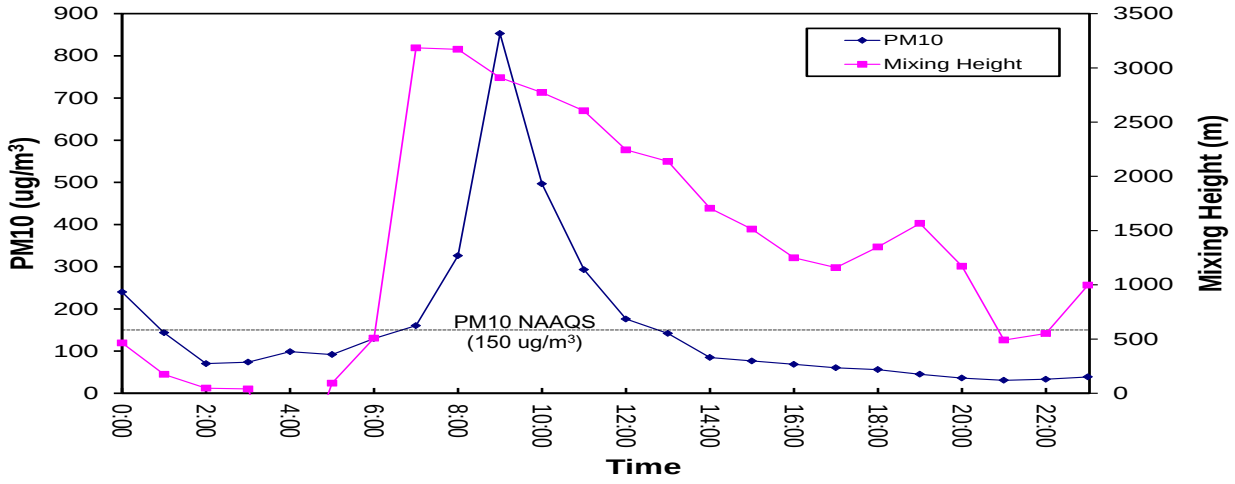


Figure F-3. PM10 vs. Mixing Height


PM10
Mixing Height
PM10 NAAQS
(150 ug/m³)
PM10 (ug/m³)
Mixing Height (m)
Time
900
800
700
600
500
400
300
200
100
0
3500
3000
2500
2000
1500
1000
500
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

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Appendix G

Statistics of the PM2.5 Exceedance Days at Cowtown in 2008

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Table G1. Statistics of the PM2.5 Exceedance Days at Cowtown in 2008

Date	Daily Average PM2.5 (ug/m^3)	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)
3/25/2008	42	497	3	5
4/12/2008	41	370	4	10
5/6/2008	40	304	7	16
4/30/2008	40	285	10	18
11/20/2008	38	345	3	6
6/23/2008	37	249	6	11
4/18/2008	36	362	3	7

PM2.5 DAY, 03/25/2008, COWTOWN

Figure G1. PM10 vs. Wind Speed

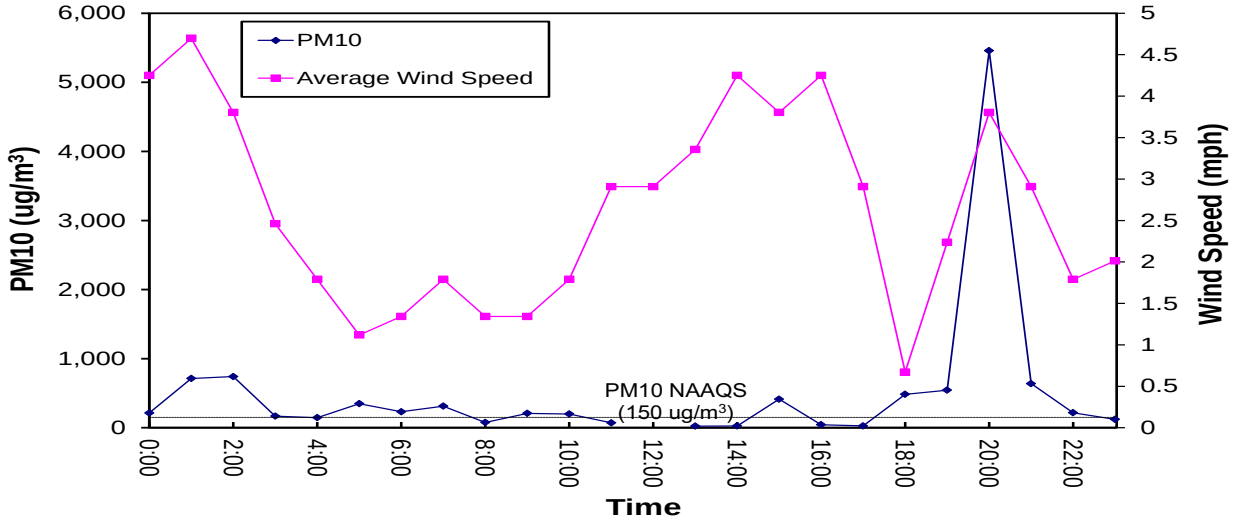


Figure G2. Wind Direction vs. Wind Speed

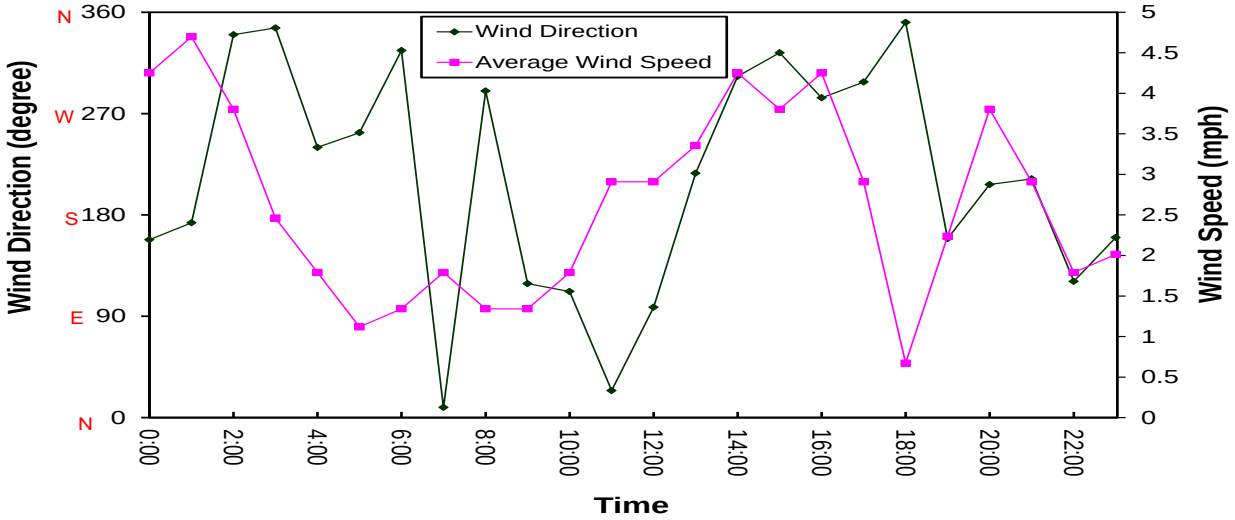
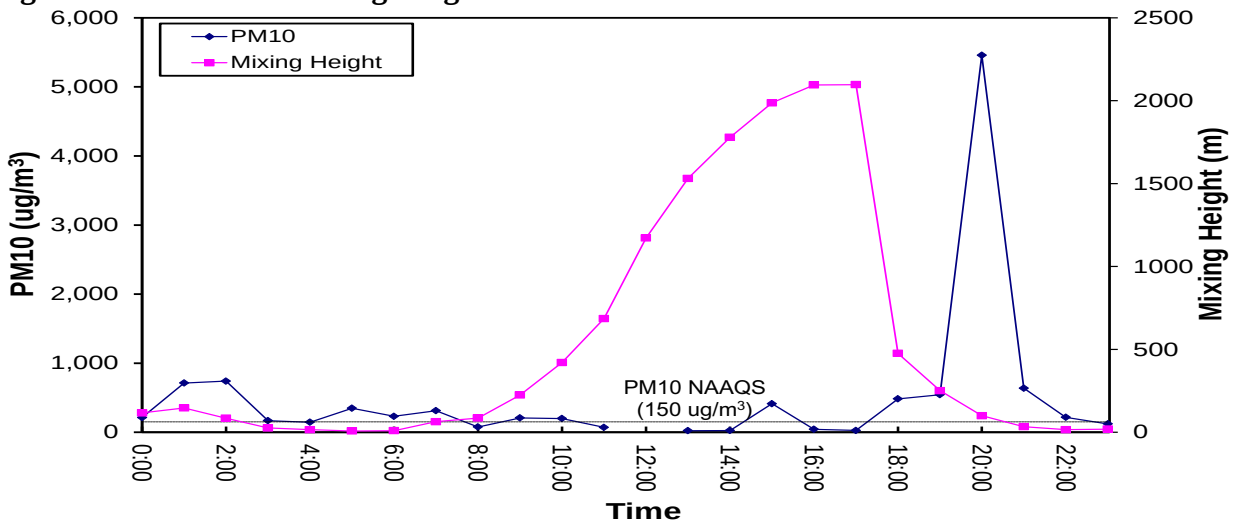


Figure G3. PM10 vs. Mixing Height



PM2.5 DAY, 04/12/2008, COWTOWN

Figure G4. PM10 vs. Wind Speed

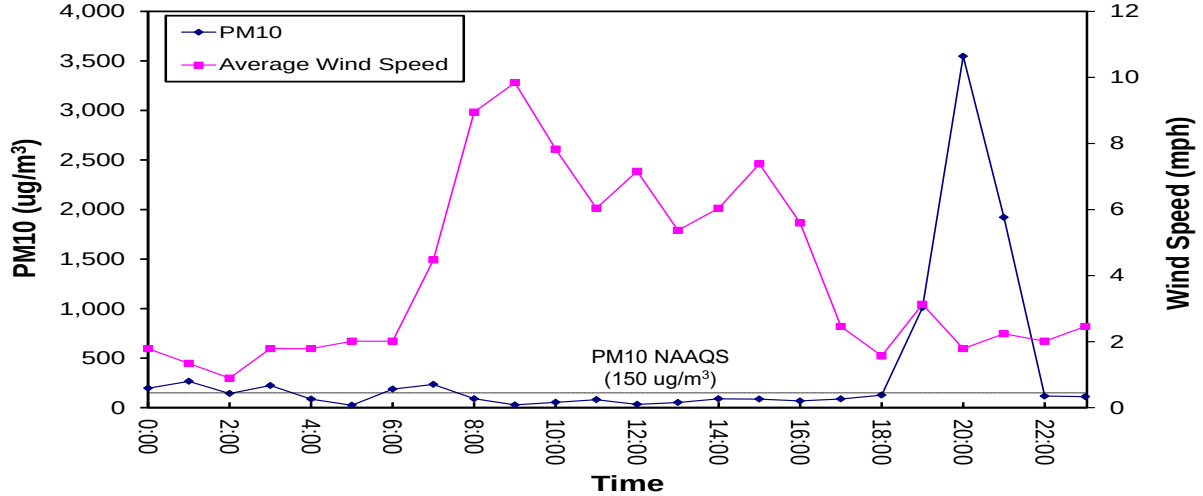


Figure G5. Wind Direction vs. Wind Speed

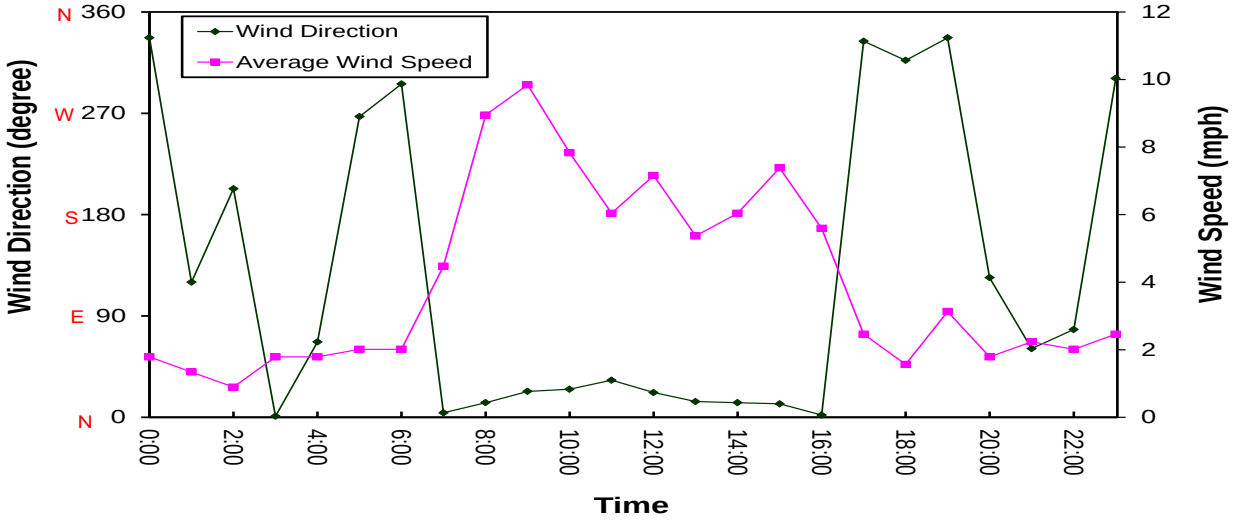
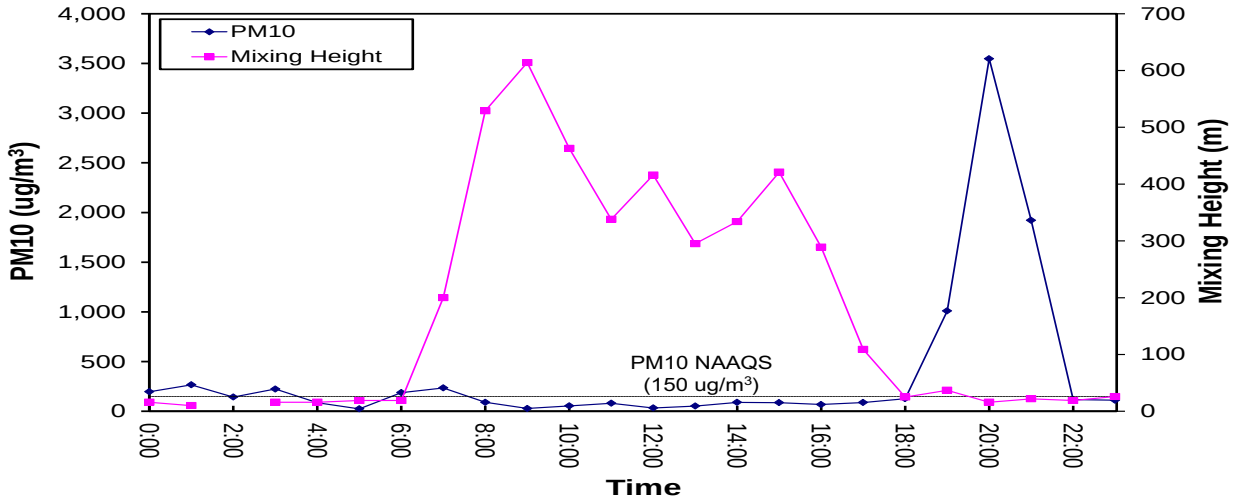


Figure G6. PM10 vs. Mixing Height



PM2.5 DAY, 05/06/2008, COWTOWN

Figure G7. PM10 vs. Wind Speed

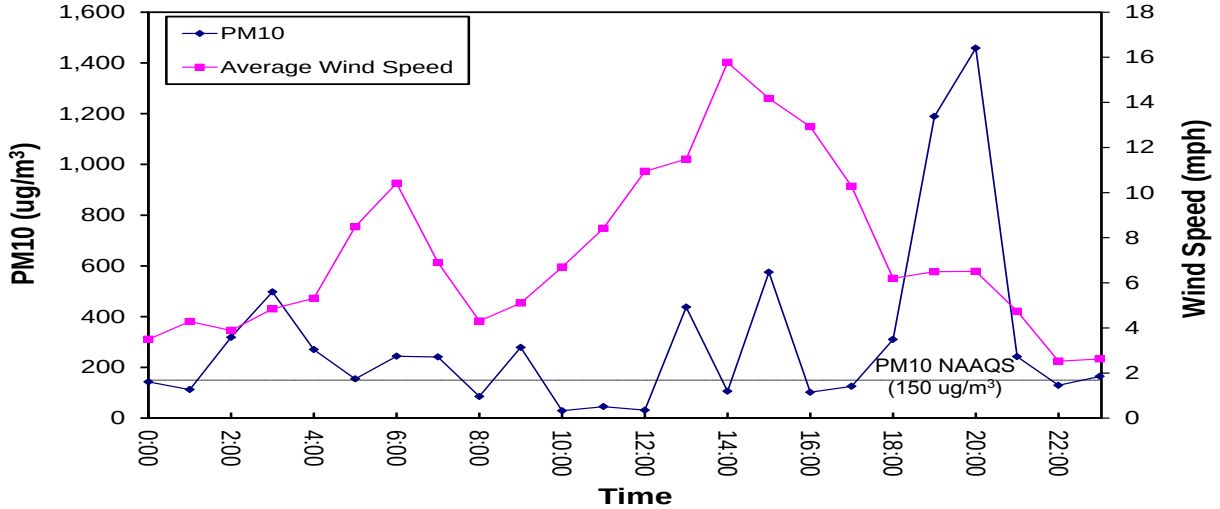


Figure G8. Wind Direction vs. Wind Speed

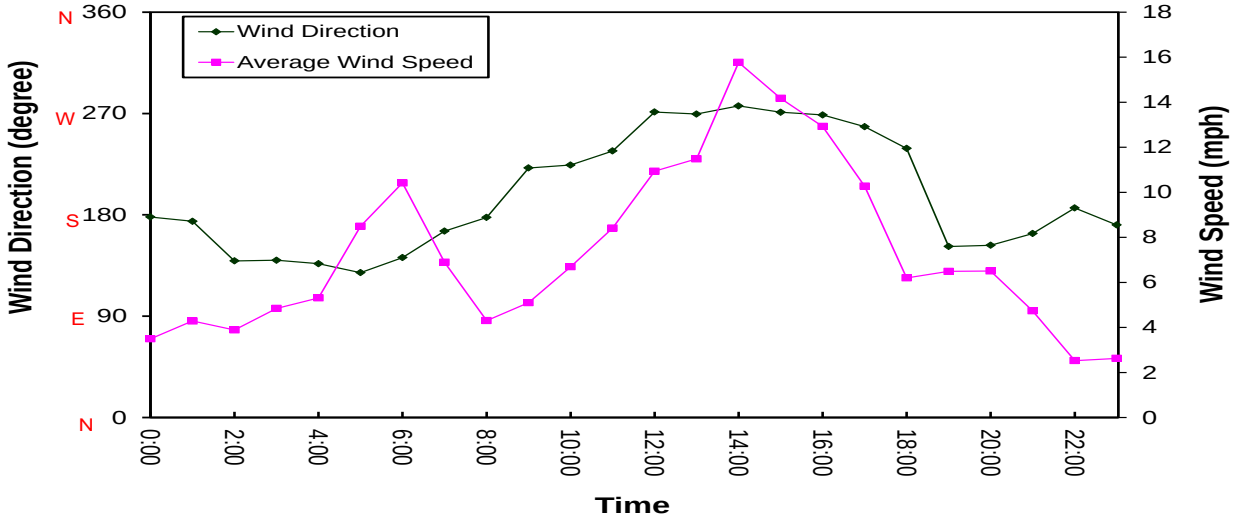
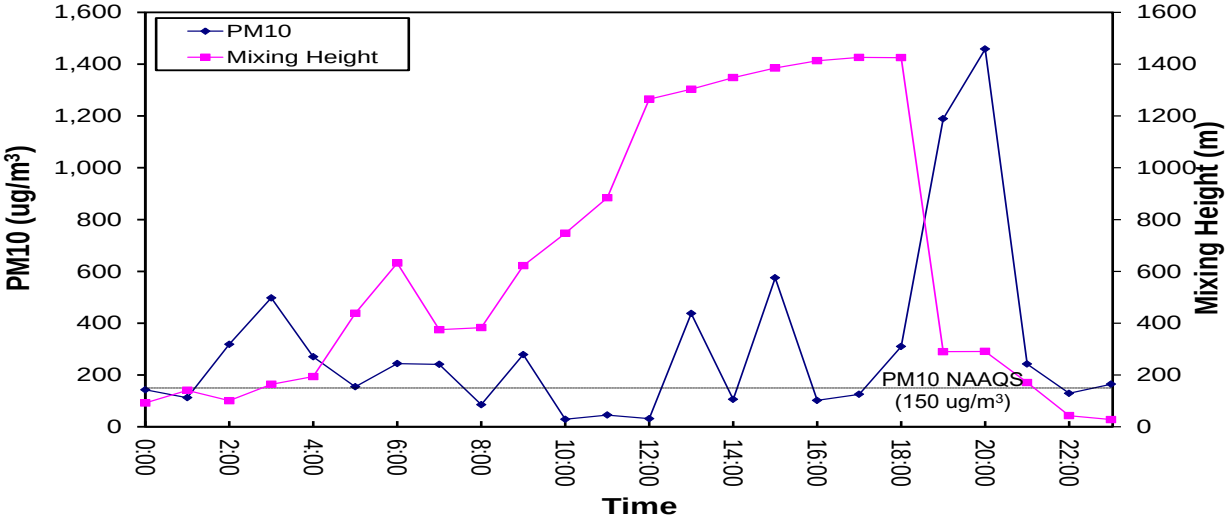


Figure G9. PM10 vs. Mixing Height



PM2.5 DAY, 04/30/2008, COWTOWN

Figure G10. PM10 vs. Wind Speed

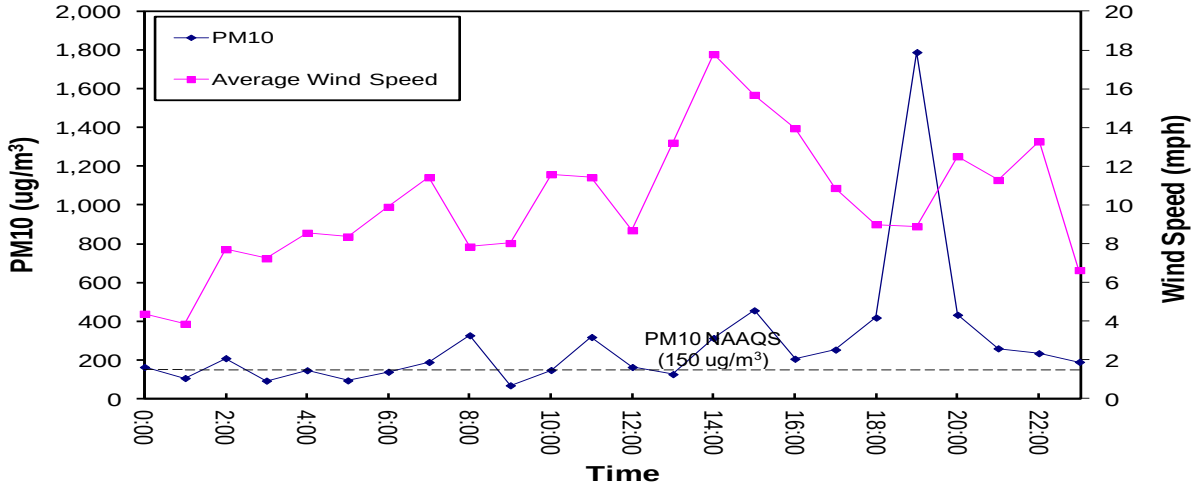


Figure G11. Wind Direction vs. Wind Speed

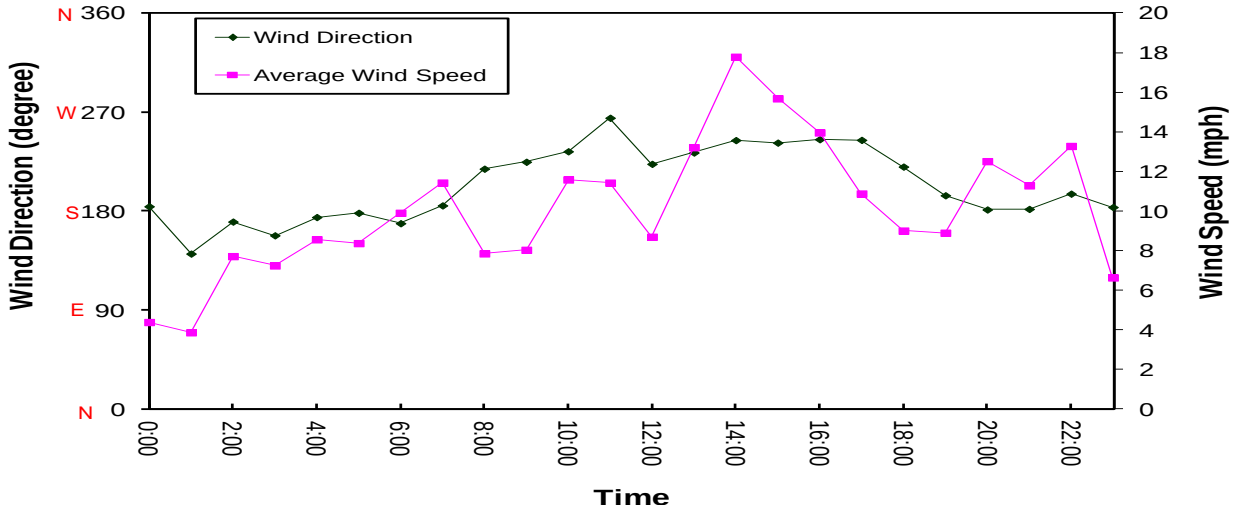
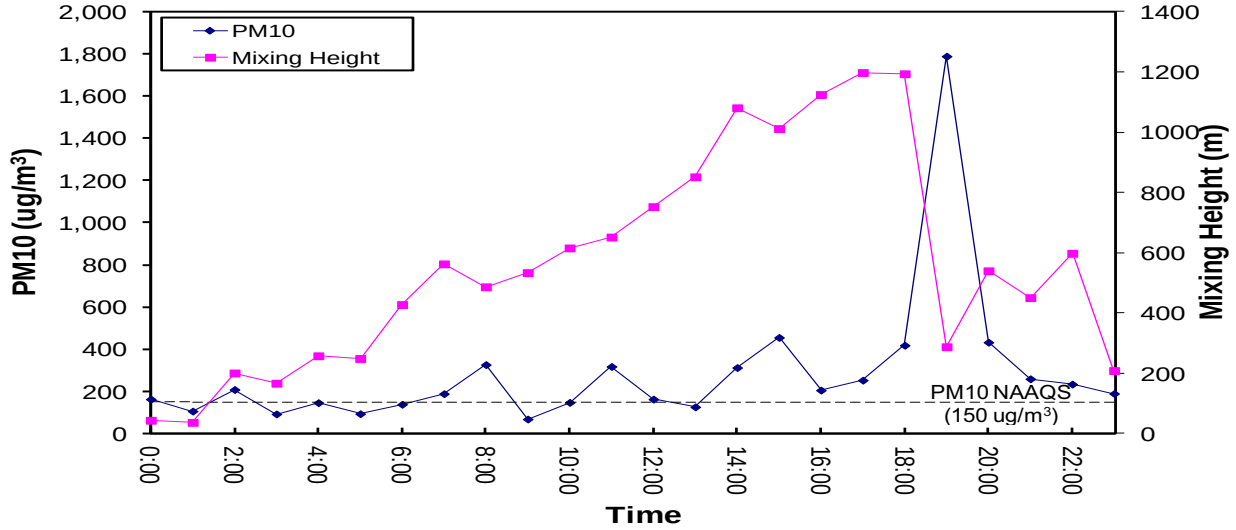


Figure G12. PM10 vs. Mixing Height



PM2.5 DAY, 11/20/2008, COWTOWN

Figure G13. PM10 vs. Wind Speed

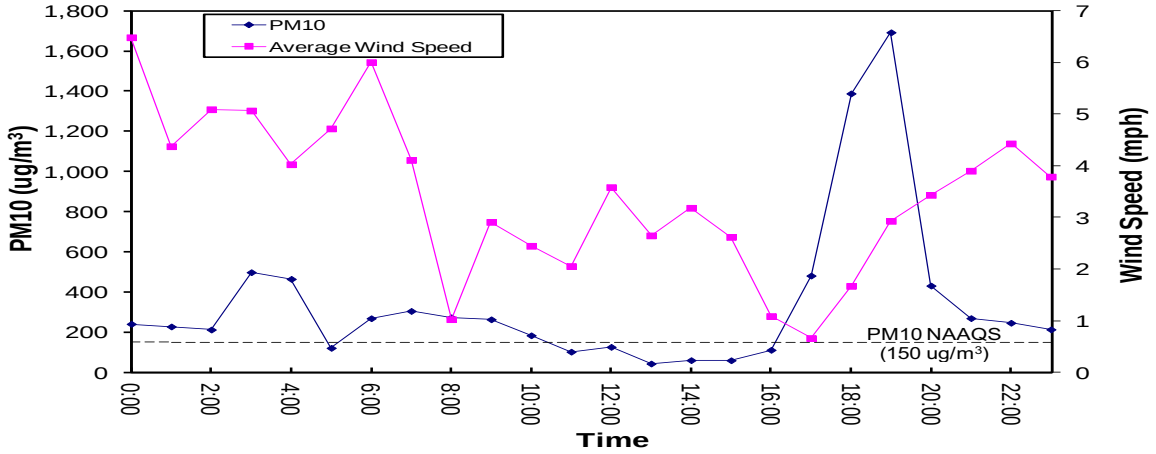


Figure G14. Wind Direction vs. Wind Speed

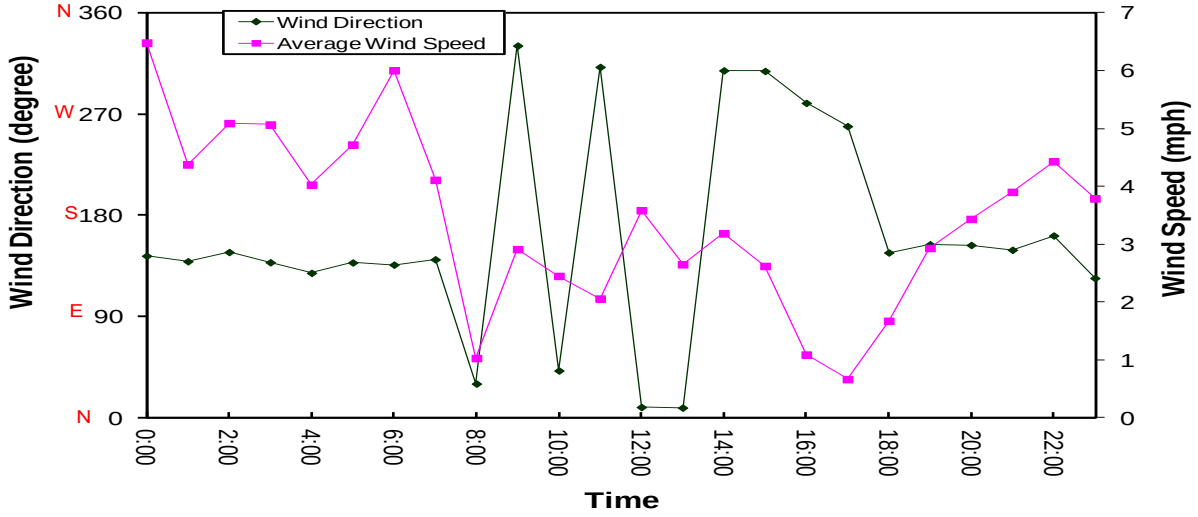
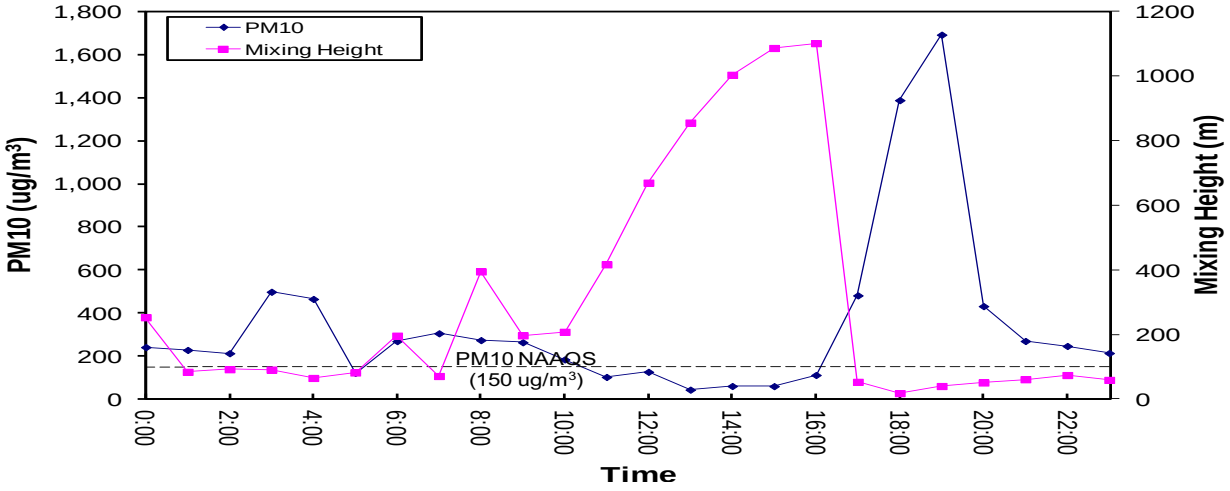


Figure G15. PM10 vs. Mixing Height



PM2.5 DAY, 06/23/2008, COWTOWN

Figure G16. PM10 vs. Wind Speed

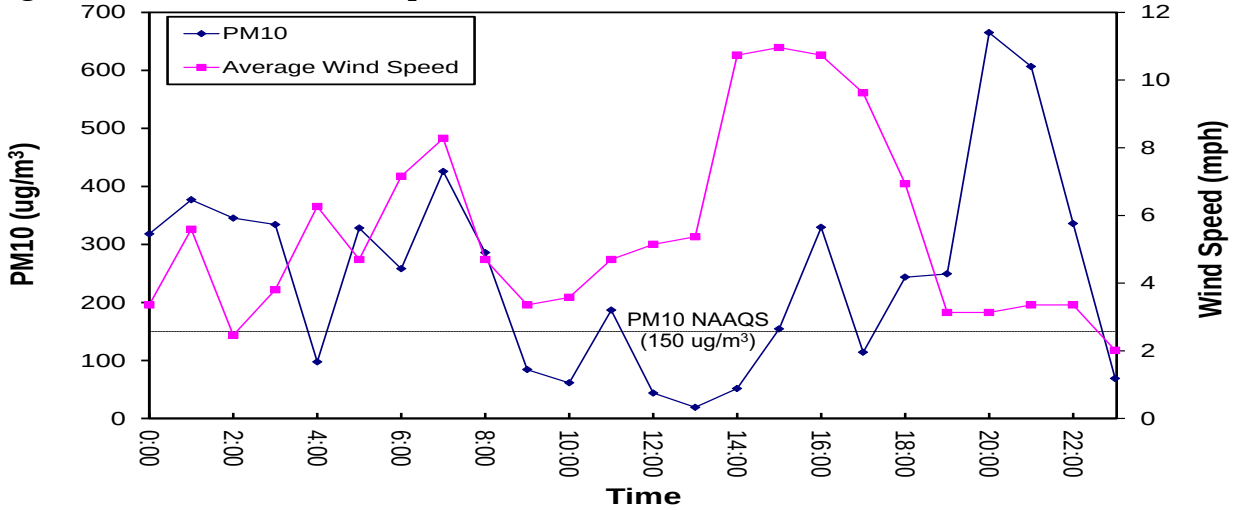


Figure G17. Wind Direction vs. Wind Speed

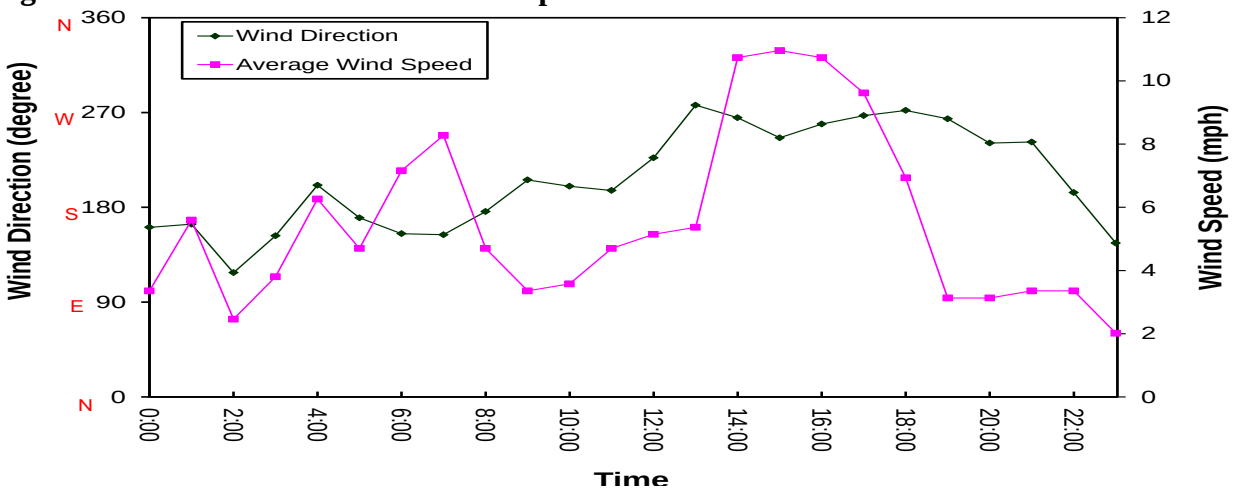
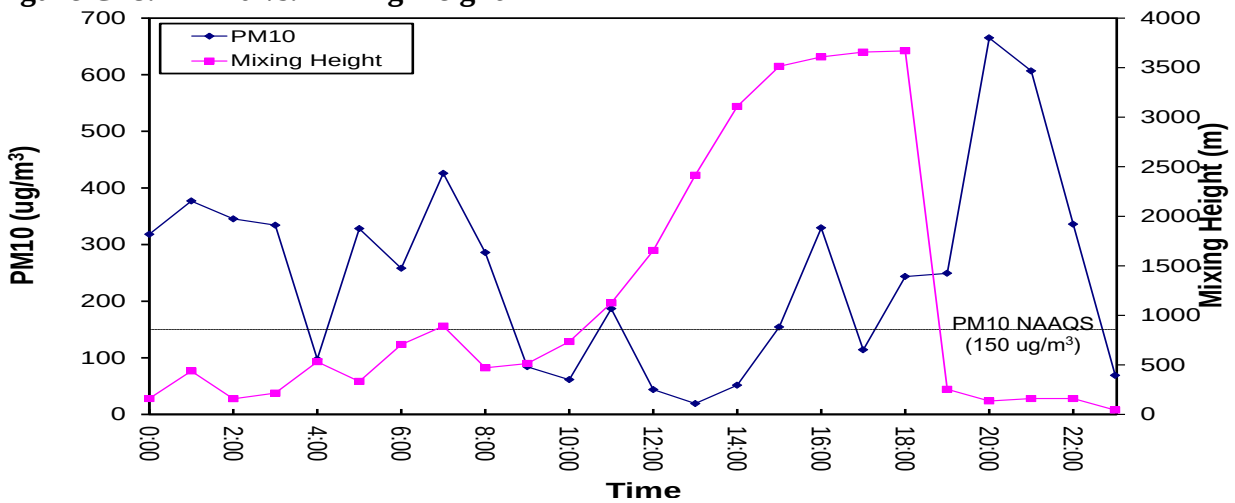


Figure G18. PM10 vs. Mixing Height



PM2.5 DAY, 04/18/2008, COWTOWN

Figure G19. PM10 vs. Wind Speed

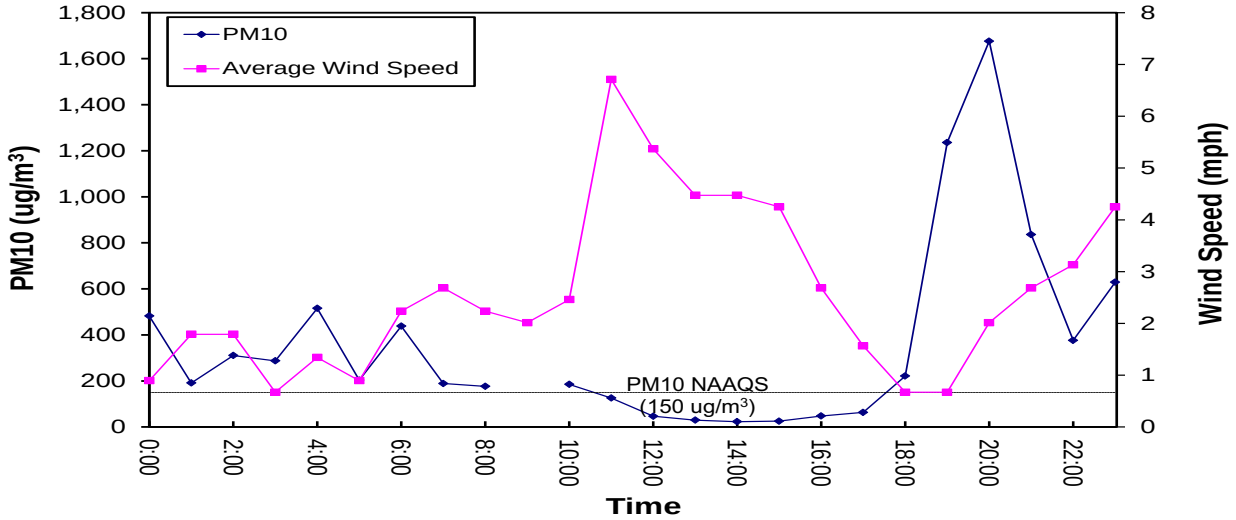


Figure G20. Wind Direction vs. Wind Speed

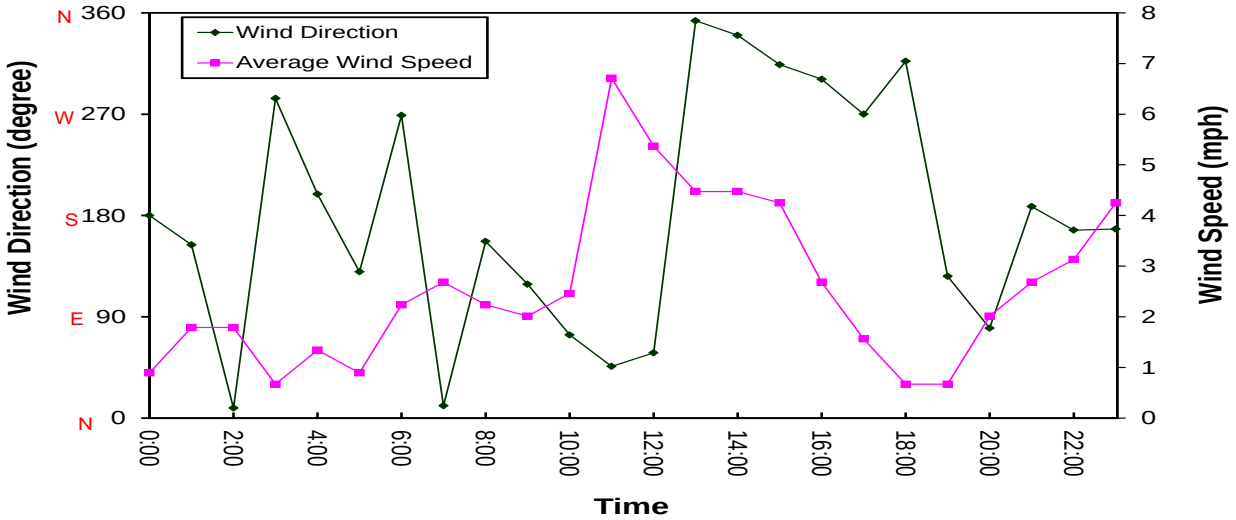
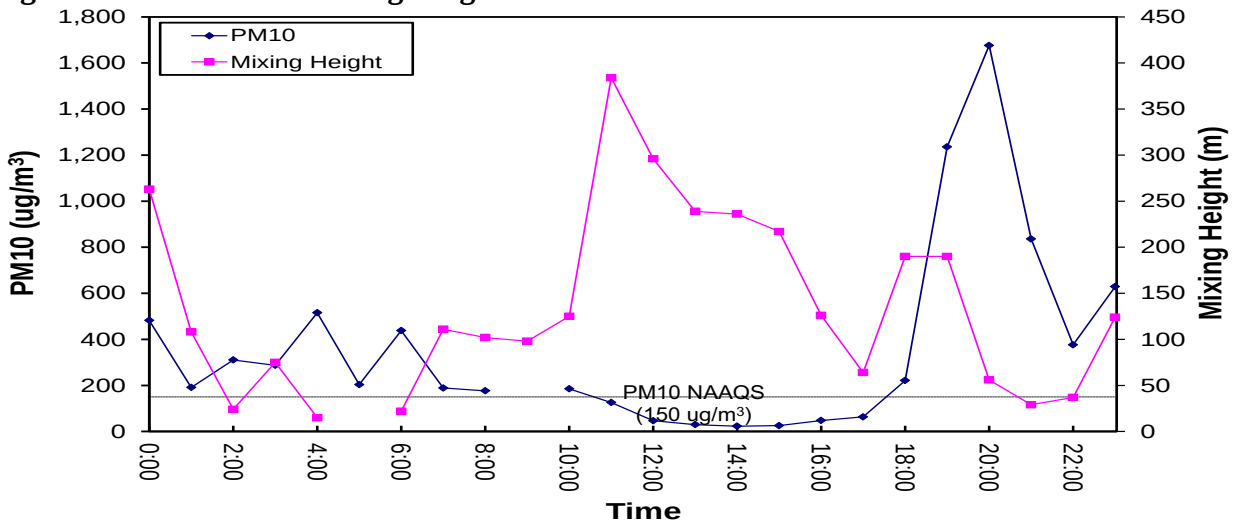


Figure G21. PM10 vs. Mixing Height



Appendix H

Road Count Data

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ROAD COUNTS CONDUCTED BY PINAL COUNTY AIR QUALITY

Road Name	Road Surface	Location of Count	Month/Year of Count	Cars per day
Signal Peak Road	Dirt	~1/2 mile south of Hwy 87	October 2001	228
Diversion Dam Road	Dirt	At the end of the pavement	November 2001	127
Gary Road	Dirt	Between Lind Rd and Gail Rd	November 2001	904
Tweedy Road	Dirt	Just south of Kleck Road	December 2001	133
Bartlett Road	Dirt	Just west of Kenworthy Road	January 2002	139
Arizona Western Road	Dirt	~1/4 mile west of Eleven Mile Corner Road	January 2002	83
Judd Road	Dirt	~1/4 mile west of Gary Road	March 2002	154
Sossaman Road	Dirt	~1/2 mile south of Empire Blvd	April 2002	117
Ellsworth Road	Dirt	~1/4 mile south of Hunt Hwy	May 2002	193
White and Parker Road	Dirt	~0.1 mile north of Farrell Road	June 2002	456
Hartman Road	Dirt	~0.1 mile north of Maricopa-Casa Grande Highway	June 2002	88
Warren Road	Dirt	~0.1 mile south of Farrell Road	July 2002	80
Amarillo Valley Road	Dirt	~0.1 mile south of Clayton Road	July 2002	643
Christensen Road	Dirt	~2 miles north of Highway 287	August 2002	21
Peralta Road	Dirt	~0.1 mile northeast of Fransisco de Coronado Road	September 2002	86
San Juan Road	Dirt	~0.1 mile north of Solano Road	September 2002	343
Ivar Road	Dirt	~0.1 mile west of Gary Road	September 2002	200
Sherry Lane	Dirt	~0.1 mile west of Schnepf Road	October 2002	65
Hash Knife Road	Dirt	~0.2 mile east of Schnepf Road	November 2002	416
Mammoth Road	Dirt	~0.5 mile north of Selma Hwy	November 2002	50
Honeycutt Road	Dirt	~1.0 mile east of Hwy 387	December 2002	423
Barnes Road	Dirt	~0.6 mile east of Ralston Road	December 2002	115
Warren Road	Dirt	~0.1 mile south of Century	January 2003	340
Houston Road	Dirt	~0.4 mile west of Ganzel	February 2003	1042
Southwood Road	Dirt	Near the intersection with Country Lane	February 2003	81
Combs Road	Dirt	~0.2 mile east of Schnepf Road	February 2003	94
Macrae Road	Dirt	~0.1 mile south of Vah Ki Inn	March 2003	166
Jacob Waltz Road	Dirt	~0.1 mile west of Mountain View Road	March 2003	268
Mountain View Road	Dirt	~0.1 mile south of Lost Dutchman Road	April 2003	494
Lost Dutchman Road	Dirt	~0.1 mile west of Mountain View	April 2003	312
Price Road	Dirt w/ soil stabilizer	~0.3 mile east of Highway 79 (Friday thru Monday of Country Thunder)	April 2003	6676
Price Road	Dirt w/ soil stabilizer	~0.3 mile east of Highway 79 (Friday thru Wednesday of Country Thunder)	April 2003	4061
Navajo Road	Paved	~50 feet mile south of Papago Road (next to Stanfield monitor)	May 2003	91
Macrae Road	Dirt	~0.1 mile south of Vah Ki Inn	May 2003	174

Foothill Road	Dirt	~0.1 mile east of Cortez Road	June 2003	110
Signal Peak Road	Dirt	~0.1 mile north of Woodruff	August 2003	206
Signal Peak Road	Dirt	~0.4 mile south of Highway 87	August 2003	127
Hidalgo Street	Dirt	~0.1 mile west of Val Vista	August 2003	91
Lost Dutchman Road	Dirt	~0.1 mile east of Val Vista	September 2003	129
Hartman Road	Dirt	~0.1 mile north of Maricopa-Casa Grande Highway	September 2003	96
Farrell Road	Dirt	~0.9 mile east of White and Parker Road	October 2003	134
White an Parker Road	Dirt	~0.1 mile north of Maricopa-Casa Grande Highway	October 2003	343
Maricopa-Casa Grande Highway	Paved	~0.1 mile southeast of White and Parker Road (next to the Cowtown monitor)	October 2003	2717
Cowtown Road	Dirt	~0.1 mile northwest of Hartman Road	November 2003	146
Saddle Butte Street	Dirt	~0.1 mile east of Ironwood Drive	November 2003	319
Plaza Drive	Dirt	~0.1 mile south of Smoketree St	December 2003	114
Combs Road	Paved	~0.2 mile east of Ganzel Road (next to Combs monitor)	December 2003	2459
Wagon Wheel Road	Dirt	~0.1 mile north of Dove Roost Road	January 2004	173
Magma Road	Dirt	~0.1 mile east of Gary Road	January 2004	84
Davis Ranch Road	Dirt	~0.6 mile west of Bootleg Road	February 2004	220
Grande Valley Road	Dirt	~0.1 mile east of Way Out Road	February 2004	83
Tomahawk Road	Dirt	~0.1 mile north of McKellips Road	February 2004	231
Cactus Road	Dirt	~0.1 mile north of McKellips Road	March 2004	184
Blanco Drive	Dirt	~ 0.1 north of Val Vista Road	March 2004	126
Greasewood Street	Dirt	~ 0.1 mile east of San Marcos	March 2004	41
Desierto Road	Dirt/Gravel	~0.1 mile eat of Estrella Road	April 2004	118
Toluca Drive	Dirt/Gravel	~0.1 mile eat of Estrella Road	April 2004	51
Price Road	Dirt w/ soil stabilizer	~0.3 mile east of Highway 79 (Thur. thru Mon. of Country Thunder)	April 2004	5737
Caballero Road	Dirt/Gravel	~0.1 mile eat of Estrella Road	May 2004	122
Eleven Mile Corner Road	Paved	~0.1 mile south of Storey Road (next to PCH monitor)	June 2004	653
Gary Road	Dirt	~0.3 mile south of Judd	June 2004	141
Judd Road	Dirt	~0.1 mile west of Bryce Trail	July 2004	245
Brenner Pass Road	Dirt	~0.1 mile south of Phillips Road	July 2004	347
Bianco Road	Dirt	~0.1 mile south of Peters Road	August 2004	66
Florence-Kelvin Hwy	Paved	~1.1 mile south of Hwy 177	August 2004	75
Arroya Road	Dirt	~0.1 mile south of Superstition Blvd.	August 2004	17
Pacific Street	Paved	~0.1 mile north of Broadway	October 2004	164

		Ave		
Rolling Ridge Road	Dirt	~0.1 mile east of Schnepf Road	October 2004	362
Queen Anne Drive	Paved	~0.2 mile south of Cavendish Drive	November 2004	785
Arizona Hwy 88 (conducted by ADOT)	Paved	~0.1 mile southwest of Superstition Blvd	November 2004	3848
Arizona Hwy 347 (conducted by ADOT)	Paved	~0.5 mile south of AZ Hwy 238	June 2004	6787
Price Road	Dirt	~0.2 mile east of Hwy 79 (non-event weekend)	February 2005 2/25 AM thru 2/28 AM	213
Price Road	Dirt	~0.2 mile east of Hwy 79 (non-event weekend)	March 2005 3/4 PM thru 3/7 AM	175
Price Road	Dirt	~0.2 mile east of Hwy 79 (Girl Scout Jamboree weekend)	March 2005 3/11 AM thru 3/14 AM	541
Selma Highway	Dirt	~0.1 mile west of Peart Rd.	March 2005	89
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Fri. thru Mon. of Country Thunder)	April 2005	6243
Hidden Valley	Dirt	~0.1 mile north of Farrell Rd.	April 2005	Road tube cut twice
Evans Road	Dirt	~0.1 north of Warren Rd.	July 2005	73
Southern Avenue	Dirt	~0.1 mile east of Geronimo Rd.	July 2005	120
Moon Vista Road	Dirt	~0.1 mile east of Ironwood Rd.	September 2005	105
Hunt to Empire Short Cut T3SR7E between S2&3	Private Property – not a road – Dirt	~0.1 mile north of Hunt Hwy	September 2005	216
Hash Knife Road	Dirt	~0.1 mile east of Schnepf	October 2005	424
Cooper Road	Dirt	~0.1 mile north of Arizona Farms Rd	October 2005	370
Scorpio Road	Dirt	~0.1 mile west of Henness Road	October 2005	25
Tweedy Road	Dirt	~0.1 south of Hwy 287	December 2005	95
Varnum Road	Dirt	~0.1 mile south of Judd Road	January 2006	71
Libra Road	Dirt	~0.1 mile east of Sagittarius Road	February 2006	55
Hewitt Station Road	Dirt	~1.8 mile north of Hwy 60	March 2006	125
Reddington Road	Dirt	~ 0.1 mile north of the County line	March 2006	112
Reddington Road	Dirt	At the end of the pavement	March 2006	162
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Thu. thru Mon. of Country Thunder)	April 2006	5952
Price Road	Dirt	~1.3 mile east of Highway 79 (Fri. thru Mon. of non-event weekend)	April 2006 4/14/06 AM thru 4/17/06 AM	212
Mitchell Trail	Dirt	~0.1 mile south of Arizona Farms Rd.	April 2006	165

Southwood Road	Dirt	~0.1 mile east of Kenworthy	May 2006	174
Sherry Lane	Dirt	~0.1 mile east of Kenworthy	May 2006	213
Hartman Road	Dirt	~0.1 mile north of Honeycutt Rd.	July 2006	81
Cooper Road	Dirt	~0.1 mile south of Judd Rd.	September 2006	225
Gary Road	Dirt	~0.1 mile north of Silverdale	October 2006	742
Hopi Road	Dirt	~0.1 mile east of Trekell	November 2006	170
Arabian Road	Dirt	~0.2 mile south of Organ Pipe Rd.	December 2006	61
Dune Shadow Road	Dirt	~0.1 mile west of Amarillo Valley Rd.	January 2007	291
Phillips Road	Dirt	~0.1 mile east of Sunland Gin Road	January 2007	100
Geronimo Road	Dirt	~0.1 mile north of Broadway Road	January 2007	270
Arabian Road	Dirt	~0.2 mile south of Organ Pipe Rd.	January 2007	60
Magma Road alignment (utility easement)	Dirt	~0.1 mile east of Edwards Rd.	February 2007	37
Mountain View Road	Dirt	~0.1 mile south of Lost Dutchman Rd	March 2007	214
Mountain View Road	Dirt	~0.1 mile north of Lost Dutchman Rd	March 2007	74
Mountain View Road	Dirt	~0.1 mile north of Jacob Waltz Rd	April 2007	206
Mountain View Road	Dirt	~0.1 mile east of Mountain View Rd	May 2007	181
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Thu. thru Mon. of Country Thunder)	April 2008 4/17/08 AM thru 4/21/09 AM	9150
Clayton Road	Dirt	~0.1 mile east of Ethington Rd.	June 2008	103
Bianco Road	Dirt	~0.1 mile south of Peters Rd.	June 2008	115
Ethington Road	Dirt	~0.1 mile south of Clayton Rd.	June 2008	126
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Wed. thru Mon. of Country Thunder)	April 2009 4/1/09 AM thru 4/6/09 AM	6681
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Tue. thru Mon. of Country Thunder)	April 2010 4/13/09 AM thru 4/19/09 AM (4/15 6pm thru 4/16 8am lost)	6760
Cooper Road	Dirt	0.1 mile south of Magma Rd.	August 2011 (8/12-19/11)	383
Cooper Road	Dirt	0.1 mile south of Magma Rd.	August 2011 (8/22-29/11)	310

Appendix I

A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM10 Concentrations

Arizona Department of Environmental Quality
Air Quality Division

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A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM_{10} Concentrations

Arizona Department of Environmental Quality
Air Quality Division

ABSTRACT

Regional variability in soil characteristics, meteorological trends, and surface disturbances lead to changes in wind blown emission factors (EFs) for a given land use (LU). Therefore, it is prudent to determine accurate EFs for Pinal County in order to provide the most accurate wind blown Emission Inventory (EI) for the completion of the Pinal County State Implementation Plan (SIP). Emission Factor Back Calculation (EFBC) is currently being proposed as a method of wind blown EF estimation in place of wind blown EF literature values for the creation of the Pinal County PM_{10} State Implementation Plan (SIP). This method relies on the use of field measured PM10 concentrations and meteorological data to back-calculate EFs for different land uses. The method depends on accurate completion of the following steps: 1) Land Use Classification, 2) Meteorological and Emission Data Processing, 3) Estimation of Emission Origination Area, 4) ArcGIS Data Integration, and 5) EF Statistical Optimization. Furthermore, the model uses the following simple linear approach during the statistical optimization step:

$$E_n = A_n * EF_n$$

where E_n is total emissions for each land use within a given footprint (tons/hr), A_n is the calculated area of each land use located within each footprint (m^2), and EF_n is the estimated emission factor for each land use located within a given footprint.

This paper presents the steps taken in the EFBC process and further presents a testing of the model, where the proposed SIP design day for the Pinal County Housing monitor of 1/1/2008 was modeled to estimate EFs for 9 different land uses. The estimated hourly EFs were then used to calculate hourly emissions for the design day. Individual hour variability between model estimated PM10 concentrations and PM10 concentrations measured in the field varied between 2% and 282% over the 24 hour period. The average 24 hour PM_{10} concentration for PCH on 1/1/2008 was 264.9 $\mu g/m^3$ as measured at the monitor. The model predicted a 24 hour average concentration for PCH on the design day of 260.4 $\mu g/m^3$.

INTRODUCTION

The Arizona Department of Environmental Quality (ADEQ) in cooperation with the Pinal County Air Quality Department is in the process of preparing a State Implementation Plan (SIP) for particulate matter less than 10 µm (PM_{10}). The purpose of the SIP is to protect human health and welfare through: 1) air monitoring data and analysis, 2) PM_{10} emission inventory, 2) air dispersion modeling to determine maximum concentrations of pollutants, and 4) control measures used in controlling particulate emissions in order to attain the PM_{10} and $PM_{2.5}$ standard.

Airborne particles are a serious threat to human health. Major health concerns due to exposure to PM_{10} include: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, are especially sensitive to the effects of particulate matter.

Ambient levels of PM_{10} measured at air quality monitoring stations within Pinal County show widespread, frequent, and in some instances, severe, violations of the PM_{10} standard, dating back to 2002. Pinal County's PM_{10} levels are among the highest in the country. Based on 2009 – 2011 certified air quality data, the Pinal County Housing monitor, located approximately 11 miles east of Casa Grande, averaged over 14 recorded exceedances per year of the 1987 PM_{10} ambient air quality standard of 150 micrograms per cubic meter ($\mu g/m^3$).

Ambient monitors located in the new nonattainment area routinely record concentrations two to three times the level of the standard and several monitors have recorded levels approaching or exceeding the significant harm level of 600 ($\mu g/m^3$). After reviewing available data, EPA redesignated much of the western half of Pinal County to nonattainment for the 1987 24-hour PM_{10} National Ambient Air Quality Standard (NAAQS) on May 23, 2012. See 75 FR 60680, October 1, 2010.

Redesignation of the western portion of Pinal County to nonattainment requires the State to create a State Implementation Plan (SIP) which proposes reasonable control methods to reduce PM_{10} emissions in Pinal County to levels which comply with EPA's PM_{10} ambient air quality standard. Conformity with these standards are exhibited through modeling of exceedance days prior to and following control technology implementation to demonstrate adequate emissions reductions have been estimated. Modeling is highly dependant on an intimate understanding of the factors within a region that contribute to emissions during low wind, stagnation, and high wind periods.

Low wind emissions are dominated by mechanical activities which cause the entrainment of particulate matter into the atmosphere. As wind speeds increase, wind blown dust entrainment increases resulting in a lower proportion of field measured PM10 concentrations originating from activity based PM entrainment. The degree to which wind blown emissions contribute to ambient air PM_{10} concentrations is dependant on the land use being analyzed. Different land uses can exhibit varying degrees of soil moisture,

soil texture, soil disturbance, surface roughness, and impermeable layer coverage. Furthermore, these characteristics can change for land uses within different regions of the US, State, or even County. For this reason, it is important to identify site specific windblown emission factors (EFs) rather than relying on literature based EFs which may originate from measurements taken from a variety of different locations.

Since performing field measurements of windblown EFs for a variety of land uses using a wind tunnel is resource intensive, ADEQ proposes another method of estimating windblown EFs. The Emission Factor Back Calculation (EFBC) method utilizes field measured meteorological and PM10 concentration data for the sites and periods of interest in order to estimate EFs for land uses that are characteristic for that region. Using field measured meteorological data, the EFBC method estimates emission particle origination areas in order to determine what land uses are contributing emissions impacting the monitor during a period of interest. The method then employs a statistical optimization approach to estimate the most logical EF for each land use within the contributing area.

In this document, ADEQ presents the steps taken to implement the EFBC method. ADEQ further tests the estimated EFs to determine how well PM10 concentrations are calculated using these EFs against the field measured PM10 concentrations for the proposed model design day and location of 1/1/2008 for the Pinal County Housing monitor.

METHODS

The process behind EF back-calculation first relies on land use classification into distinct categories. These categories should cover all land uses necessary to perform a comprehensive EI calculation for the non-attainment area. The second step of the EF back-calculation process is data processing of meteorological and PM10 concentration field data in order to remove periods of incomplete data. This step further requires wind speed, wind direction, mixing height (the height at which there is negligible vertical atmospheric mixing), air temperature, sensible heat flux (the conductive heat flux from the Earth's surface to the atmosphere), and PM10 concentration data be averaged at the daily scale and for some categorizes to be analyzed for variability to insure a group of representative sample periods are utilized for analysis. The third step utilizes the Korman and Meixner analytical footprint model in order to estimate particle emission origination location. This method utilizes probability analysis to calculate an area from which particles (PM_{10}) are most likely to have originated. The next step requires the integration of aerial photography, calculated footprint extents, and land use information into ArcGIS in order to characterize the land uses located within each footprint surrounding the monitors of interest. One footprint analysis is performed for each land use classification previously categorized. The idea is to use the total emissions (as determined from PM_{10} monitor measurements) and the calculated area of each land use (as determined from ArcGIS) within a footprint to back calculate the unknown emission factors utilizing the equation:

$$E_n = A_n * EF_n$$

These equations cannot be solved individually, but must be solved utilizing a statistical optimization technique such as the Newton Method. The Newton Method requires an equal number of equations as unknowns. Therefore, if nine land use types have been identified for EF estimation, nine different equations and thus nine individual footprints must be described. Once all footprints have been created, the Newton Method can be used to solve for all EF's simultaneously by using the Excel Addin known as Solver.

The following sections will outline the steps which were taken to implement this method for the Pinal County Housing (PCH) proposed design day of January 1, 2008. The following steps to the EFBC method are described:

- Land Use Classification
- Meteorological and PM10 Concentration Data Processing
- Estimation of Emissions Origination Area
- ArcGIS Data Integration
- EF Statistical Optimization

Following the estimation of EFs, the proposed design day for PCH of January 1st was modeled to assess the accuracy of these EFs to produce field collected PM10 concentration values.

Land Use Classification

The first step in the EFBC method is to identify and classify the land use types which require EF determination. This will be limited to those land use types within approximately 6 km of the PM_{10} monitors (the distance from the monitors will change with the wind speed examined). For all meteorological conditions tested, land use classification for a 6 km radius area surrounding the monitor was adequate since the Footprint estimation model only identifies those land uses contributing 90% of total emissions to the monitor. Therefore, the footprint emissions origination model predicts that for the meteorological extremes tested in Pinal County, emissions originating from >6 km from the monitor will always comprise < 10% of the total emissions impacting the monitor. Aerial photography and activity records supplied by Pinal County Air Quality Department (PCAQD) were used to classify land uses. The following land uses were identified within 6 km of the Stanfield, Cowtown, Maricopa, and Pinal County Housing monitors:

- Developed Urban Lands
- Developed Rural Lands
- Paved Roads
- Unpaved Roads
- Cleared Areas

- Construction Areas
- Concentrated Animal Feeding Operations - CAFOs (Feedlots & Dairies)
- Desert Shrubland
- Cropland (Fallow & Vegetated)

Characterization of land use for the 1/1/2008 design day was achieved through the examination of an aerial photograph taken of the western portion of Pinal County in early April of 2008 (LandisCor), PCAQD and ADEQ road maps, and 2008 active CAFO location maps and active construction areas provided by PCAQD. Each land use required the creation of 1 emission footprint (as discussed later in this document). Therefore, 9 land use classifications will require 9 footprints with each footprint's extent covering a unique land use classification.

Meteorological and Emission Data processing

The next step requires the acquisition and processing of wind speed, wind direction, mixing height, sensible heat flux, and field measured PM10 concentration data from the stations of interest. For the purposes of testing the PCH 1/1/2008 design day, data was processed from 4 monitors within the nonattainment area: Cowtown, Pinal County Housing, Stanfield, and Maricopa. These 4 monitors recorded the highest number of exceedances during the year of 2008 providing the most conservative datasets available from a regulatory standpoint. Furthermore, processing multiple meteorological and PM10 concentration datasets allowed ADEQ to create EFs representative of the entire nonattainment area rather than for a small section of the nonattainment area.

The first step of data processing was to isolate only the hourly data which occurred during the winter of 2008 (December 22nd – March 20th). Arizona Meteorological Network (AZMET) rainfall data was analyzed for all rain gauges located within the nonattainment area. Any date when a rain gauge registered greater than 2 mm for the day was removed from the data pool to minimize the effects of precipitation. Hourly periods where data were missing were interpolated. Wind speed, wind direction, and PM_{10} concentration values were taken from field measurements. Mixing heights and sensible heat fluxes were calculated by AERMET using meteorological data (including upper air sounding information) from Tucson, AZ. Hourly seasonal temperature was averaged from AZMET values for the year of 2008. Hourly data at each station was then separated by hour of the day, wind direction, and wind speed at a 10 m height into the following groupings:

Hour periods: 0-700, 800-1500, 1600-2300
Wind Direction: 20 degrees increments
Wind speed periods (mph): 0-3. 3-6, 6-9, 9-12, 12-15, 15-18, 18+

Data was then averaged in each group. Averaging of similar data allows the model to create sample sizes greater than 1 to reduce the effect of outliers. The averaged data created a representative dataset of meteorological and PM10 concentration data to be utilized for emission footprint creation.

Estimation of Emissions Origination Area

Characterization of the land uses contributing to emissions impacting the monitor requires the estimation of the area from which the emissions originate. Back trajectories were considered for this purpose; however, the use of back trajectories does not account for particle deposition rates. In order to account for this, emission footprints were estimated using the EdiTools program known as "Footprint" *(http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/).* Footprint creates an image representative of the measurement site of interest dependent on the meteorological characteristics input into the model. This image can then be imported into ArcGIS for characterization contributing land uses. The Footprint model is a windows desktop implementation of the Korman and Meixner analytical footprint model (2001). This model accounts for vertical turbulence and cross-wind dispersion in order to back calculate particle motion based on a range of meteorological inputs such as: wind speed, wind direction, distance to obstructions, air temperature, sensible heat flux, mixing height, and surrounding vegetation canopy density and height. The model originates from the advection/diffusion equation but has shown good agreement with a Lagrangian stochastic particle dispersion model (Kljun *et al.* 2003).

The following information was utilized for creation of footprints for the modeling of the PCH 1/1/2008 design day:

- "Map X/Y dimension, meters" is the distance from the station to the nearest large obstruction (i.e. hill, mountain, etc) in the direction from which the wind flow originates, which was determined from aerial photography of the region to be approximately 15 km for each of the monitors,
- "Maximum Fetch" was determined by the length of the footprint,
- "Measurement height" was set to the height at which the PM10 concentration measurements were taken and varied for each monitor,
- "Canopy Height" was estimated as 0.6m,
- "Canopy Area Density" was estimated as 1.0,
- "Boundary Layer Depth" is the average mixing height estimated by AERMET,
- "Sensible Heat Flux" was estimated by AERMET,
- "Air Temperature" was estimated to hourly averages for the season based on AZMET data from 2008,
- "Wind Speed" was obtained from field measurements at the monitors,
- "Wind Direction" was obtained from field measurements at the monitors,
- And the "Brightness distribution footprint boundary, %" was set to 90% to estimate the origination area of 90% of the emissions.

A single emission estimation origination footprint was created for each EF needed to model the January 1, 2008 proposed design day for PCH. For each unique wind speed and hour of day grouping it was necessary to create 9 footprints. Each of these footprints contained a unique land use type so that EFs could be created for all 9 land use types for

each wind speed/hour of day grouping. The total number of footprints created for the testing of the PCH 1/1/2008 design day was 80.

ArcGIS Data Integration

The next step of the method utilized ArcGIS (Esri) to plot each footprint and to determine the boundaries for each land use within a given footprint. Images created during the Footprint processing portion of the method were loaded into ArcGIS. The receptor (i.e. PM_{10} monitor) on each footprint was geo-rectified to match the physical location of the monitor station of interest and the scale of the footprints were adjusted to match that of the land use data layer. New polygons were created to outline the footprint boundary. When necessary, these polygons were clipped to insure the extent of the footprint did not exceed the distance a parcel of air could travel in an hour. The land use polygon was then clipped to the boundary of the individual footprint polygons to create a land use polygon unique to each footprint polygon. Land use areas and road lengths were then calculated in ArcGIS. Road width was utilized to estimate road area for unpaved and paved roadways.

Statistical Optimization of EFs

The final step of the emission factor back calculation process involves data consolidation and statistical optimization in order to estimate the EFs for each land use. For each footprint, the total area of each land use type was summed in ArcGIS. After calculating the total land use area for each footprint, the data was compiled in MS Excel. For the optimization process each land use must be contained within at least one unique footprint.

Following the consolidation of data, the emissions from the total footprint must be calculated from the field PM_{10} average concentrations for the period of interest. Daily average emissions at the station are calculated using the following equation:

$$E = \frac{A_{FP} * H_M * C}{907{,}184{,}740{,}000}$$

where E is the average emissions captured by the station [tons], A_{FP} is the area of the emissions origination footprint [m^2], H_M is the atmospheric mixing height [m], C is the average hourly measured PM_{10} concentration [$\mu g/m^3$], and 907,184,740,000 is the conversion factor from micrograms to tons. Once this has been calculated for each footprint, an E_{80} or E_{90} can be calculated so 80% or 90% of the total emissions can be attributed to the 80% or 90% footprint (percentage is dependant on which footprint size reasonably fit within the boundaries of the Footprint model boundaries):

$$E_{80} = 0.8 * E \text{ or } E_{90} = 0.9 * E$$

The final step requires the use of statistical optimization in order to simultaneously back calculate all 9 EFs for each wind speed/diurnal temporal grouping. In order to complete this process, the Excel Addin - Solver was utilized to apply the Newton Method. Solver

was set up to simultaneously calculate all EFs and the difference between the calculated PM10 concentrations using those EFs for each footprint and the field measured PM10 concentrations for each footprint (this value is known as the Error). Solver was then instructed to minimize the sum of the individual Errors squared for all footprints. Using this method, Solver determined the most appropriate EF values for each land use across all footprints in order to minimize Error using the equation:

$$\sum_{x=a}^{o} A_x * EF_x + \varepsilon$$

where A_x is a given land use Area, EF_x is the estimated Emission Factor of land use x, and ε is the Error associated with the footprint of interest.

After the creation of individual EFs for all land uses at all wind speeds for the 3 periods of the day, wind blown EFs were determined by subtracting low wind EFs (i.e. 0-3 mph winds) from all higher wind speed emission factors (i.e. 3-6, 6-9, 9-12, 12-15, 15-18, and 18+ mph) for all 9 land uses during each of the 3 temporal periods of the day (0-700, 800-1500, and 1600-2300 hours). By doing so, activity driven emissions could be separated from wind blown emissions in order to adequately calculate EFs which were only dependant on emissions originating from windblown PM_{10} entrainment.

Design Day Modeling

Due to time constraints, modeling using AERMOD could not be performed to test the validity of the back calculated EFs. Therefore, a simplified model was utilized to test the accuracy of the estimated EFs. Model validity was tested using the EFs estimated for each land use by the EFBC method and applying the appropriate EFs to each hour of the design day. Since PM_{10} entrainment originating from stagnation activities were unknown, estimated EFs created prior to the wind blown correction were utilized in this testing in order to account for unknown stagnation emissions as well. Testing was achieved by using the meteorological data for each hour of the January 1st proposed PCH design day to create 24 unique emission origination footprints using the EdiRe Footprint program. These footprints represented the estimated origination area of 90% of the emissions impacting the station for a given hour of the design day. These 24 footprints were used in the same method described on the "*ArcGIS Data Integration*" section to determine the total land use area contributing emissions for each hour of the day. Each hour was modeled separately, multiplying EFs by the corresponding land use area to determine the emissions from each land use type and then summing all land use emissions for the hour. Total emissions were then converted to PM_{10} atmospheric concentrations to compare to monitor measured concentrations on the design day by modifying the equation:

$$E = \frac{A_{FP} * H_M * C}{907{,}184{,}740{,}000}$$

to calculate for C, whereby:

$$C = \frac{907{,}184{,}740{,}000 * E}{A_{FP} * H_M}$$

The variables *A* and *H* were based on the hourly measurements specific to the design day being tested. Hourly calculated concentrations were then compared to PM_{10} concentrations measured at the monitor for the design day.

RESULTS

EF Estimation

The EFBC method relies upon adequate characterization and classification of emission contributing lands into discrete categories. For the purposes of the initial test of this method, land uses were classified into 9 categories. Table 1 gives a description of each of these Land Use (LU) codes. These LU codes will be used in subsequent graphs and tables.

Table 1: Land use code categories

Landuse Code	Description
A	Developed Urban Lands
B	Developed Rural Lands (low density residential)
C	Paved Roads
D	Unpaved Roads
E	Cleared Areas
F	Construction Area
G	CAFOs and Dairies
H	Desert Shrubland
I&J	Fallow and Active Crop Fields

For the purposes of creating the necessary EFs for all land uses during the PCH January 1, 2008 design day, nine wind speed/period of day combinations were required. Table 2 shows these combinations. For instance, on January 1stfor 000-700 hours winds speeds between 0-3 mph and 3-6 mph were registered at the PCH monitor, but no wind speeds higher than this were registered during this timeframe. Therefore, EFs were developed for these 2 wind speed bins, but not for any higher wind speeds for this time of day. Altogether, Table 2 gives 80 estimated EFs for 9 LUs as determined using the EFBC methodology. These EFs were estimated during the winter period of 2008 (Dec 21 – Mar 20). These EFs have not been corrected to remove stagnation, activity driven emissions. An emission factor for land use G (CAFOs and Dairies) could not be determined for the winter of 2008 for wind speeds over 18 mph at a 10m height between the hours of 1600 and 2300 due to lack of available data. This EF was not necessary to test the PCH 1/1/2008 proposed design day.

Table 2: Estimated EFs [tons/m^2/hr] for different wind speeds and times of the day for the winter months of 2008. These EFs were calculated using the EF back calculation (EFBC) model. These EFs include emissions originating from stagnation activities.

LU ID	A	B	C	D	E	F	G	H	I&J
0-3mph 000-700hrs	5.45E-10	1.87E-10	1.18E-10	3.14E-11	2.07E-10	6.43E-10	2.45E-09	7.68E-10	1.37E-09
0-3mph 800-1500hrs	6.70E-09	2.94E-10	3.13E-08	5.73E-11	7.13E-11	2.89E-08	4.84E-10	2.58E-10	2.33E-09
0-3mph 1600-2300hrs	2.10E-10	1.41E-10	5.09E-11	7.12E-11	1.59E-10	5.32E-11	6.44E-08	6.86E-10	6.39E-09
3-6mph 000-700hrs	1.44E-09	1.36E-09	3.53E-10	1.60E-10	1.21E-09	2.34E-10	1.62E-10	1.97E-09	2.00E-09
3-6mph 800-1500hrs	1.32E-09	9.49E-10	1.73E-10	7.34E-11	1.84E-10	1.88E-10	2.35E-09	5.25E-10	1.63E-09
15-18mph 800-1500hrs	7.39E-07	4.57E-07	1.04E-07	4.23E-08	2.29E-08	8.48E-09	1.57E-09	7.58E-07	3.28E-08
15-18mph 1600-2300hrs	1.65E-07	1.45E-07	3.70E-08	9.63E-09	3.40E-08	5.67E-08	2.02E-09	1.75E-07	1.80E-07
18+mph 800-1500hrs	5.93E-07	1.09E-06	1.87E-07	1.12E-07	5.13E-07	1.21E-08	4.36E-10	2.07E-06	1.21E-06
18+mph 1600-2300hrs	1.35E-08	1.11E-07	2.33E-07	1.67E-07	3.95E-06	1.48E-06	NA	6.60E-08	2.36E-07

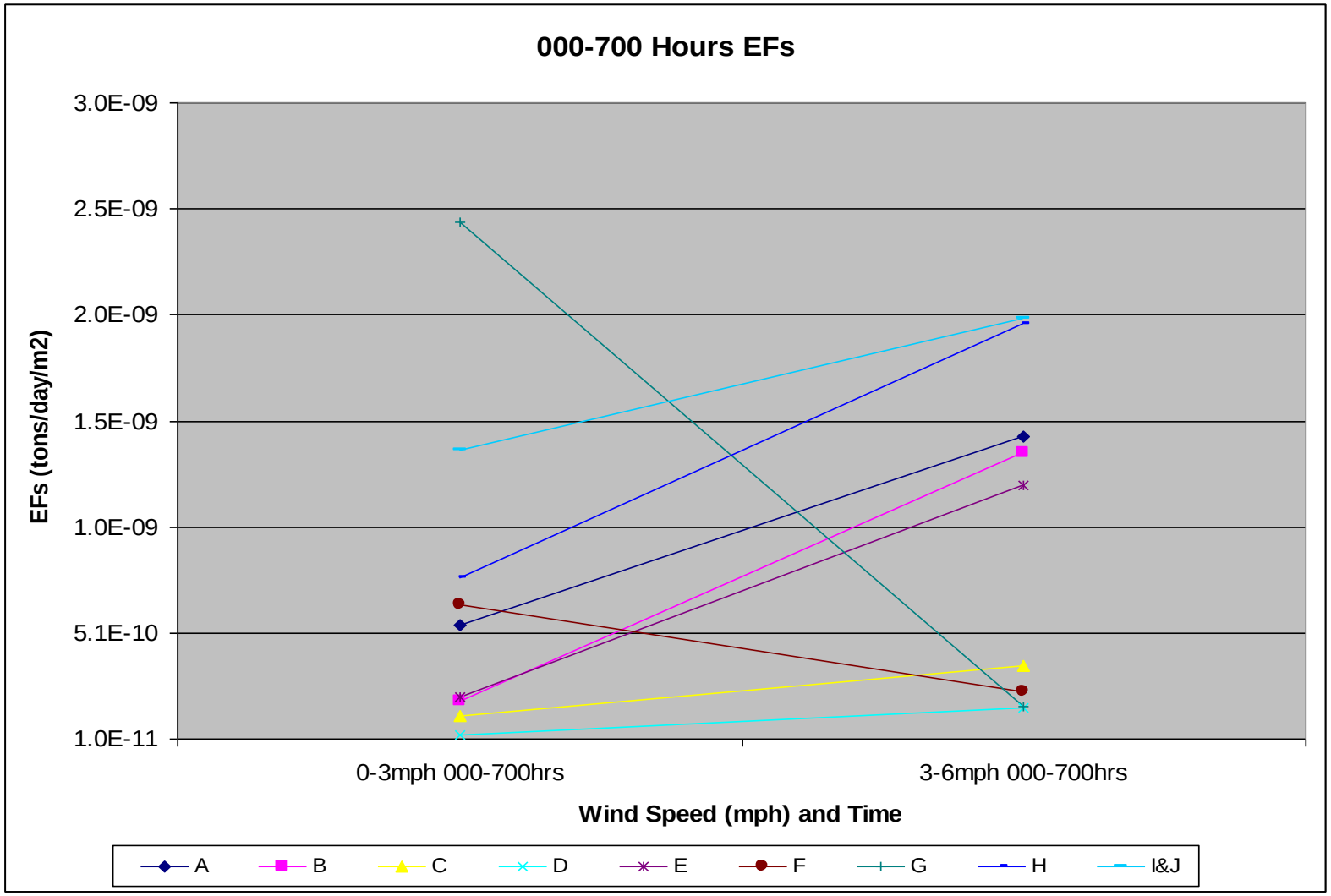

Figure 1: Estimated Winter Emission Factors [tons/m2/hour] for all land uses between 0-700 hours for the wind speed categories of 0-3 mph and 3-6 mph. Wind speeds were adjusted for a 10m height.

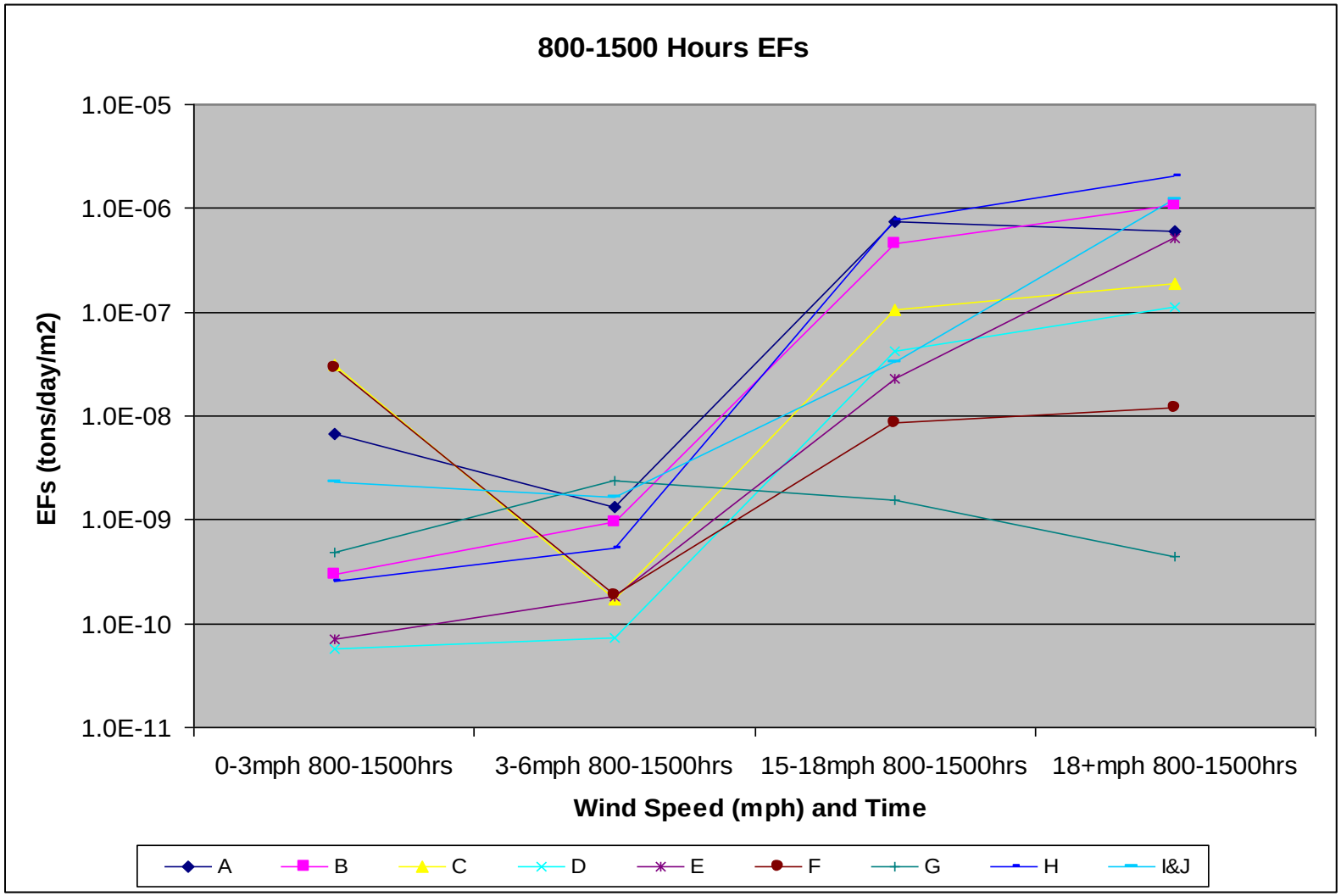

Figure 2: Estimated Winter Emission Factors [tons/m2/hour] for all land uses between 800-1500 hours for the wind speed categories of 0-3 mph, 3-6 mph, 15-18 mph, and 18+ mph. Wind speeds were adjusted for a 10m height.

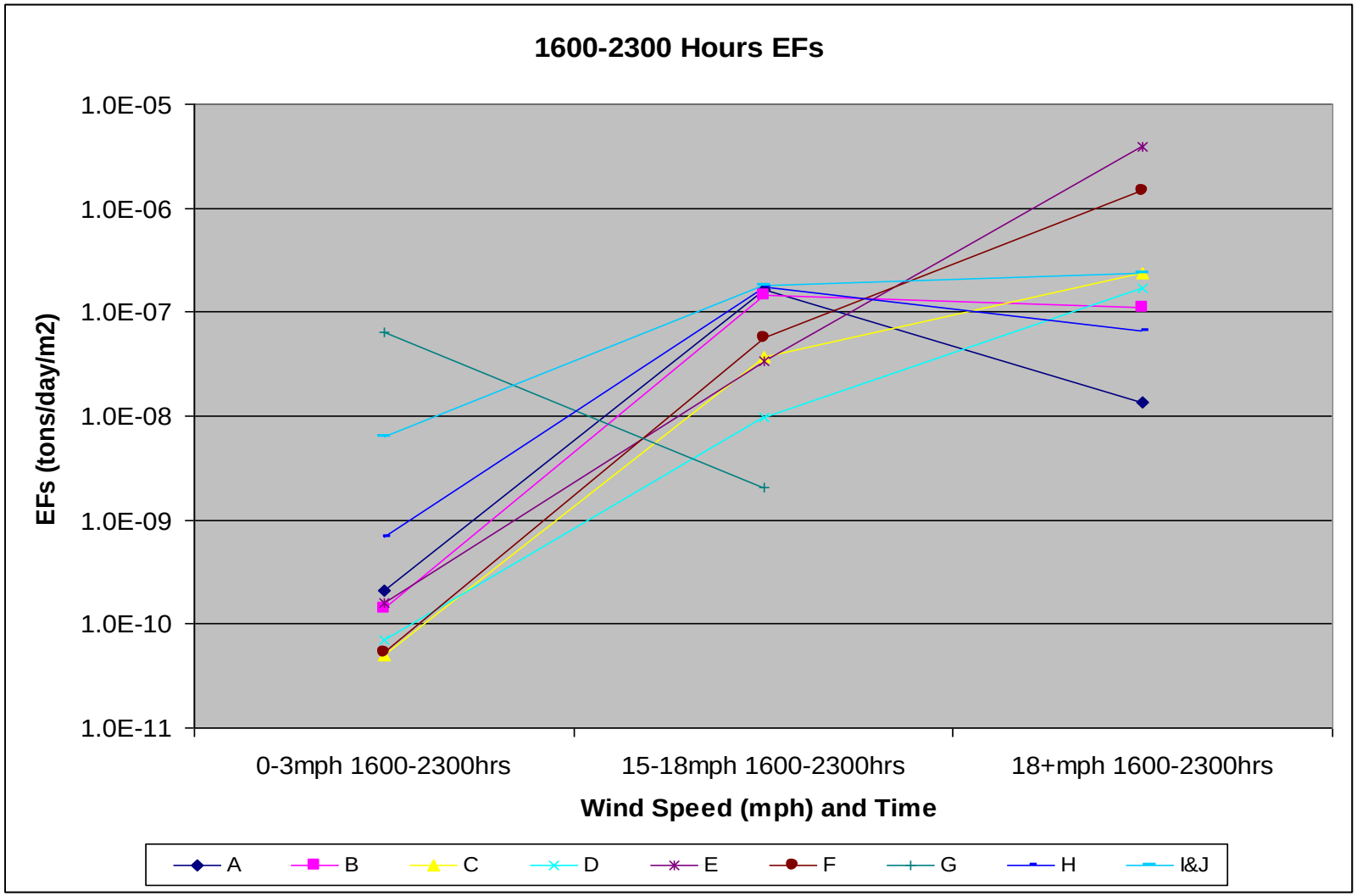

Figure 3: Estimated Winter Emission Factors [tons/m2/hour] for all land uses between 1600-2300 hours for the wind speed categories of 0-3 mph, 15-18 mph, and 18+ mph. Wind speeds were adjusted for a 10m height.

Figures 1-3 show how these estimated EFs change with varying wind speeds for the three periods of the day for which they were calculated (0-700 hours, 800-1500 hours, and 1600-2300hours). CAFOs and Dairies (Land Use type G) is the only land use which showed decreasing emission rates with increasing wind speeds. This could be attributed to cattle movement patterns. As wind speeds increase, especially into extreme speeds such as 15+ mph, cattle may be less likely to move around which would reduce mechanical entrainment not related to windblown emissions. During the early and late hours of the day, Croplands and CAFOs have the highest EFs under stagnation conditions, likely due to the increased activity on these lands in comparison to other land uses at the same time of day. During the mid-hours of the day, construction areas, paved roads, and urban developed lands have much higher stagnation related emission rates. This is also attributable to the increased activity on these lands during the middle portion of the day for winter months.

The next step in the windblown EF estimation process was to correct the EFs listed above for stagnation, activity driven emissions. In order to do so, EFs for wind speeds less than 3 mph were subtracted from wind speeds greater than 3 mph. In this way, windblown EFs were created through the removal of activity driven emissions. Land uses which exhibited decreasing emission factors with increasing wind speeds were assumed to have negligible emissions originating from wind and were thus given wind blown EFs of 0 tons/m^2/hour. Table 3 presents wind blown EFs after correcting for stagnation, activity driven emissions.

For the early hours of the day (000-700 hours) low speeds (i.e. 0-3 mph) exhibited the highest windblown EFs for Desert Shrublands, Developed Rural Lands, and Cleared Areas followed by Developed Urban Lands and Crop Fields. The first 3 land use types are likely to have large reservoirs for PM_{10} entrainment with the possibility of being highly disturbed. Developed Urban Lands and a majority of Crop Fields are going to have a high degree of land coverage to reduce emission factors.

For all hours of the day, as wind speeds increase Desert Shrubland EFs increase with the exception of the late hours of the day. As wind speeds transition from 15-18 mph to 18+ mph Desert Shrubland EFs decrease slightly which could be an artifact of reservoir depletion in the late hours of the day. In fact, 3 of the 4 instances where EFs decreased when transitioning from 15-18 mph to 18+ mph for a given land use occurred in the later hours of the day (1600-2300 hours), indicating reservoir depletion may in fact be playing a significant role. Cleared Areas and Crop Fields showed drastic increases in EFs during the middle of the day (800-1500 hours) with increasing wind speed, while in the late hours of the day (1600-2300 hours) Unpaved Roads, Cleared Areas, and Construction Areas showed the greatest increases in emission factors with increasing wind speed. Developed Urban and Rural Lands had consistently high EFs as did Paved Roads. The elevated Developed Urban Lands and Paved Road EFs were surprising due to the degree to which these land uses have coverage to reduce the reservoir size.

Table 3: Estimated wind blown EFs [tons/m^2/hr] for different wind speeds and times of the day for the winter months of 2008. These EFs were calculated using the EF back calculation model, and were corrected to remove stagnation activities.

LU ID	A	B	C	D	E	F	G	H	I&J
3-6mph 000-700hrs	8.91E-10	1.17E-09	2.35E-10	1.28E-10	1.00E-09	0.00E+00	0.00E+00	1.20E-09	6.26E-10
3-6mph 800-1500hrs	0.00E+00	6.55E-10	0.00E+00	1.61E-11	1.13E-10	0.00E+00	1.86E-09	2.66E-10	0.00E+00
15-18mph 800-1500hrs	7.32E-07	4.57E-07	7.28E-08	4.22E-08	2.29E-08	0.00E+00	1.08E-09	7.58E-07	3.05E-08
15-18mph 1600-2300hrs	1.65E-07	1.45E-07	3.69E-08	9.56E-09	3.39E-08	5.67E-08	0.00E+00	1.75E-07	1.74E-07
18+mph 800-1500hrs	5.86E-07	1.09E-06	1.55E-07	1.12E-07	5.13E-07	0.00E+00	0.00E+00	2.07E-06	1.21E-06
18+mph 1600-2300hrs	1.33E-08	1.11E-07	2.33E-07	1.67E-07	3.95E-06	1.48E-06	0.00E+00	6.53E-08	2.30E-07

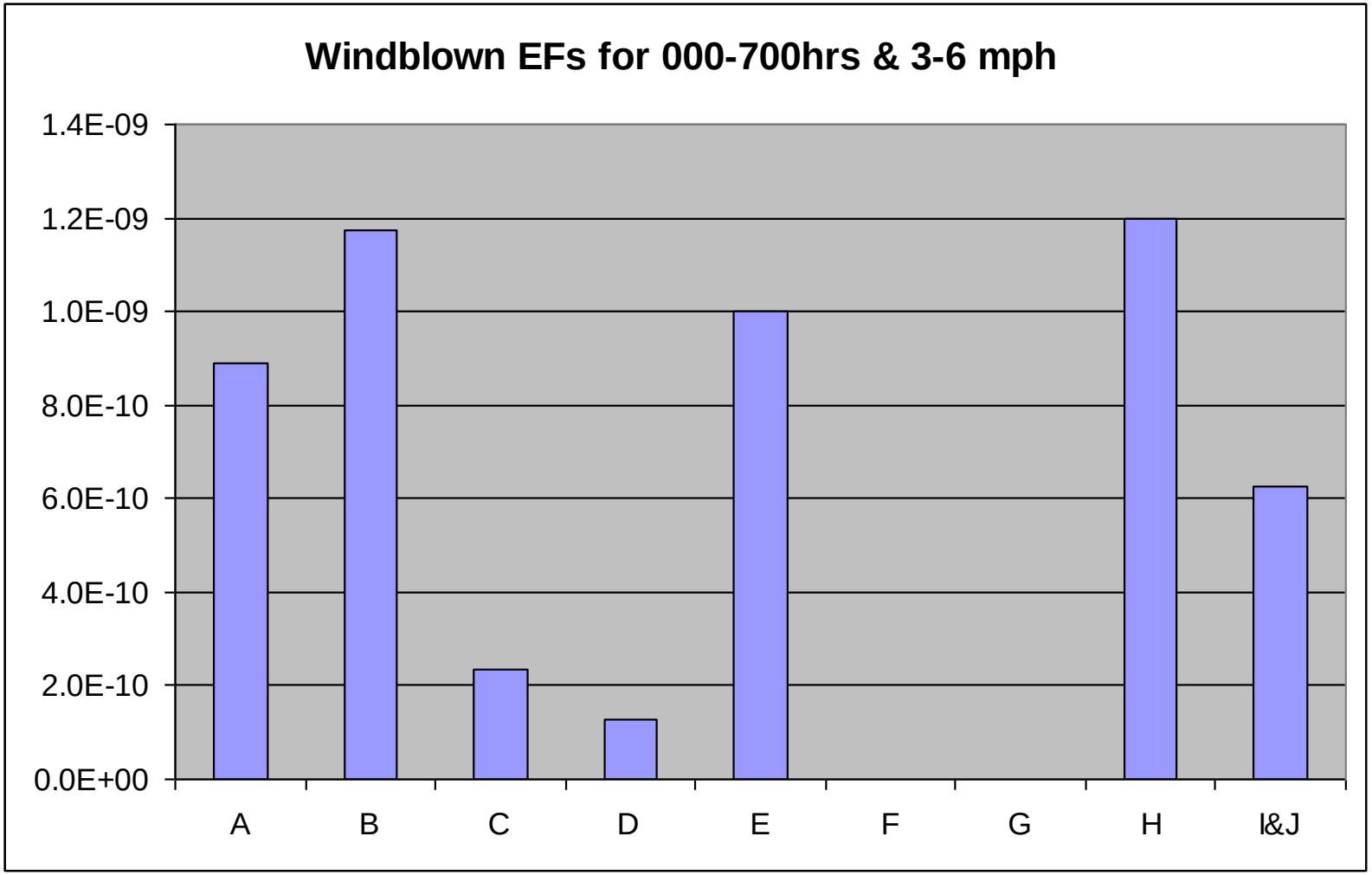

Figure 4: Estimated Winter Windblown Emission Factors [tons/m2/hour] for all land uses between 0-700 hours for the wind speed category of 3-6 mph. Wind speeds were adjusted for a 10m height. These EFs were corrected for stagnation, activity driven emissions.

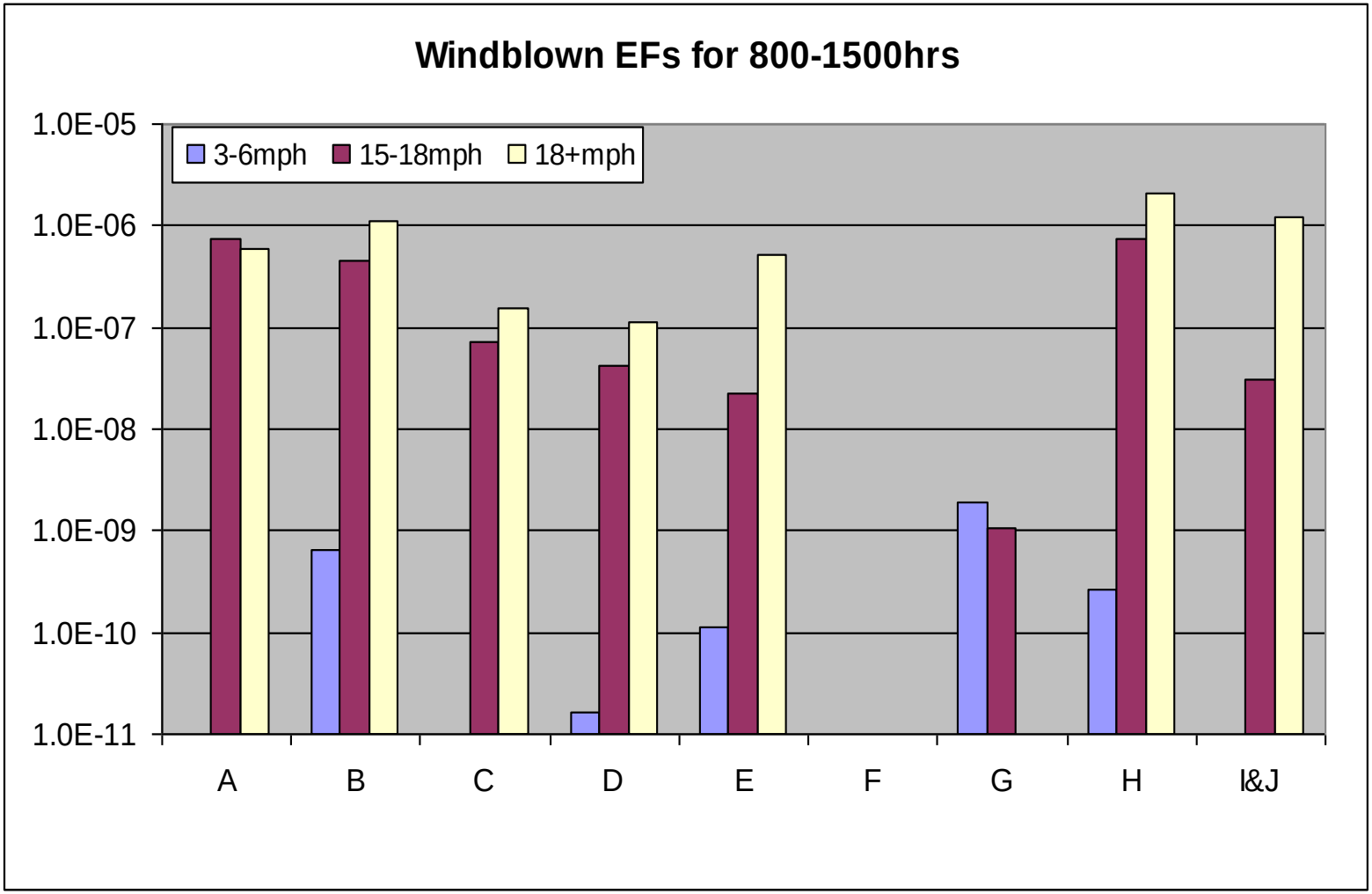

Figure 5: Estimated Winter Windblown Emission Factors [tons/m2/hour] for all land uses between 800-1500 hours for the wind speed categories of 3-6 mph, 15-18 mph, and 18+ mph. Wind speeds were adjusted for a 10m height. These EFs were corrected for stagnation, activity driven emissions.

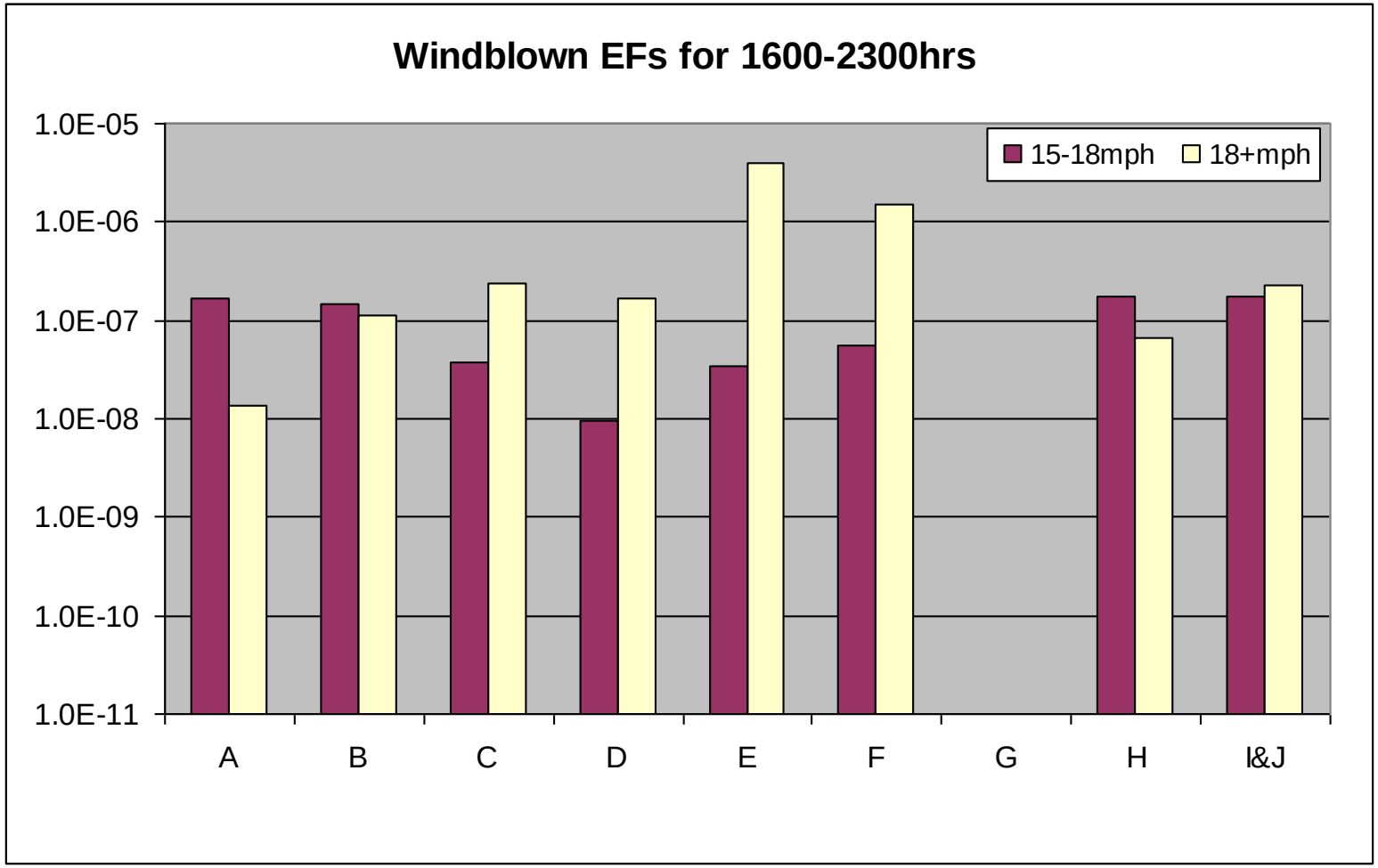

Figure 6: Estimated Winter Windblown Emission Factors [tons/m2/hour] for all land uses between 1600-2300 hours for the wind speed categories of 15-18 mph and 18+ mph. Wind speeds were adjusted for a 10m height. These EFs were corrected for stagnation, activity driven emissions.

EF estimation Variability and Error

The EF back calculation method attempts to minimize data variability by grouping similar wind speeds, wind directions, hours of the day, and only utilizing data from the season of interest on dates where rainfall was less than 2 mm. However, natural variability will still occur in emissions data due to soil texture variability within the modeled region; reservoir depletion over consecutive high wind hours; variability in soil moisture over the modeled region; variability in stagnation, activity related emissions; etc. This variability is reflected in Table 3. Table 3 presents the error matrix which calculates the percent error for each footprint when back calculating the EFs for each wind speed/diurnal temporal grouping (separated by rows in the table). This error was calculated using the following equation:

$$\%\varepsilon = \frac{\left(E - |\varepsilon|\right)}{E}$$

where E is the field measured emissions [tons/hour] and $|\varepsilon|$ is the absolute value of the error from the previously mentioned equation:

$$\sum_{x=a}^{o} A_x * EF_x + \varepsilon$$

The variability in this error accentuates the variability which can be seen in field measured PM10 concentrations under similar meteorological conditions.

Table 3: This error matrix shows the percent errors associated with each footprint during the back calculation portion for determining EFs. Positive errors indicate that the measured field PM10 concentrations are larger than the errors for that footprint during statistical optimization. Negative errors indicate that the measured field PM10 concentrations are larger than the errors for that footprint during statistical optimization. Strongly negative values show poor correlation resulting from highly variable data. Only 8 footprints were calculated for the last row of data since CAFOs and Dairies were not found to contribute during any hours with these meteorological characteristics.

EF Back Calculation Error Matrix (%)									
	1	2	3	4	5	6	7	8	9
0-3mph 000-700hrs	72	102	-51	-63	105	119	23	-131	124
0-3mph 800-1500hrs	198	179	197	156	198	198	98	95	100
0-3mph 1600-2300hrs	-108	25	-245	-704	-573	124	116	71	-25
3-6mph 000-700hrs	83	88	-239	-66	69	70	91	100	88
3-6mph 800-1500hrs	116	98	23	124	15	100	-149	-140	100
15-18mph 800-1500hrs	86	-335	-1862	-251	-1594	-575	-2297	-890	-3447
15-18mph 1600-2300hrs	-449	-191	34	-125	-155	-2937	-523	-322	-252
18+mph 800-1500hrs	48	-3601	93	-3519	-2673	-1240	-3693	-1543	-33
18+mph 1600-2300hrs	-133	40	-388	-333	100	-1	-2755	-17271	

Design Day Modeling

The estimated EFs for the winter of 2008 presented in Table 2 were used to test how well total hourly estimated PM10 concentrations using a simplified modeling approach would compare to field measured PM10 concentrations for the Pinal County Housing design day of January 1, 2008. Wind blown EFs could not be used since activity driven emissions from the January 1st design day had not yet been determined. Therefore, uncorrected emission factors (i.e. EFs which account for stagnation, activity driven emissions as well as wind blown emissions) were utilized in testing the model performance against field measured PM10 concentrations. Figure 7 presents this comparison and shows fairly good model results against field measured values. Modeled peak PM10 concentrations are delayed by 3 hours in comparison to field measured data; however, the overall trend is captured and for most hours of the day there is only a small amount of error between field measured and model estimated PM_{10} atmospheric concentrations. The average hourly error throughout the day is 97%, as calculated by the equation:

$$\%Difference = \frac{\left|C_{Model} - C_{Measured}\right|}{C_{Measured}}$$

Where C_{Model} is the PM_{10} concentration which was modeled ($\mu g/m^3$) and $C_{Measured}$ is the PM_{10} concentration ($\mu g/m^3$) measured at the monitor for that hour of the design day. The model performed very well at the daily scale. PCAQD reported a 24 hour PM_{10} concentration for PCH on 1/1/2008 of 264.9 $\mu g/m^3$ and the model predicted a 24 hour average concentration of 260.4 $\mu g/m^3$. The estimated 24 hour average was calculated by averaging each of the individual 24 hourly estimated PM_{10} concentrations, where:

$$C_{24} = \frac{\sum_{h=100}^{2400} C_h}{24}$$

C_{24} is the average 24 hour concentration ($\mu g/m^3$) and C_h ($\mu g/m^3$) is the estimated PM_{10} concentration for each of the 24 estimated hourly concentrations.

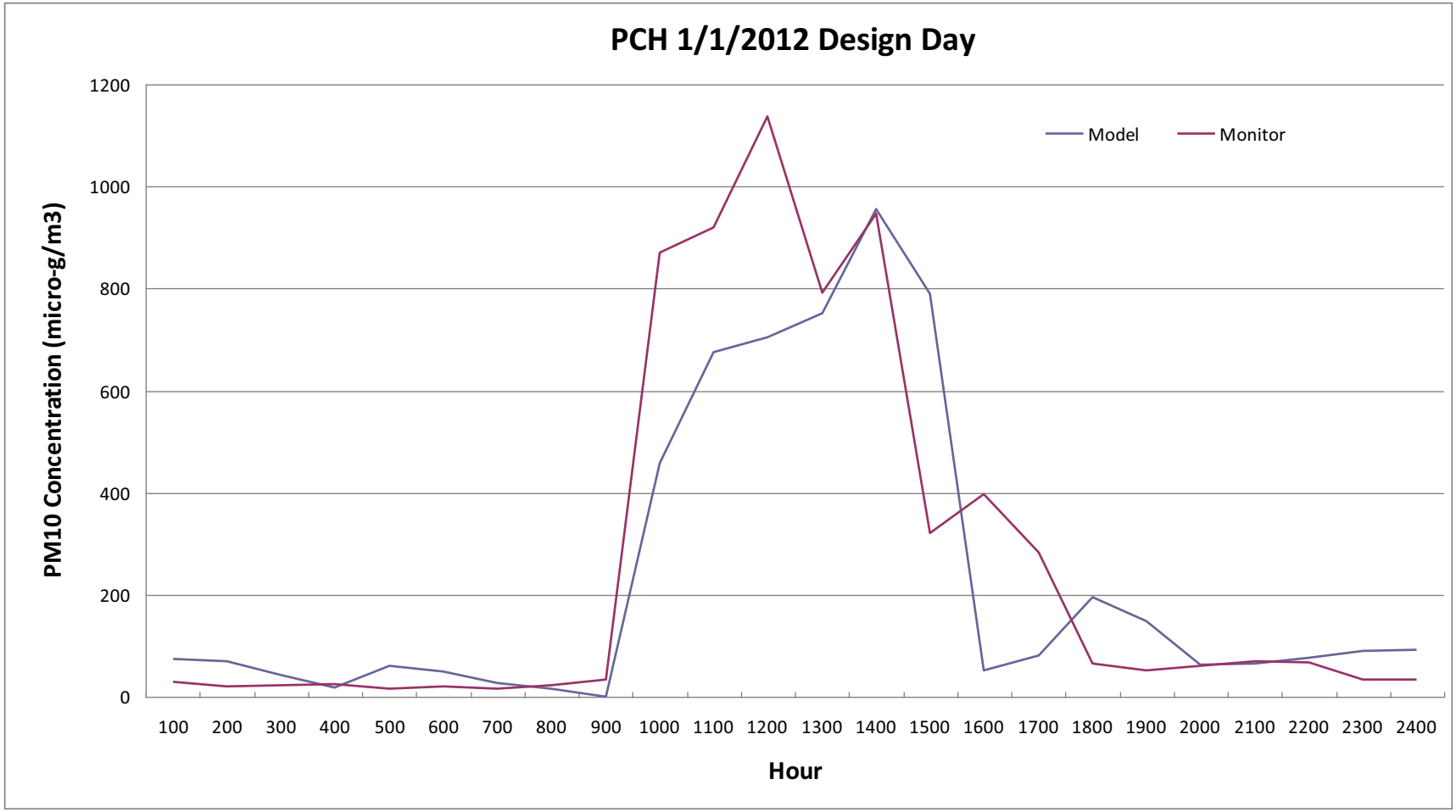

Figure 7: A comparison of field measured PM10 concentrations (Monitor) against PM10 concentrations predicted using EFs estimated by the back calculation method (Model) for each hour of the 1/1/2008 PCH design day.

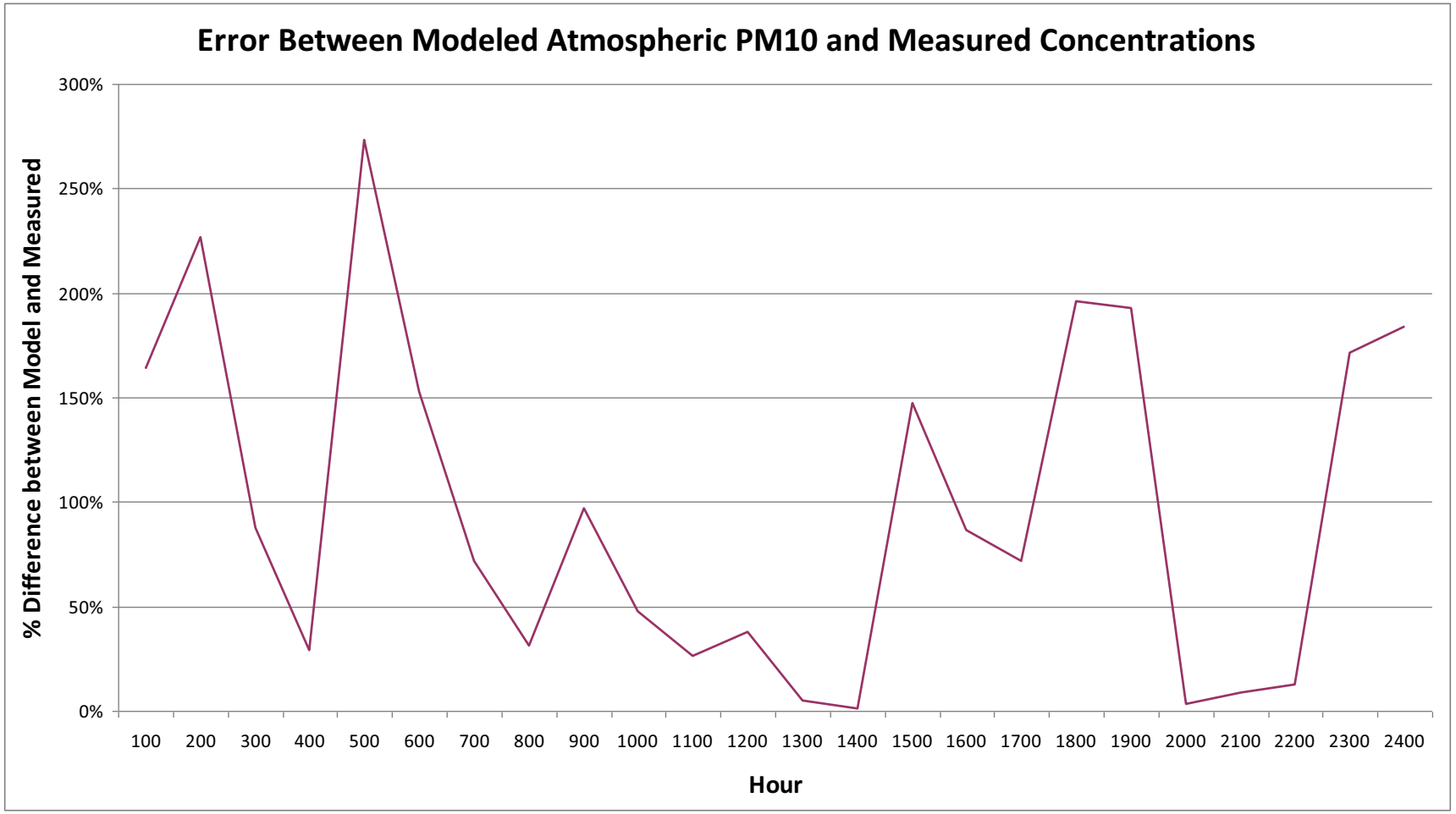

Figure 8: Calculated Difference between modeled and measured atmospheric PM_{10} concentrations for each hour of the PCH 1/1/2008 design day.

DISCUSSION

The EF Back Calculation Method utilizes field measured PM10 concentrations and meteorological data in an attempt to accurately estimate EFs for a variety of land use types within a given area. The estimated EFs using this method are specific to the area for which the model is run. This is preferential to literature reported EFs which may be calculated in an environment uniquely different from the modeled area. Pinal County is a region of high soil disturbance, low annual rainfall, and low surface friction due to a lack of vegetative cover. For these reasons, EFs specific to the region were needed and the EFBC method was employed. In this document, the methodology behind the EF back calculation method is presented. In addition, the resulting estimated EFs from a test run were utilized in a simplified model to gauge the accuracy of these EFs for one of the design days proposed for modeling in the Pinal County State Implementation Plan. The EFBC method provided some individual EFs which were counter intuitive, such as EFs from paved and unpaved roads being comparable. These issues could be due to statistical optimization problems with these land use types due to the small relative area they exhibit in relation to other land use types used in the model. This could also be due to incorrect characterization of land uses, requiring a review of the land use classification layers used for the model. Despite these issues, when the EFBC estimated EFs were modeled for the PCH January 1, 2008 design day, the results exhibited good agreement with field measured PM_{10} concentrations at the hourly scale and excellent agreement at the daily scale (i.e. 24 hour average PM_{10} concentrations) using a simplified modeling approach. Further work will need to be done to test validity of these estimated EFs in an EPA approved model such as AERMOD. The use of AERMOD will provide a different modeling domain than that used in the simplified modeling approach presented in this paper as well as account for deposition and dispersion effects on the modeling domain not directly accounted for in the simplified approach presented above. However, the preliminary results presented in the model above using EFs estimated by the EFBC method indicate this method represents a reasonable way to estimate area specific EFs from field measured meteorological and PM10 concentration data for PM_{10} concentration modeling. While WRAP or AP-42 regionally or nationally based EF values and equations present more generalized values, this method allows the user to specify the land use types of interest and develop EFs originating from locally sampled data.

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Kljun, N.; Kormann, R.; Rotach, M.W.; Meixner, F.X. Comparison of the Lagrangian Footprint Model LPDM-B with an Analytical Footprint Model. 2003. *Boundary-Layer Meteorology*, 106: 349-355.

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Appendix J

MAG 2012 Five Percent Plan for PM10 for the
Maricopa County Nonattainment Area
May 2012

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INVENTORY DEVELOPMENT

Under a rollback modeling scheme, reductions of emissions that impact the monitor are assumed to result in an equal reduction in monitor concentrations. As such, both base case (2007) low and high wind inventories must be developed along with control case (2012) low and high wind inventories. This following describes in detail how the 2007 base year and 2012 control/attainment year high and low wind inventories were developed. Details on how the base and attainment year inventories are developed for the entire nonattainment area are presented in Chapters II and III of this TSD.

High Wind Inventories

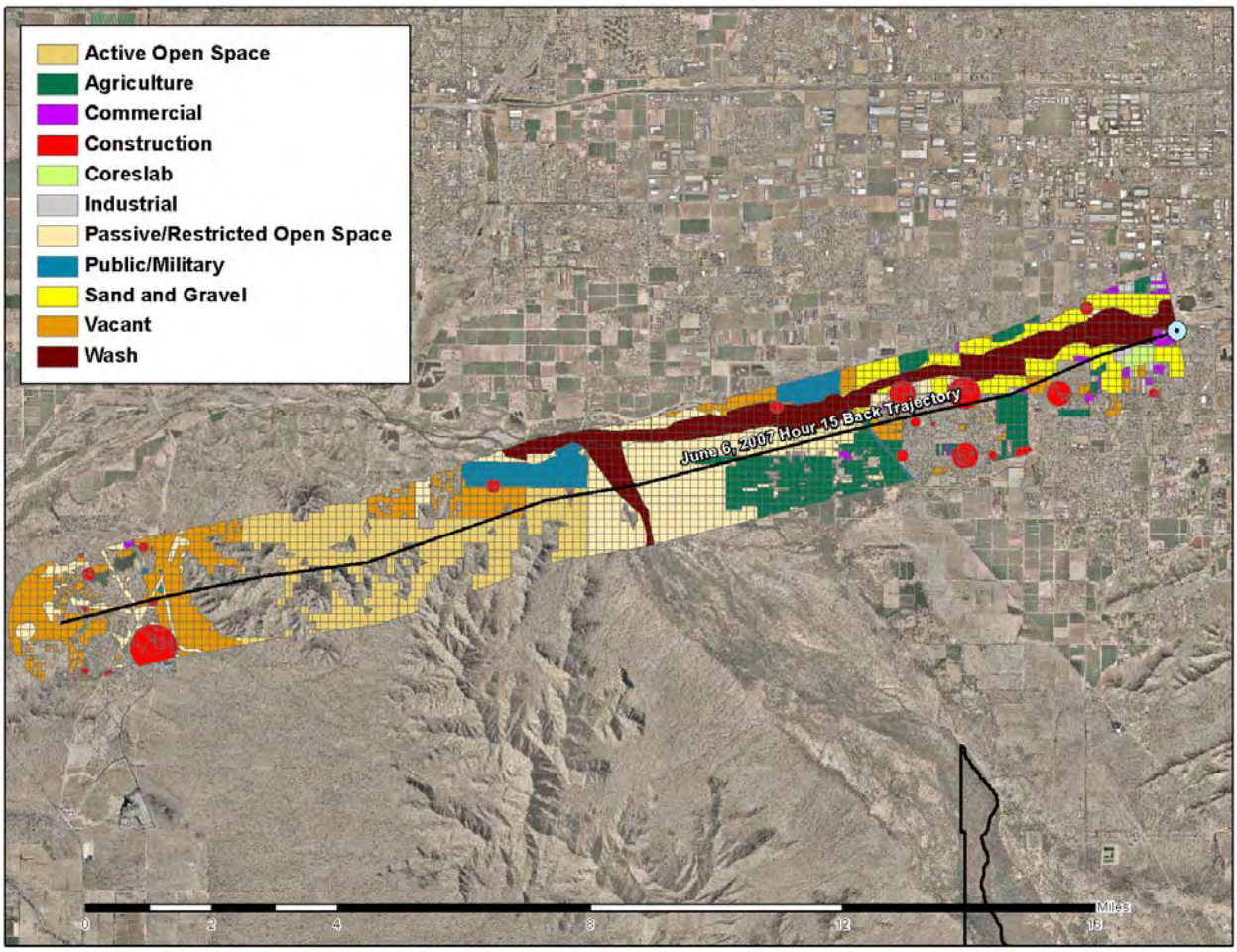
For the high wind hours, hourly windblown PM-10 emissions are calculated based upon the land uses that fall within each of the hourly high wind domains. Land use data, with the exception of construction data, comes from the MAG information services and represents land use patterns as of 2009. Land use is held constant between calculation of 2007 and 2012 year inventories. A detailed write-up of how the land use data is created is included in the 2008 PM-10 Periodic Emissions Inventory as an Appendix to the windblown dust section. Construction data was provided by the Maricopa County Air Quality Department for the year 2007. To be conservative this data is also held constant through 2012 even though there is substantially less construction occurring due to the economic recession. Windblown PM-10 emissions for the subject land uses are calculated per the methodology described in the 2008 PM-10 Periodic Emissions Inventory (Appendix A, Exhibit 1). As an example, emissions from the West 43rd Avenue monitor hour 15 high wind domain (June 6, 2007 design day) are explained below. All of the hourly high wind emissions are calculated in the same manner shown in this example.

Initially, through the use of ArcGIS, the land uses subject to windblown dust emissions within the high wind domain are identified. For the hour 15 example, 11 unique land uses within the high wind domain are subject to windblown dust as shown in Figure V-16. They include the land uses of Active Open Space (i.e., parks), Agriculture, Commercial, Construction, Coreslab (a large combination of sand and gravel and industrial facility), Industrial, Passive/Restricted Open Space (i.e., preserves), Public/Military Space (i.e., jails, bases), Sand and Gravel facilities, Vacant, and Dry Washes. These land uses are chosen because either all or some of their acreage is bare soil from which windblown dust can be generated. Land uses such as residential or golf courses are not included as land uses subject to windblown dust since none (or a very limited amount) of the acreage associated with these land uses is bare soil. Land uses on the steep slopes of mountain preserves are also excluded as the surface roughness of the slope severely limits the production of windblown dust.

After the land uses are identified, a 10-acre fishnet grid is applied to the land uses, so that no individual land use parcel is larger than ten acres. This allows for calculating the distance from each parcel boundary to the modeled monitor; which is West 43rd Avenue in this example. The distance of the parcel to the monitor is necessary in order to apply

the distance weighting factor to the calculated emissions as discussed earlier in this chapter.

Figure V-16
Land Uses Capable of Producing Windblown Dust Within the Hour 15, West 43rd Avenue Monitor, High Wind Domain (June 6, 2007)



To be conservative, all but four of the land uses shown above are assumed to have 100% of their acreage capable of emitting windblown dust. The land uses of Commercial, Coreslab, Industrial and Public/Military are exempted from this assumption because these land uses are known to have a mix of large buildings and paved parking lots/access roads in addition to areas of bare soil. Over 2500 aerial photographs of these types of parcels in the Salt River area were evaluated to determine the average percentage of bare soil present on each of these land uses. The results of that analysis are listed in Table V-22. To be conservative, the mean value was chosen to represent the average percentage of bare soil on these land uses, as this value was higher than the median in all cases. Note that Coreslab is considered an industrial parcel, and as such is assigned the average of 24% for the amount of bare soil present.

Table V-22
Results of Aerial Photography Analysis of Percentage of Bare Soil on Land Uses with Both Bare and Covered Surfaces

Land Use	Mean	Median	Std. Deviation
Commercial	26%	20%	23%
Industrial	24%	17%	21%
Public/Military	35%	21%	35%

After the land uses within the high wind domain have been classified and selected, the process for calculating windblown emissions from these land uses can begin. The 2008 PM-10 Periodic Emissions Inventory developed emission factors for two classes of bare soil: disturbed and stable. Disturbed soils emit at a much higher rate than stabilized soils because there is more loose soil available to be entrained by the wind. As wind speeds increase, both disturbed and stable soils emit at higher rates, as the extra energy from the wind entrains more material from both surfaces. Thus, the main elements needed to calculate windblown PM-10 emissions are the number of acres of bare soil, the wind speeds over that soil, and the percentage of the acres that are disturbed or stable.

Table V-23 displays the emission factors by wind speed bins as developed in the 2008 Periodic Emissions Inventory. These emission factors were developed based upon local testing of Arizona soils. The units of the emission factors are tons per acre per five-minute, as the input wind speed data for most of the high wind domains is a five-minute average wind speed.

Table V-23
Windblown PM-10 Emission Factors (tons /acre-five-minute) by 10-Meter Wind Speed Bin and Soil Stabilization

Soil Stabilization	Wind Speed 12-15 mph	Wind Speed 15-20 mph	Wind Speed 20-25 mph	Wind Speed 25-30 mph	Wind Speed 30-35 mph
Disturbed	5.44E-05	1.69E-04	5.14E-04	1.24E-03	2.57E-03
Stable	1.10E-05	2.93E-05	7.68E-05	1.64E-04	3.10E-04

Continuing with the use of the hour 15, West 43rd Avenue, high wind domain example, the hourly average wind speed for that hour was 18.1 mph. An examination of the five-minute wind speed data for that hour reveals that ten of the five minute periods had wind speeds between 15-20 mph and two of the five minute periods had wind speeds between 20-25 mph. This means that the emissions factors from only two wind speed bins (15-20 and 20-25) will be used to calculate emissions for this hour.

At this point, the amount of acreage by land use and the five minute wind speeds have been determined for the example high wind domain. The one variable that is left to be

determined is how much of the land use acreage is disturbed or stable. A direct measurement of this variable is not possible, as stabilization rates change over time with meteorological and anthropogenic activities unique to each individual parcel. Therefore, a surrogate variable is needed to assume an average disturbance level for each land use subject to producing windblown dust. As discussed in Chapter Five of the main plan and the 2008 PM-10 Periodic Emissions Inventory, rule effectiveness has been chosen as the surrogate for the disturbance levels of bare soils. As an example, a rule effectiveness of 80% would assume that 80% of the acreage is stable and 20% is disturbed. Maricopa County Air Quality Department performed rule effectiveness studies for three fugitive dust rules: Rule 310, earthmoving activities, Rule 310.01, open and vacant areas, and Rule 316, sand and gravel sites. These studies were done on an annual basis and are shown in Table V-24. The values for calendar years 2007, 2008 and 2010 were all derived per the methodology listed in the 2008 PM-10 Periodic Emissions Inventory. The increases in rule effectiveness through time is a direct result of the implementation of the control measures in this plan. The value for 2012 is the assumed value achieved as a result of the control measures in this plan projected out through 2012 (See Chapter Five of main plan for more explanation).

Table V-24
Calendar Year Rule Effectiveness Rates as Surrogates for Soil Disturbance Rates

Rule	2007	2008	2010	2012
310	76%	90%	94%	94%
310.01	85%	95%	96%	97%
316	40%	65%	73%	73%

The 11 land uses identified earlier in Figure V-16 are thus assigned disturbance rates based upon the rule effectiveness rates in Table V-24. Rule 310 serves as a surrogate value for construction land uses, Rule 316 serves as a surrogate for sand and gravel land uses, and Rule 310.01 serves as a surrogate for all remaining land uses. Rule 310.01 directly regulates all open areas and industrial/commercial areas that are permitted or un-permitted. The only land use under which Rule 310.01 does not regulate is agriculture. However, because there are no quantitative rule effectiveness or disturbance rates studies available that are applicable to agricultural land, Rule 310.01 disturbance rates are assumed to apply, as was assumed in the 2008 PM-10 Periodic Emissions Inventory. It is important to point out however, that because there are no benefits for agricultural land taken as part of the attainment demonstration or the five percent reductions, the assumed 2007 rule 310.01 effectiveness rate of 85% is held constant through 2012, meaning windblown dust emissions from agricultural lands in 2012 are the same as in 2007. All other land uses besides agriculture experience a reduction in emissions between 2007 and 2012 as a result of the benefit of increased rule effectiveness; which is pragmatically translating as an assumption of less disturbed soil in the windblown dust inventory.

Now that all of the required elements (acreage, percent disturbed, and wind speeds) have been determined, the elements are simply multiplied in order to obtain PM-10 windblown dust emissions for each land use within the high wind domain. An example equation using data from the hour 15 example high wind domain is shown below to detail how high wind emissions are calculated:

Example for calculating base year (2007) windblown dust emissions from Commercial land uses:

(1) Land use * % acreage * 15-20 mph wind * % Stable * Stable 15-20 mph = Stable Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (10) * (85%) * (2.93E-05) = 1.62E-02 Tons

+

(2) Land use * % acreage * 20-25 mph wind * % Stable * Stable 20-25 mph = Stable Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (2) * (85%) * (7.68E-05) = 8.49E-03 Tons

+

(3) Land use * % acreage * 15-20 mph wind * % Disturbed * Disturbed 15-20 mph = Disturbed Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (10) * (15%) * (1.69E-04) = 1.65E-02 Tons

+

(4) Land use * % acreage * 20-25 mph wind * % Disturbed * Disturbed 20-25 mph = Disturbed Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (2) * (15%) * (5.14E-04) = 1.00E-02 Tons

Sum of above equations (1 through 4) = 5.12E-02 Tons of PM-10 emissions from Commercial land uses.

This process is repeated for all land uses and then summed to calculate total PM-10 emissions from all land uses within the high wind domain. The only difference between 2007 and 2012 year emissions is that the disturbance rates change based upon gains in rule effectiveness, thus the reductions in emissions between 2007 and 2012 are solely attributable to increases in rule effectiveness.

The emissions that are calculated per the steps above, represent maximum potential PM-10 emissions from windblown dust. As explained in the 2008 PM-10 Periodic Emissions Inventory, a whole host of other factors including supply limitations, surface roughness, soil moisture content, vegetative cover, soil texture, etc. and would likely limit the PM-10 emissions from windblown dust to levels below what is calculated in each of the high wind domains. The 2008 PM-10 Emissions Inventory corrects for these limiters by standardizing PM-10 emissions as compared to concentrations seen at the monitor under high wind conditions. This helps to ensure the scale of the emissions estimate is not too

large. However, this step is not necessary for high wind emission inventories prepared for use in an attainment demonstration, as what is important in this rollback modeling is the difference between 2007 and 2012 emissions, not the scale of those emissions as compared to low wind emission sources. Since both 2007 and 2012 high wind emissions are calculated in the same way, the difference between the two inventories provides the reductions needed to model attainment at the monitors. The unit and scale of the inventories thus do not matter, only that the methodology is the same between the base and controlled inventories in order to claim the benefits of the measures in this plan as applied to the modeled concentrations.

Once high wind PM-10 emissions have been calculated for the land uses, one final step is required to prepare the emissions for attainment modeling. The calculated emissions for each land use parcel are divided by the distance (feet) from the modeled monitor. As discussed in an earlier section in this chapter, distance weighting is applied to this emissions in order to account for their diminishing impact on monitor concentrations with distance. The best weighting function was determined to be a simple inverse distance ratio (1/d) through analysis of dispersion behavior provided by sample AERMOD model runs (see earlier sections on source weighting and temporary monitor insights).

Tables V-25 through V-31 provide the results of the high wind emissions inventories for the high wind domains of each modeled monitor, based upon the process outlined above. They list both the calculated emissions and the inverse-distance weighted emissions for the base and controlled year inventories.

Table V-25
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for May 4, 2007 Design Day at the West 43rd Avenue Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
12	3.05	2.09	2.872E-04	1.900E-04	33.8%
13	9.49	6.36	6.529E-04	4.245E-04	35.0%
14	9.94	6.67	6.866E-04	4.454E-04	35.1%
15	13.94	9.19	8.721E-04	5.581E-04	36.0%
16	13.36	8.81	8.921E-04	5.699E-04	36.1%
17	19.01	12.39	1.190E-03	7.505E-04	36.9%
18	11.84	7.86	7.837E-04	5.033E-04	35.8%
19	6.58	4.44	5.158E-04	3.364E-04	34.8%
21	4.02	2.72	3.236E-04	2.129E-04	34.2%
22	6.63	4.48	5.104E-04	3.330E-04	34.8%
Total	97.86	65.02	6.714E-03	4.324E-03	35.6%

Table V-26
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Central Phoenix Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
0	1.90	1.32	7.549E-05	5.230E-05	30.7%
1	0.99	0.74	5.184E-05	3.687E-05	28.9%
6	1.69	1.18	6.873E-05	4.797E-05	30.2%
7	0.99	0.74	5.254E-05	3.730E-05	29.0%
10	0.88	0.64	4.939E-05	3.485E-05	29.4%
11	2.01	1.41	7.319E-05	5.123E-05	30.0%
12	4.01	2.91	1.706E-04	1.166E-04	31.7%
13	7.52	5.04	2.448E-04	1.625E-04	33.6%
14	7.28	4.96	2.265E-04	1.520E-04	32.9%
15	4.33	3.04	1.657E-04	1.121E-04	32.3%
16	4.27	3.13	1.737E-04	1.192E-04	31.4%
17	2.29	1.60	8.494E-05	5.855E-05	31.1%
18	2.21	1.55	7.971E-05	5.545E-05	30.4%
Total	40.39	28.25	1.517E-03	1.037E-03	31.7%

Table V-27
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Durango Complex Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
11	1.99	1.37	1.340E-04	9.011E-05	32.8%
12	3.69	2.55	2.267E-04	1.543E-04	31.9%
13	3.12	2.15	1.876E-04	1.281E-04	31.7%
14	8.02	5.49	4.672E-04	3.093E-04	33.8%
15	9.84	7.07	4.992E-04	3.379E-04	32.3%
16	5.62	3.79	3.247E-04	2.160E-04	33.5%
17	2.47	1.72	1.619E-04	1.110E-04	31.4%
Total	34.74	24.13	2.001E-03	1.347E-03	32.7%

Table V-28
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Greenwood Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
12	1.05	0.77	5.872E-05	4.191E-05	28.6%
13	1.03	0.80	6.482E-05	4.701E-05	27.5%
14	3.03	2.16	1.618E-04	1.110E-04	31.4%
15	2.34	1.75	1.266E-04	8.868E-05	30.0%
Total	7.45	5.49	4.119E-04	2.886E-04	29.9%

Table V-29
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Higley Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
10	0.74	0.55	6.103E-05	4.481E-05	26.6%
11	3.00	2.05	1.944E-04	1.330E-04	31.6%
12	2.15	1.54	1.805E-04	1.270E-04	29.6%
13	2.41	1.69	1.824E-04	1.268E-04	30.4%
14	5.61	3.83	2.282E-04	1.553E-04	31.9%
15	5.70	3.98	2.113E-04	1.442E-04	31.8%
16	5.65	3.90	2.065E-04	1.403E-04	32.1%
17	1.50	1.11	6.687E-05	4.791E-05	28.4%
Total	26.76	18.64	1.331E-03	9.195E-04	30.9%

Table V-30
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the West Phoenix Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
11	0.65	0.53	2.164E-05	1.680E-05	22.4%
12	1.78	1.33	5.329E-05	3.930E-05	26.2%
13	3.35	2.45	8.177E-05	5.933E-05	27.4%
14	4.27	3.08	1.123E-04	8.105E-05	27.8%
15	1.63	1.21	4.623E-05	3.396E-05	26.5%
Total	11.67	8.60	3.152E-04	2.304E-04	26.9%

Table V-31
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the West 43rd Avenue Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
0	2.29	1.59	2.064E-04	1.388E-04	32.8%
5	3.31	2.29	2.894E-04	1.924E-04	33.5%
6	5.05	3.43	4.359E-04	2.860E-04	34.4%
10	3.44	2.38	2.835E-04	1.898E-04	33.1%
11	6.67	4.51	4.937E-04	3.237E-04	34.4%
12	6.02	4.06	5.697E-04	3.704E-04	35.0%
13	5.66	3.82	4.721E-04	3.088E-04	34.6%
14	9.67	6.48	6.830E-04	4.425E-04	35.2%
15	13.99	9.12	9.717E-04	6.168E-04	36.5%
16	9.67	6.48	6.630E-04	4.304E-04	35.1%
17	5.10	3.45	4.285E-04	2.812E-04	34.4%
18	4.94	3.34	3.857E-04	2.526E-04	34.5%
Total	75.81	50.97	5.883E-03	3.833E-03	34.8%

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APPENDIX B

Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains

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FINAL REPORT

Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains

prepared for:

Arizona Dept. of Environmental Quality

December 2013

prepared by:

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FINAL REPORT

Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains

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Arizona Dept. of Environmental Quality

December 2013

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Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains

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1. INTRODUCTION

1.1 Background

To guide the preparation of a PM_{10} State Implementation Plan (SIP) for Pinal County, the Arizona Department of Environmental Quality (ADEQ) commissioned an analysis of the 2008 base year monitoring data, the selection of design days, the identification of emission inventory calculation procedures for key source categories, and quality assurance/quality control (QA/QC) procedures for emission inventory development. The results of this effort were documented in an Inventory Preparation Plan (IPP).[1] It showed that two separate meteorological scenarios produced concentrations in excess of the 24-hour PM_{10} National Ambient Air Quality Standard (NAAQS) of 150µg/m^3: high wind and stagnation conditions. The emission sources responsible for the elevated concentrations are fundamentally different under these two scenarios.

During high wind conditions, disturbed soil surfaces typically dominate PM_{10} emissions, because of the tendency of wind trajectories to remain somewhat constant during these periods, sources within a narrow band along the upwind trajectory tend to contribute significantly to recorded PM_{10} concentrations. Conversely, during stagnation periods, when wind speeds are typically below 3 mph, wind entrainment of loose soil particles is virtually nonexistent and mechanical sources that lift particles into the air through combustion, vehicle movement, and other anthropogenic activities are primarily responsible for recorded concentrations. To the extent observed emissions are dominated by the coarse fraction of PM_{10}, only those sources within a mile in any direction of a monitor significantly contribute to high hourly concentrations during stagnation conditions. Because of these differences in source mix and the need to demonstrate attainment under the range of meteorological conditions found at Pinal County monitors, the ADEQ and Pinal County Air Quality Control District advisory committee providing technical guidance for SIP development recommended that each violating nonattainment monitor selected for emission inventory and attainment demonstration development include at least one stagnation and one high wind design day.

The analysis of PM_{10} exceedances on stagnation days[2] resulted in the selection of October 29, 2008, as being representative of meteorological conditions (i.e., wind speed and mixing height) leading to elevated concentrations. Three monitors exceeded the

[1] "Pinal County PM Inventory Preparation Plan," Report No. SR2013-01-01, prepared by Sierra Research for the Arizona Department of Environmental Quality, February 2013.

[2] The basis for distinguishing between low and high wind hours, and days, is the 12 mph aerodynamic entrainment threshold (i.e., five-minute average) established in MCAQD's 2008 PM10 Periodic Emissions Inventory.

24-hour PM_{10} NAAQS on that date: Cowtown,[3] Pinal County Housing, and Stanfield. Because no PM_{10} exceedances occurred on stagnation days at the Maricopa, Casa Grande, or Combs School monitoring sites, they were not included in the list of low wind speed attainment demonstrations to be addressed in the SIP. To guide the preparation of the modeling inventories, rectangular low wind domains were defined based on the maximum hourly distance traversed by wind parcels from the monitor to the source on the basis of wind speed and direction. Separate domains were defined for each monitor. The IPP also provided guidance on the activity data and methodology to be used in quantifying emissions for key source categories.

The analysis of PM_{10} exceedances on high wind days selected four monitors determined to be representative of conditions throughout the year, at the sites and dates listed below.

- Cowtown – April 27, 2008
- Pinal County Housing – January 1, 2008
- Stanfield – November 21, 2008
- Maricopa – October 27, 2008

The low wind domains were selected using the methodology described above; a more complex approach was used to define domains for high wind days. The domain for the high wind hours followed the methodology the Maricopa Association of Governments (MAG) used in the 2012 Five Percent Plan,[4] which plotted a back trajectory based on the average wind speed and direction recorded for each high wind hour. Each of these trajectories included land within a mile perpendicular to the trajectory on both sides; the result was therefore a 2-mile-wide parcel following the back trajectory for a distance equal to the average wind speed. To simplify the MAG methodology and limit repetitive calculations, all high wind hours were assembled into a single domain, which was easy to implement because there is little variation in wind direction during the high wind hours. The horizontal boundaries were defined by including land within a mile perpendicular to the bounding wind trajectories (i.e., all trajectories and land between them were included and the outside boundaries were extended by a mile). More discussion of the domain selection is presented in Section 2.

1.2 Approach

Since the completion of the IPP, substantial effort has been devoted to assembling the activity data and related insights needed to calculate emission inventories for each of the

[3] In 2008, 139 out of 147 low wind exceedances were recorded at the Cowtown monitor. While meteorological conditions—both wind speed and mixing height—on the Cowtown design day were found to be more severe (i.e., lower) than seasonal average exceedance values, peak nighttime concentrations were lower than average seasonal peaks. Since the concentration profile for the rest of the design day matched or exceeded the seasonal exceedance values, a decision was made in concert with EPA to continue to use the selected design day for Cowtown.

[4] "MAG 2012 Five Percent Plan for PM10 for Maricopa County Nonattainment Area," Maricopa Association of Governments, May 2012.

specified modeling domains and design days. A variety of data collection activities have been undertaken to better characterize local activity and conditions, including those listed below.

- Traffic Research and Analysis was hired to collect hourly counts of vehicles operating on 20 separate unpaved road links within the selected modeling domains.

- The Arizona Department of Transportation (ADOT) provided modeled estimates of VMT, speed, and vehicle mix operating on paved roads.

- ADOT also provided information on road shoulders (paved, graveled, etc.), which was supplemented with observations from Pinal County Air Quality Control District (PCAQCD).

- ADEQ and PCAQCD collected soil samples from a representative sample of unpaved roads (public and agricultural) and farm land.

- JBR analyzed the collected samples and measured silt and moisture levels.

- Cotton Research and Protection Council (CRPC) provided GIS shapefiles documenting crops under cultivation within selected modeling domains in 2008.

- The Arizona Beef Council provided information on the number of cattle located within specific stockyards on design days in 2008 and diurnal profiles of activity.

- Farmers provided information on hours of operation when harvesting and related traffic levels on agricultural roads.

- PCAQCD summarized disturbance levels observed by land use type within the nonattainment area.

- ADEQ prepared estimates of PM emission factor adjustments to account for saltation, diminished particle supply, etc., during high wind conditions.

- PCAQCD provided copies of permits for stationary sources operating within the selected modeling domains.

- PCAQCD provided information on construction permits issued in 2008.

- Rail activity levels were obtained from reviews of local planning (e.g., National Environmental Policy Act [NEPA]) documents.

- Meteorological data were obtained from the nonattainment monitors and from other stations located within the nonattainment area.

- ADEQ, with support from PCAQCD, provided GIS shapefiles that define land use for each parcel located within the PM_{10} nonattainment area.

- Numerous studies and emission inventory development methods employed in related PM_{10} SIPs (e.g., MAG's Five Percent Plan) were investigated.

Collectively, this information and other sources of data were combined to prepare hourly parcel-specific estimates of PM_{10} emitted for each land use category on the selected design days within the selected modeling domains. Stagnation and related low wind hour emissions are calculated from source-specific activity levels. High wind day and related high wind hour emissions are calculated from wind speed, surface area, and disturbance observations (and crop type for agricultural emissions). Discussions of the results and findings were presented in weekly and sometimes biweekly discussions with ADEQ and PCAQCD staff as well as monthly meetings with stakeholders. Preliminary summaries of the methods and data used to compute emissions were circulated to ADEQ, PCAQCD, and stakeholders for review and comment. This document addresses comments received.

1.3 Report Organization

Following this introduction, Section 2 discusses the need to address inconsistencies between the spatial extent of available activity data (particularly information on crops under cultivation) and modeling domains specified in the IPP. Section 3 documents the data and methods used to compute PM_{10} emissions for each of the selected source categories. Section 4 presents tabular summaries of hourly PM_{10} emissions by source category for the design days and monitors to be used in preparing attainment demonstrations. Section 5 summarizes the annual emissions inventory. A series of appendices provides more detailed information as aspects of the analysis.

###

2. MODELING DOMAIN REVISIONS

As noted in the introduction, separate modeling domains were defined for both high wind and stagnant day conditions. For high wind days, separate domains were defined for high wind hours (i.e., those exceeding 12 mph) and low wind hours (i.e., those with speeds of 12 mph or less). The largest domains were defined for the high wind hours, because they extended 12+ miles upwind from the monitor. The next largest domains were defined for the low wind hours on high wind days, because the wind speeds, while less than 12 mph, were generally higher than those found under stagnation conditions (3 mph or less). Domains for stagnation conditions were the smallest because they had the lowest wind speeds. In the course of assembling the collected activity data, it was found that one of the key land use information sources—the Cotton Research and Protection Council (CRPC)—was able to provide data on crops under cultivation in 2008 only within a 6 km radius of each of the selected monitors for lands not included in Indian Reservations. Thus, while the GIS shapefiles from ADEQ/PCAQCD provide land use information for the entire nonattainment area, no information on crops under cultivation is available for agricultural lands located outside of the 6 km radius supplied by CRPC. This is a significant issue because agriculture is the dominant land use within the nonattainment area and agricultural emissions (both low and high wind) are strongly affected by the crop under cultivation. Two options are available to address this limitation: (1) assume the distribution of crops outside of the 6 km CRPC area is proportional to the crop distribution within the CRPC area or (2) restrict the size of the domain to relevant boundaries within the 6 km CRPC area. The question is really which approach limits the uncertainty in the emissions calculations. Presented below is a brief review of issues considered, the approach adopted, and figures displaying differences in the IPP and revised domains.

Each of the domains selected presents information on land use from both CRPC and from ADEQ/PCAQCD shapefiles. CRPC provided information on the crops being cultivated in 2008 and each parcel is color coded to identify the crop listed in the legend on the right of the figures. ADEQ/PCAQCD provided information on the land uses[5] listed in Table 2-1 below.

[5] A detailed description of the procedures used to identify the land uses and a description of each land use category is presented in "Twelve Pinal County Land Use Descriptions, 9/17/2013" from ADEQ.

Table 2-1 ADEQ/PCAQCD Land Use Categories
Developed Urban Lands
Developed Rural Lands (low density residential)
Paved Roads
Unpaved Roads
Cleared Areas
Residential Construction
CAFOs and Dairies
Desert Shrubland
Agricultural Croplands
Commercial Construction
Other
Site Development

2.1 High Wind Domains

High Wind Hours – The results of the source-weighting analysis[6] presented in Appendix B of the 2012 MAG Five Percent Plan were used to examine the impact of excluding sources beyond the 6 km CRPC upwind boundary. It found that "Without question, receptors close to an upwind source will be much more dramatically impacted by emissions from that source—emission rates being equal—than by similar sources at increasing distances upwind of receptors." Based on the results of AERMOD modeling for sources located at different upwind distances, a weighting factor of 1/distance was recommended to adjust windblown dust emission impacts with increasing downwind distance in any modified rollback analysis in the Salt River area. Using this relationship, it was determined that 80% of the impacts, assuming equivalent source strength, would come from sources located within 4 miles of a 12 mile upwind trajectory (i.e., 12 mph high wind threshold). Based on this information, it was determined that little insight would be gained from characterizing sources beyond the 6 km (3.7 miles) boundary and that uncertainty of assuming crop distributions in upwind areas was unwarranted. A multistep process was then followed to select the appropriate domains for high wind hours on high wind days for each of the selected monitors. The process is described below, followed by a series of figures displaying (a) the original IPP domain, (b) the impact of the 6 km CRPC boundary, and (c) the boundaries of the final domain selected for modeling. They are displayed sequentially for each monitor, starting with Cowtown.

- *Figure 2-1a* displays the domain that encompasses the 7 high wind hours recorded at the Cowtown monitor on April 27, 2008. It shows each of the hourly back trajectories as well as the 1-mile area perpendicular to the bounding (outermost) trajectories.

[6] "MAG 2012 Five Percent Plan for PM10 for Maricopa County Nonattainment Area," Maricopa Association of Governments, May 2012.

- *Figure 2-1b* displays the effect of limiting the upwind domain to the 6 km radius of the CRPC boundary. Two legends are displayed: one shows crop type and has different colors[7] for each; the other delineates land use and crops under cultivation on non-Indian lands[8] within the 6-km CRPC boundary and land use outside of the 6-km domain. The orange area outside of the 6-km boundary predominantly to the northwest delineates Gila River Indian Community (GRIC) lands. Also displayed is a triangular domain extending along the high wind trajectory hours from the monitor. This domain is bounded by the 6-km arc and the area of dispersion impacting the monitor from each of the bounding high wind hours. AERMOD identifies sources that impact a monitor as being limited to 15° on either side of the upwind trajectory. Thus, for a one-hour period, a "V" shaped domain is defined by the area of dispersion impacting the monitor. Since multiple hours are included in the domain, the 15° area of influence is added to the outside of each bounding wind trajectory. The hypotenuse of the triangle is a straight line just inside of the 6-km CRPC boundary. To simplify calculations, emissions are computed for the domain inside of the triangle, not the slightly larger domain with the 6 km arc.

- *Figure 2-1c* provides higher resolution view of the sources located within the selected modeling domain. It shows that vacant land and alfalfa are nearest to the monitor and desert shrubland is located farthest upwind from the monitor.

Similar plots are presented in Figures 2-2 and 2-3 for Maricopa and for Pinal County Housing. Unlike Cowtown or Pinal County Housing, the Maricopa domain is shown to be predominantly composed of urban developed land, with much less land devoted to agriculture.

[7] Unfortunately, the color scheme employed by ARCGIS cannot be held constant; it changes as the number of land use categories shift. Thus, the colors in Figure 1b will not be consistent with Figure 1c or succeeding domain displays.

[8] ADEQ and PCAQCD provided land use information for Indian lands within the 6-km CRPC domain, as determined through aerial photography.

Figure 2-1a
High Wind Hours Modeling Domain Proposed in IPP for Cowtown

Figure 2-1b
Land Use for High Wind Hours Modeling Domain at Cowtown

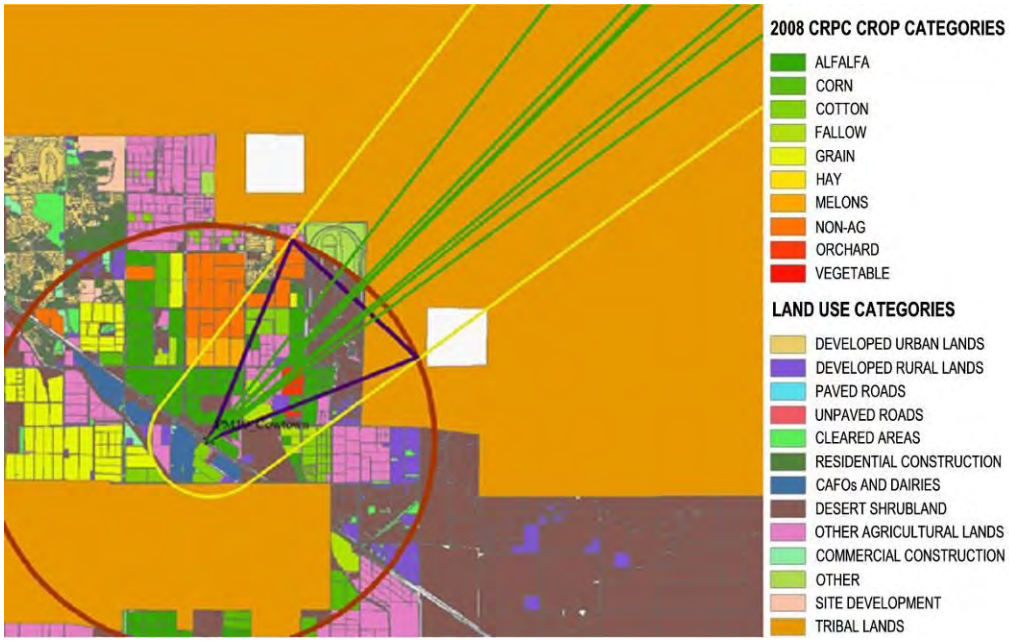


Figure 2-1c
High Wind Hours Modeling Domain Selected for Cowtown

Figure 2-2a
High Wind Hours Modeling Domain Proposed in IPP for Maricopa

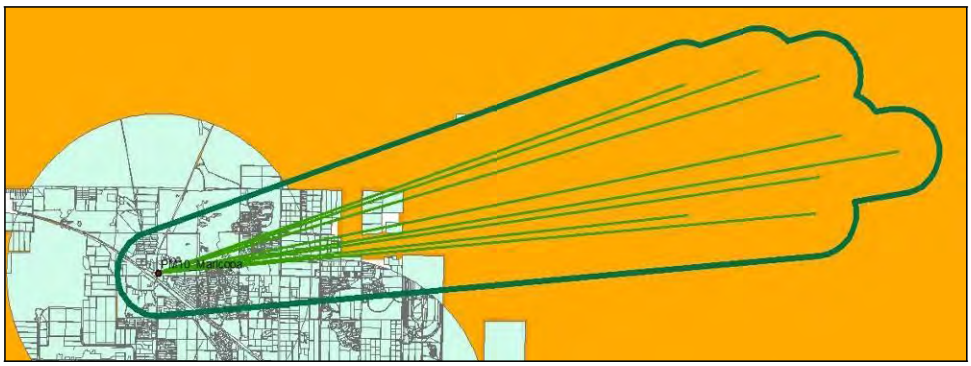


Figure 2-2b
Land Use for High Winds Hour Modeling Domain at Maricopa

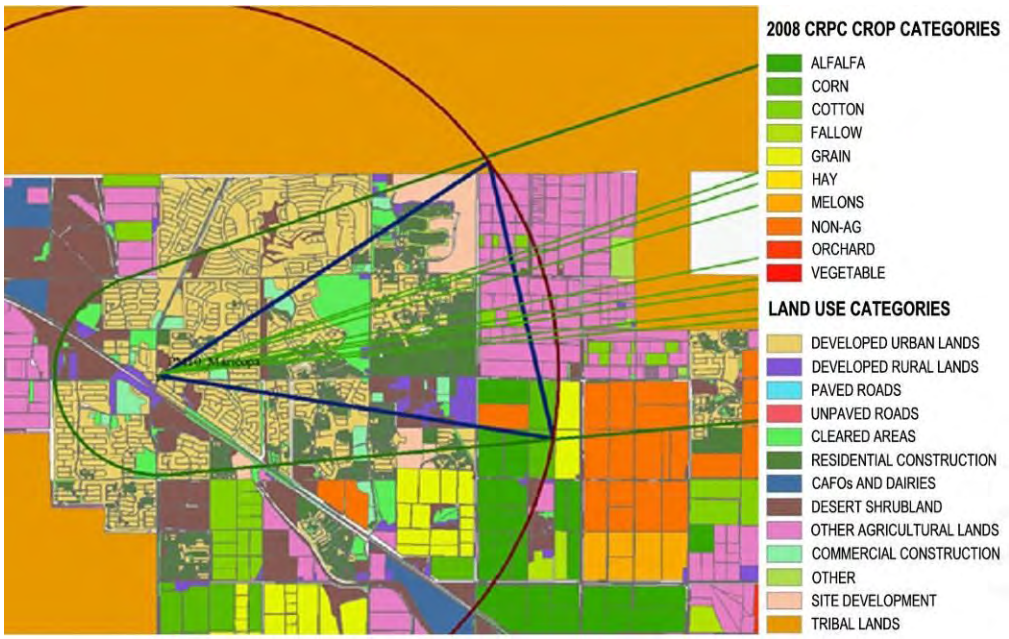


Figure 2-2c
High Wind Hours Modeling Domain Selected for Maricopa

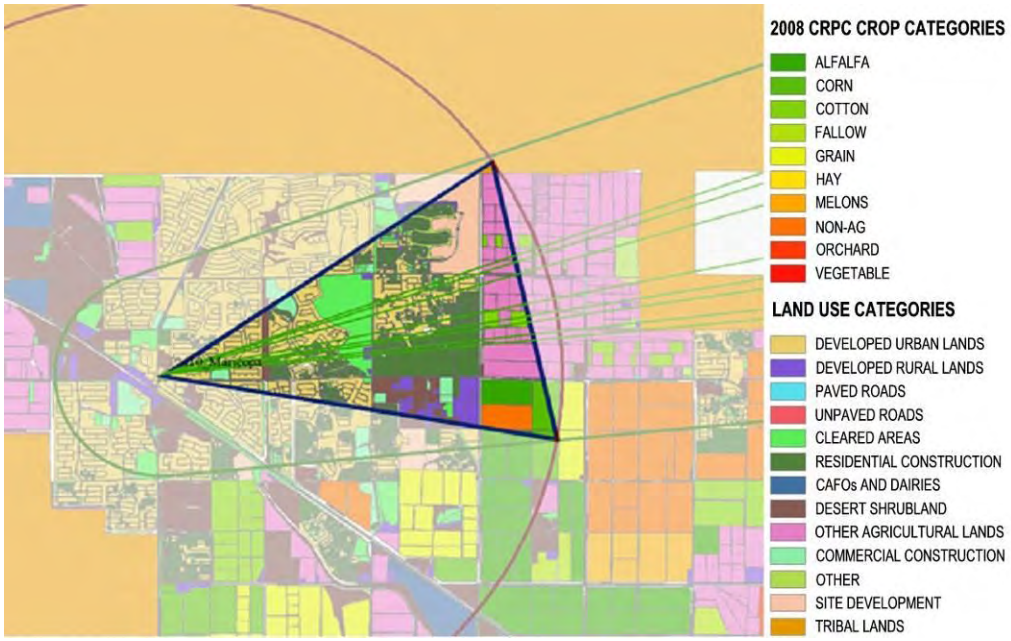


Figure 2-3a
High Wind Hours Modeling Domain Proposed in IPP for Pinal County Housing

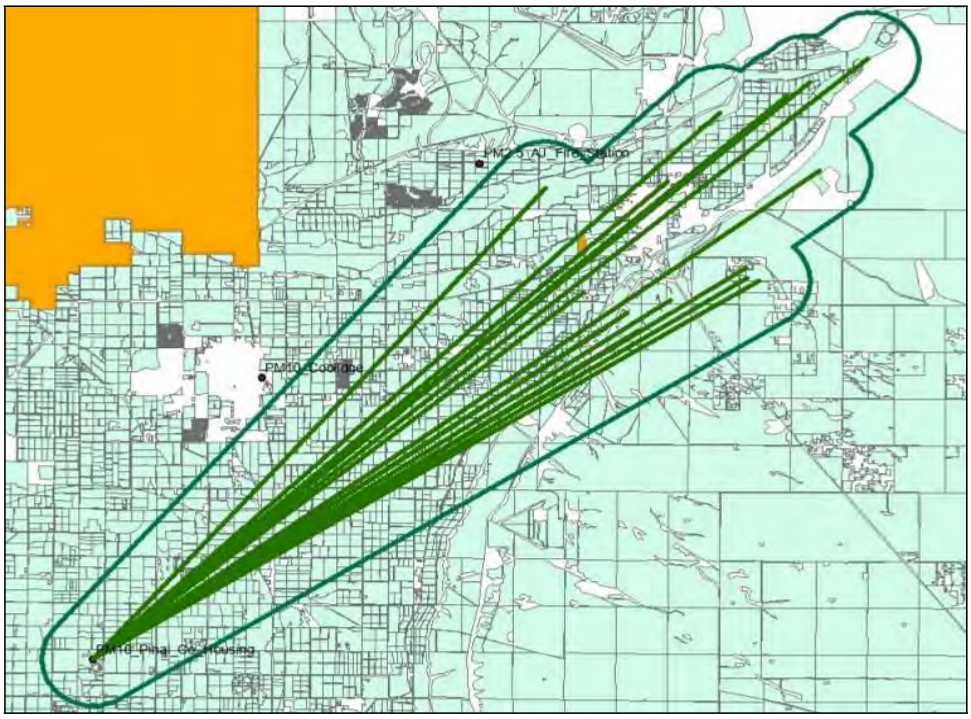


Figure 2-3b
Land Use for High Wind Hours Modeling Domain at Pinal County Housing

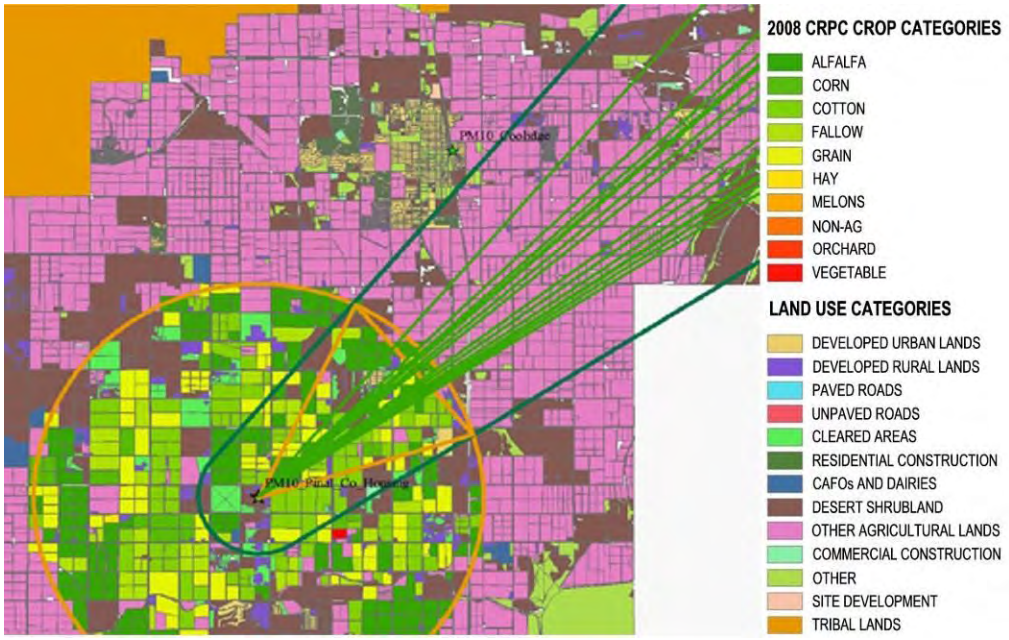
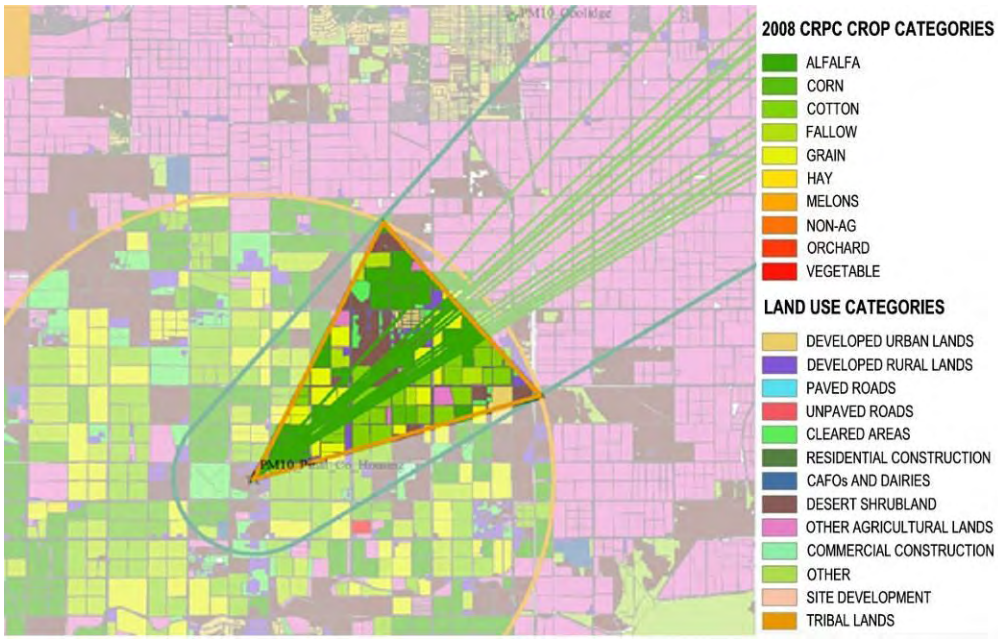


Figure 2-3c
High Wind Hours Modeling Domain Selected for Pinal County Housing



The remaining high wind domain is displayed in Figure 2-4 for Stanfield. The original IPP domain, shown in Figure 2-4a, was based on 15-minute meteorological measurements available for that site, whereas only hourly data were available for the remaining monitors. It shows that the calculated back trajectories do not follow a straight line but shift in response to the incremental values. To both standardize and simplify the inventory calculations, average hourly trajectories were computed from the 15-minute data and are plotted in Figure 2-4b. A review of the differences in land use from the two domains found that agriculture dropped from 83% in the 15-minute based domain to 73% in the average hourly domain and that desert shrubland increased from 11% to 18% with little change in the other categories. However, those values are for differences between the entire 1-hour domains—the change within the 6-km upwind domain was much less modest. Therefore, the straight-line hourly domain was employed. Figures 2-4c and 2-4d illustrate the effect of limiting the size of the upwind domain to the 6-km CRPC data and the arcs of dispersion influence. As shown, the selected domain is largely composed of active farmland.

Figure 2-4a
High Wind Hours Modeling Domain Proposed in IPP for Stanfield (15-minute data)

Figure 2-4b
High Wind Hours Modeling Domain for Stanfield (hourly data)

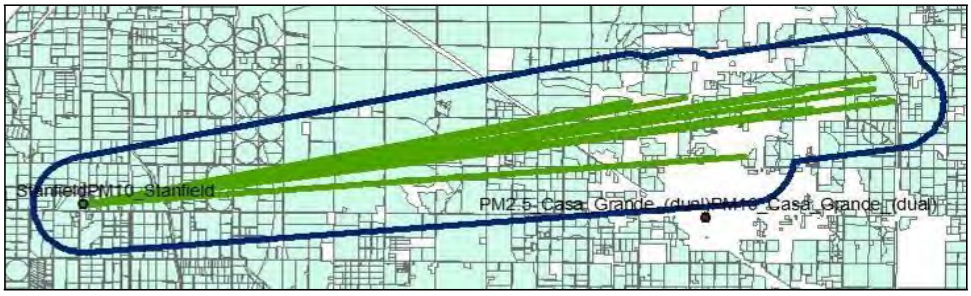


Figure 2-4c
Land Use for High Wind Hours Modeling Domain at Stanfield

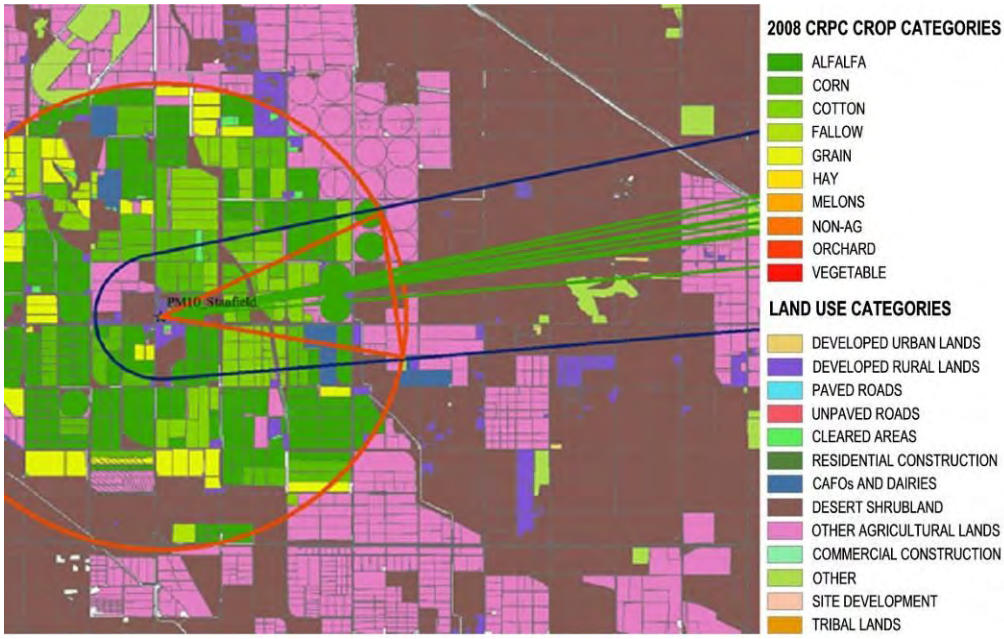
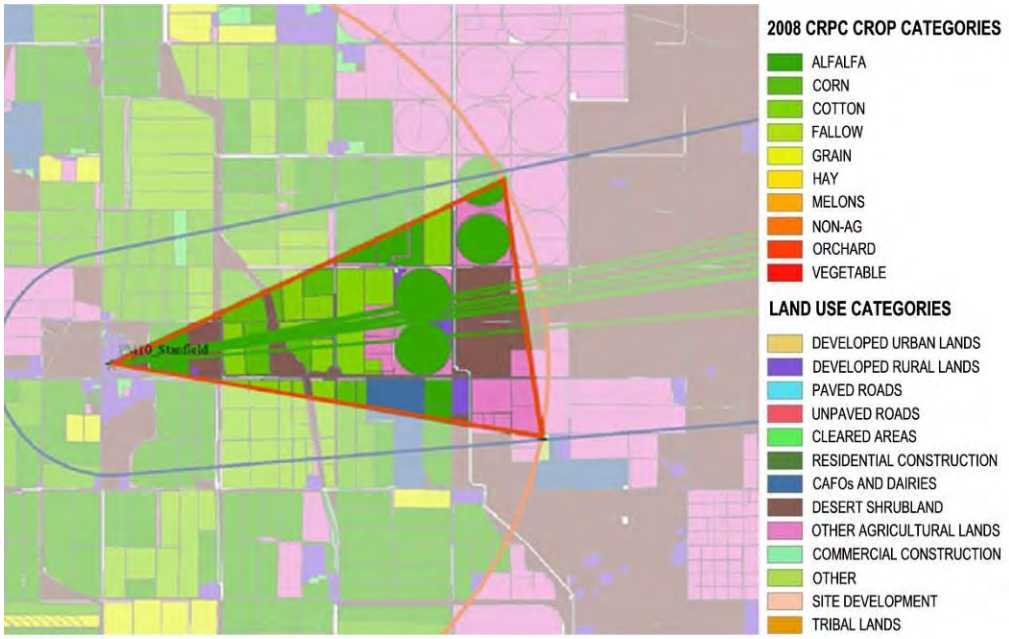


Figure 2-4d
High Wind Hours Modeling Domain Selected for Stanfield



Low Wind Hours – Following the pattern used to display the development of the high wind domains. Figures 2-5a, 2-5b, and 2-5c are displayed for the low wind hour domains associated with each high wind monitor: (a) the original IPP domain, (b) the impact of the 6-km CRPC boundary, and (c) the boundaries of the final domain selected for modeling. They are displayed sequentially for each monitor, starting with Cowtown.

Figure 2-5a
Low Wind Hours Modeling Domain Proposed in IPP for Cowtown

Figure 2-5b
Land Use for Low Wind Hours Modeling Domain at Cowtown

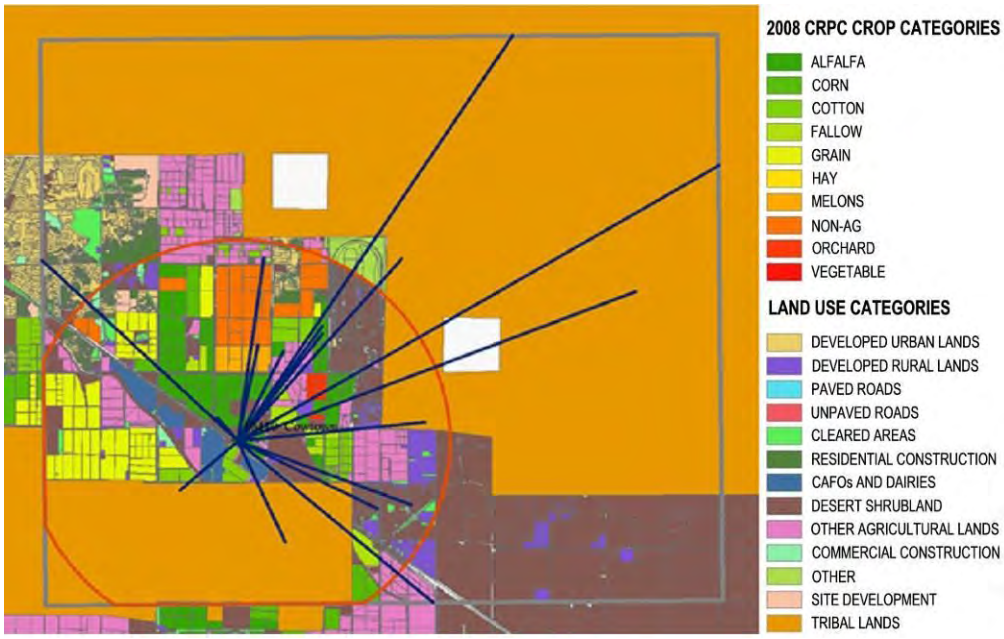
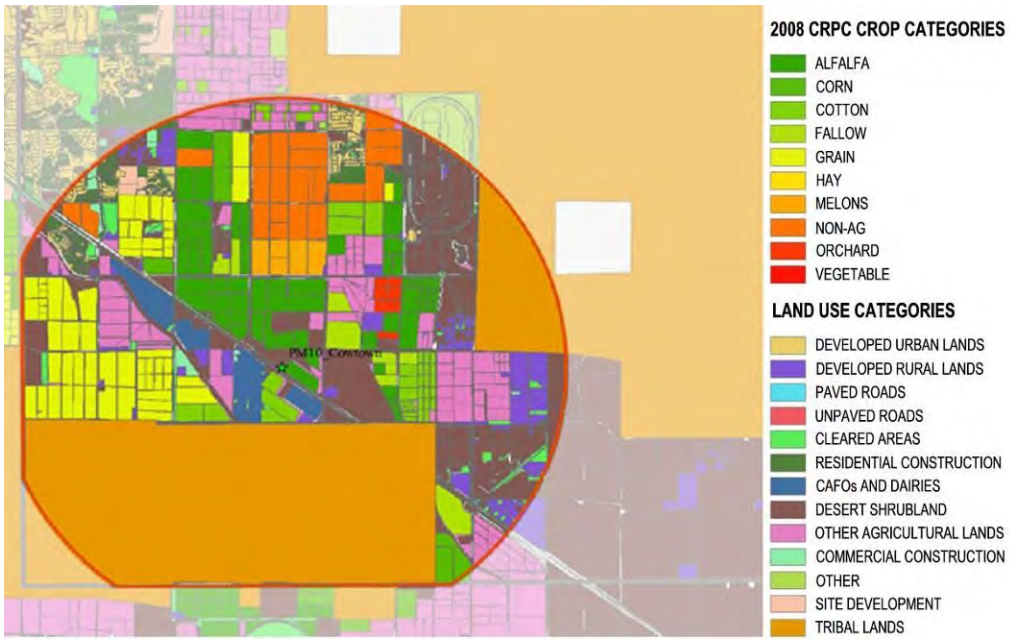


Figure 2-5c
Low Wind Hours Modeling Domain Selected for Cowtown



- *Figure 2-5a* displays the domain that encompasses the 17 low wind hours recorded at the Cowtown monitor on April 27, 2008. Unlike the high wind domains where wind direction and emissions are consistently from a single quadrant, wind and emissions impacting the monitor come from all directions. The rectangle for the domain is defined by the maximum hourly wind directions and speeds. It shows the domain is considerably larger than the 6 km radius of crop data provided by CRPC. It also shows that portions of GRIC lands are encompassed both within the overall low wind domain and within the CRPC domain. While the land use of GRIC parcels within the CRPC boundary is defined, the crops under cultivation are unknown. Thus, assumptions are required for activities within the GRIC lands included within the selected modeling domain(s).

- *Figure 2-5b* has two legends: one shows crop type and has different colors for each; the other delineates land use for non-agricultural lands within the 6-km CRPC boundary and agricultural and non-agricultural land use outside of the 6-km domain. The orange area outside of the 6-km boundary predominantly to the northeast delineates GRIC lands. The Ak-Chin lands lie to the south/southwest of the monitor and are identified as having active and fallow crop land (almond and light blue colors). Similar to the GRIC, no information about crop type is available from the CRPC data for the Ak-Chin lands.

- *Figure 2-5c* shows that, given the lower wind speeds, the five hours with trajectories extending beyond the 6-km CRPC domain have little influence on the

Cowtown monitor, based on the MAG weighting calculation. For this reason, a decision was made to truncate the low wind boundary to the intersection of the CRPC data and the overall domain (hence the flat boundary at the bottom of the CRPC domain).

Similar plots are presented in Figures 2-6, 2-7, and 2-8 for Maricopa, Pinal County Housing, and Stanfield.

Figure 2-6a
Low Wind Hours Modeling Domain Proposed in IPP for Maricopa

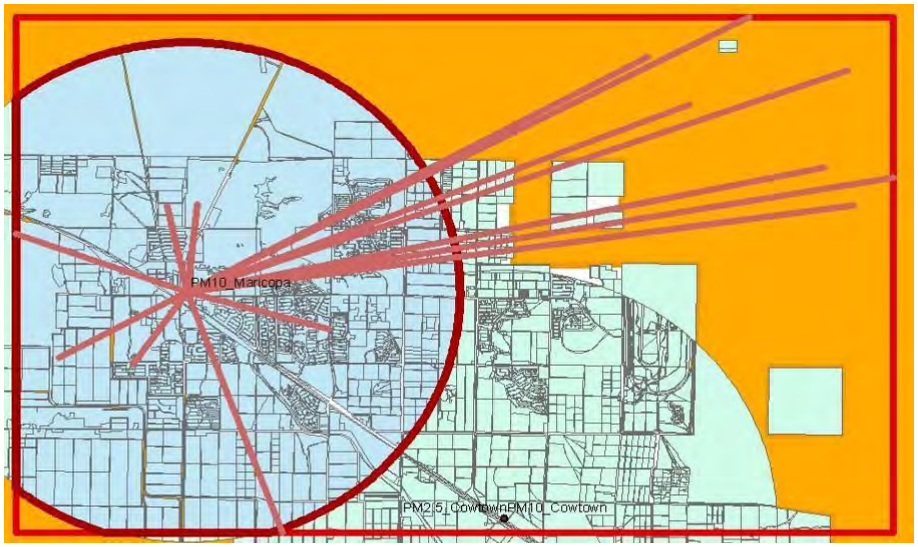


Figure 2-6b
Land Use for Low Wind Hours Modeling Domain at Maricopa

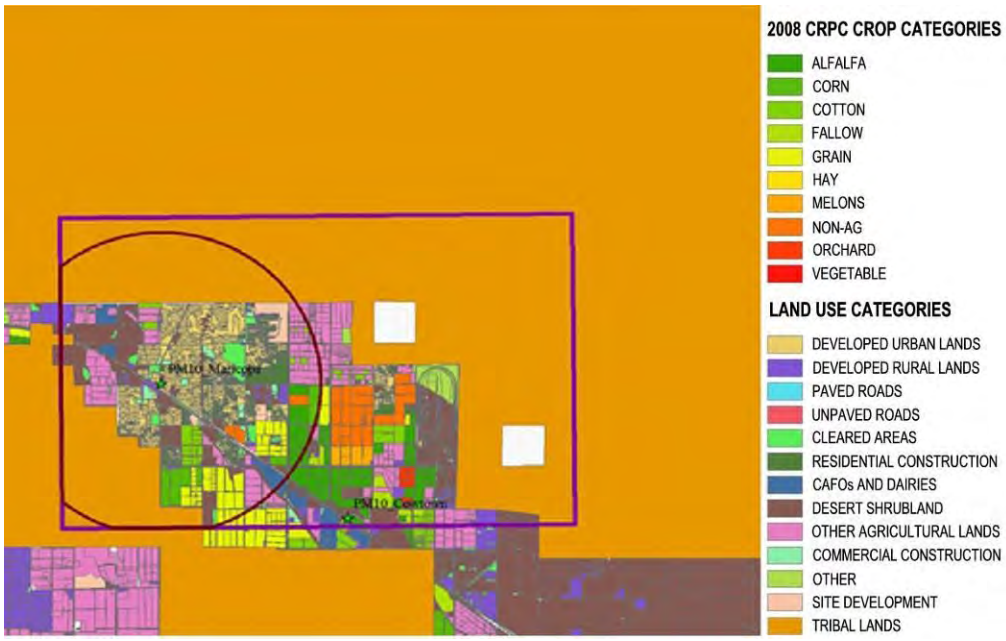


Figure 2-6c
Low Wind Hours Modeling Domain Selected for Maricopa

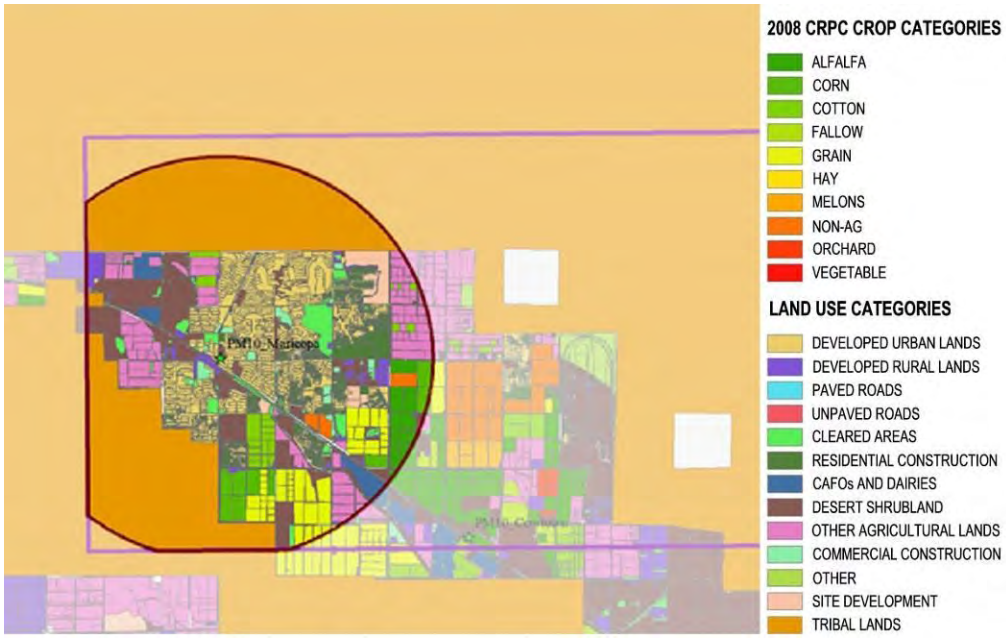


Figure 2-7a
Low Wind Hours Modeling Domain Proposed in IPP for Pinal County Housing

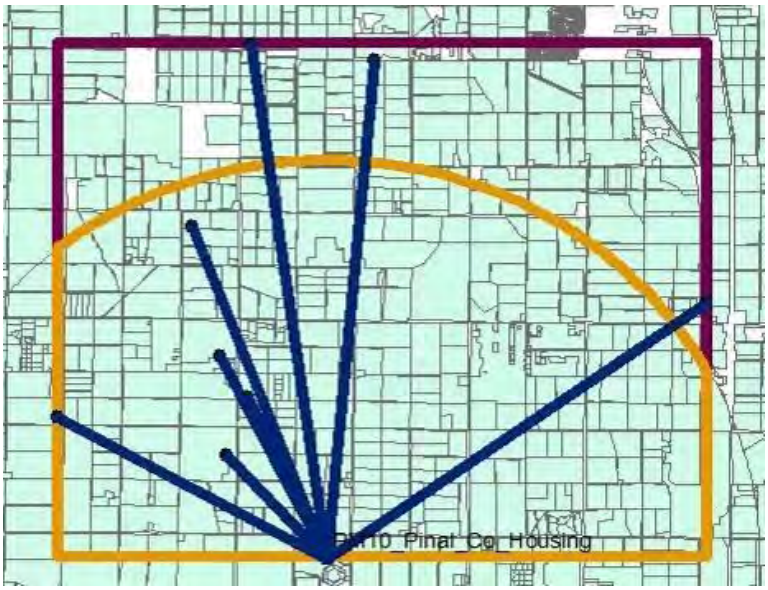


Figure 2-7b
Land Use for Low Wind Hours Modeling Domain at Pinal County Housing

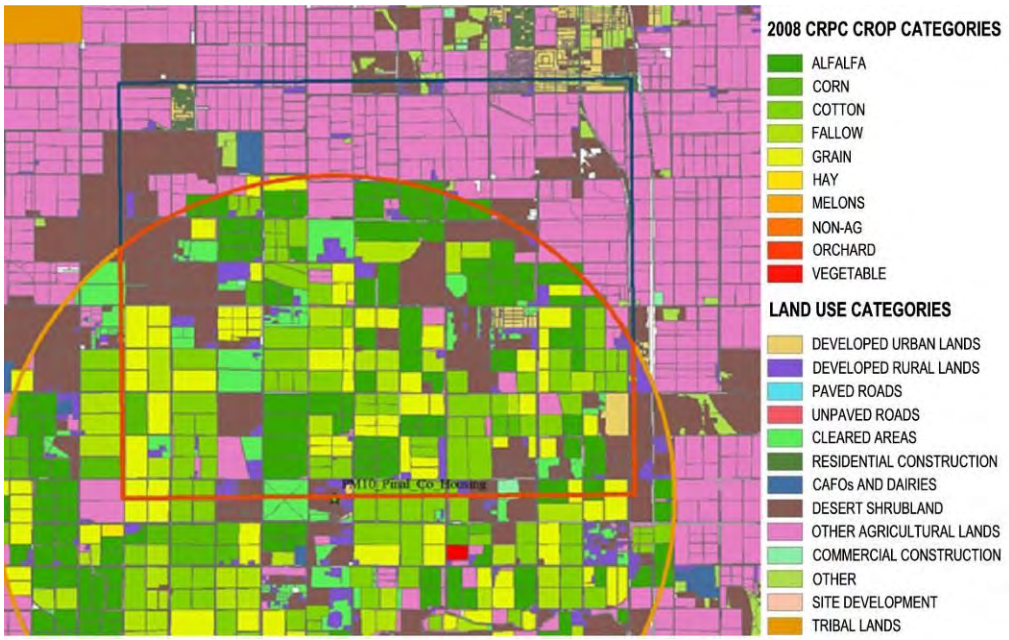


Figure 2-7c
Low Wind Hours Modeling Domain Selected for Pinal County Housing

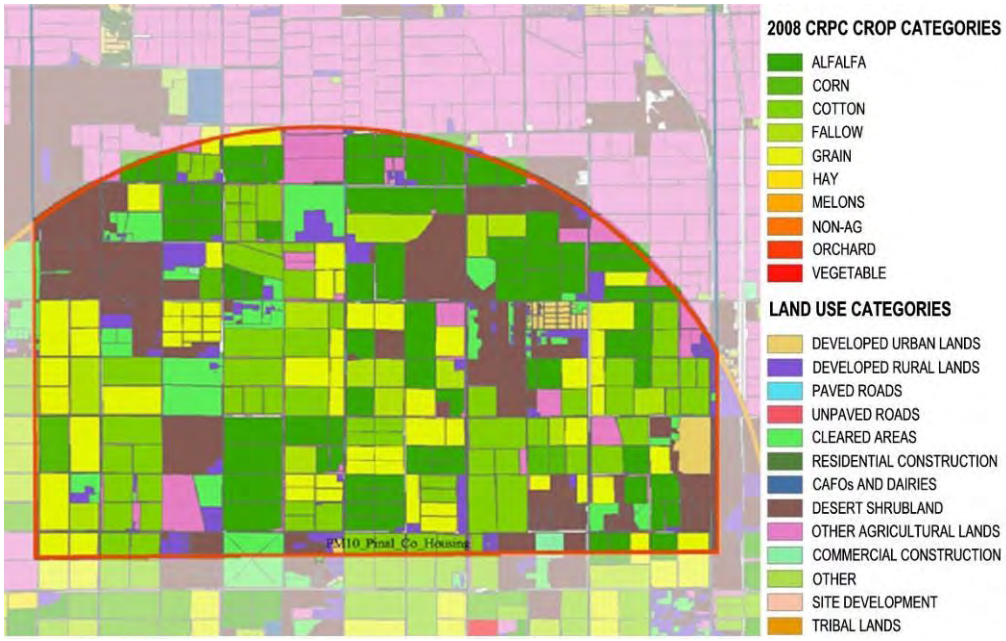


Figure 2-8a
Low Wind Hours Modeling Domain Proposed in IPP for Stanfield

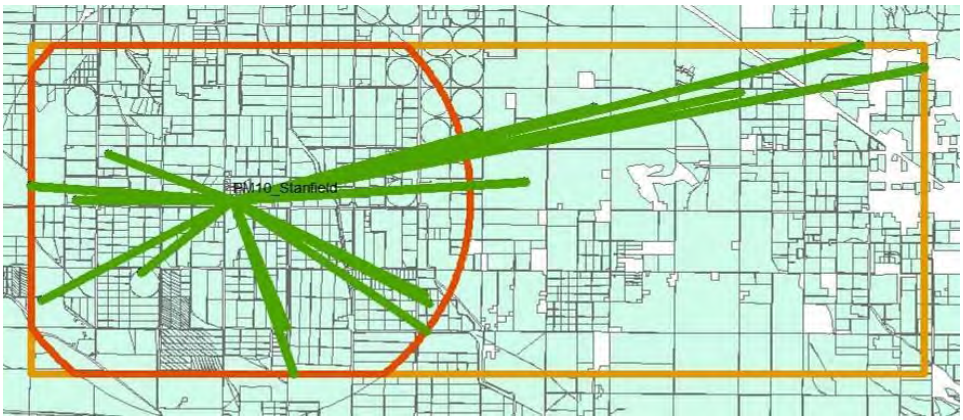


Figure 2-8b
Land Use for Low Wind Hours Modeling Domain at Stanfield

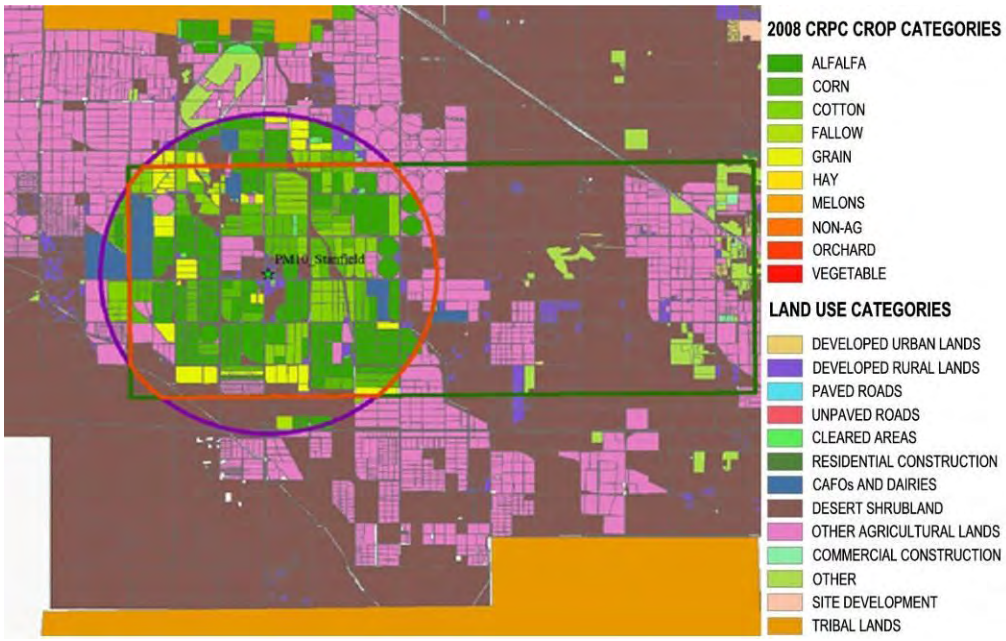
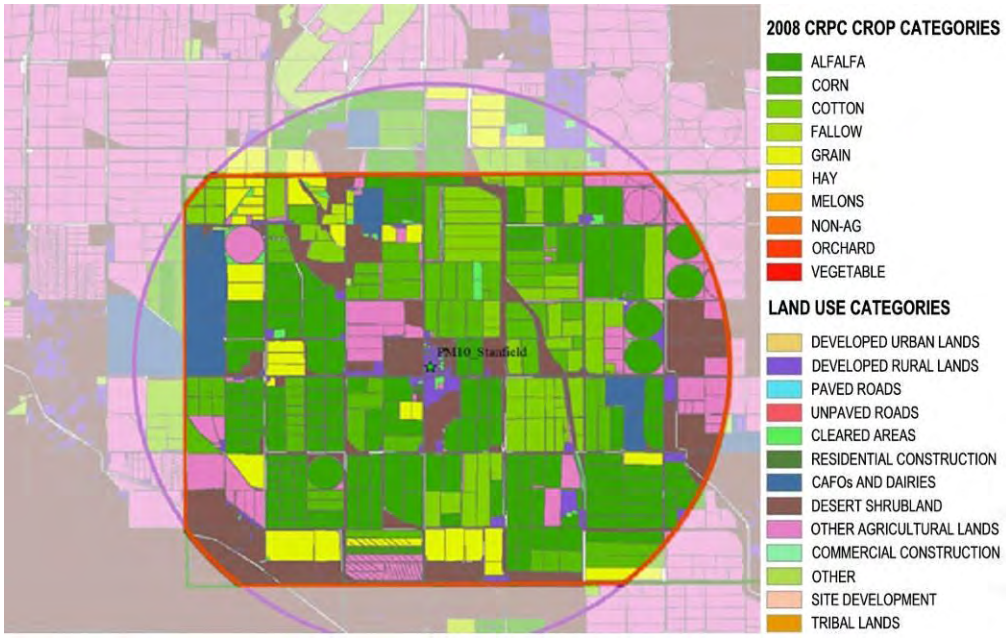


Figure 2-8c
Low Wind Hours Modeling Domain Selected for Stanfield



2.2 Low Wind Domains

As noted earlier, three monitors exceeded the 150 $\mu g/m^3$ standard under stagnation conditions: Cowtown, Pinal County Housing, and Stanfield. Since the wind speeds on the October 29, 2008 design day were extremely low (some fell below the measurement threshold of the monitor), the domains generally fell within the 6 km boundary of the data provided by the CRPC. Figures 2-9, 2-10, and 2-11 display the relationship between the IPP boundaries and the CRPC boundaries.

Figure 2-9 shows that the Cowtown domain is slightly larger than the CRPC domain and that assumptions will be needed for addressing crops under cultivation on both GRIC and Ak-Chin lands. Figure 2-10 shows that the low wind domain for Pinal County Housing falls entirely within the CRPC domain, so no additional assumptions about crop activity will be required. Figure 2-11 shows that small portions of the Stanfield modeling domain fall outside of the CRPC boundary so that assumptions about crop activity on agricultural lands outside the boundary are needed (no Indian lands fall within this domain). These assumptions, which are described in Section 3.1.11, parallel the approach adopted to characterize crops cultivated on Indian Lands.

Figure 2-9
Stagnation Modeling Domain Selected for Cowtown

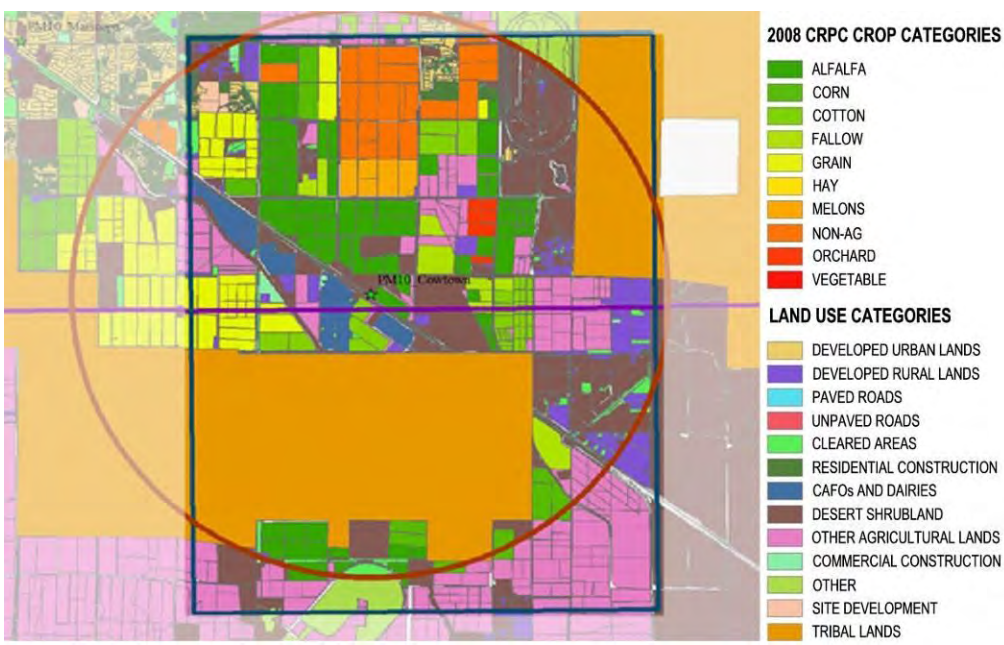


Figure 2-10
Stagnation Modeling Domain Selected for Pinal County Housing

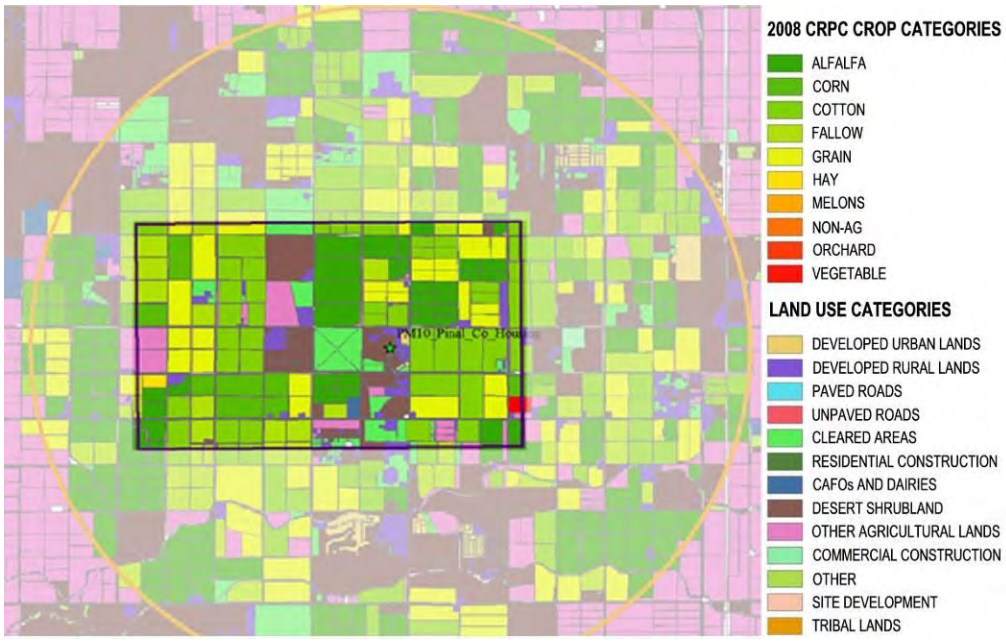
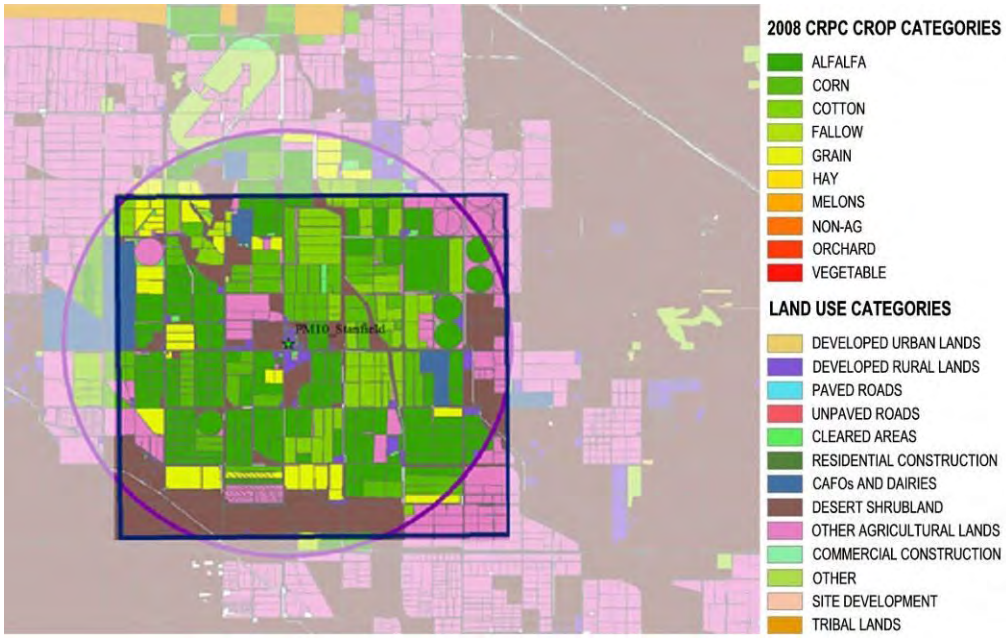


Figure 2-11
Stagnation Modeling Domain Selected for Stanfield



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3. EMISSION METHODS

As noted in the Introduction, considerable effort has been devoted to collecting, assembling, and assessing the activity data and related insights needed to calculate emission inventories. Presented are separate discussions of methods for calculating low wind emissions and high wind emissions.

3.1 Low Wind

A review of the data and methods employed to quantify emissions for each of the key low wind source categories is provided below.

3.1.1 Agriculture Methodology

Several methods are available to estimate fugitive dust emissions from agricultural operations; these include the Technical Support Document (TSD)[9] developed for Agricultural Best Management Practices (BMP) in Arizona, the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook,[10,11] and the California Air Resources Board (CARB) paper titled "Computing Agricultural PM_{10} Fugitive Dust Emissions Using Process Specific Emission Rates and GIS."[12] Maricopa County in both the 2008 Periodic Emissions Inventory[13] and the MAG 2007 Five Percent Plan modeling[14] used the tillage methodology from the TSD, and estimated harvest emissions using crop-specific emission factors from CARB. Since these methods are designed to produce annual emission estimates associated with these activities, the challenges when modeling a specific design day include not only how to allocate the annual estimates to a daily value, but also how to spatially apportion the emissions to specific parcels. Several methods have been developed to address the allocation challenge, because without information on how operations occurring in the fields are impacting violating monitors on the design day, it is not possible to have certainty about the fugitive dust produced by agricultural operations on a day-to-day basis.

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[9] *http://www.azdeq.gov/environ/air/plan/download/tsd.pdf*.
[10] *http://www.wrapair.org/forums/dejf/fdh/content/Ch2-Agricultural_Tilling_Rev06.pdf*
[11] *http://www.wrapair.org/forums/dejf/fdh/content/Ch10-Harvesting_Rev06.pdf*
[12] *http://www.epa.gov/ttnchie1/conference/ei12/fugdust/yu.pdf*
[13] *http://www.maricopa.gov/aq/divisions/planning_analysis/docs/2008_PM10/08_PM10_PEI_Entire.pdf*
[14] "Air Quality Modeling for the Salt River Area in Support of the Five Percent Plan for PM-10," Sierra Research, November 2007

Presented below is a summary of the methods used to quantify annual emissions and to assess their potential impacts on selected design days. It is important to note that the number of operations required to cultivate and harvest a crop varies and therefore emissions vary considerably by crop type. Given the predominance of agricultural land use within the nonattainment area and most of the selected modeling domains, considerable effort was devoted to researching information about the crops being cultivated on individual land parcels. More information about the approaches adopted to research and apply information provided by the CRPC on crops under cultivation in 2008 is presented in Section 2.

Tilling – Tillage emissions were estimated using the emission factor equation employed in the TSD, combined with tillage activity estimates. The tillage emission factor equation is shown below.

$$EF_{tillage} = k\,(4.8)\,s^{0.6}$$

where:

$EF_{tillage}$ = Agricultural emission tillage factor (lbs PM_{10}/acre-pass)
k = Particle size multiplier (this value is 0.15 for PM_{10})[9]
s = Percent silt content of soil (12.1% for Pinal County)[15]

Given that the silt content of the soil in Pinal County is 12.1%, as listed above, the tillage emission factor for Pinal County is calculated as follows:

$$EF = 0.15 \times 4.8 \times (12.1)^{0.6} = 3.21 \text{ lbs } PM_{10}\text{/acre-pass}$$

This emission factor is used to calculate the annual crop-specific PM_{10} emissions associated with agricultural tillage using the following equation[9]:

$$\text{Tillage}_{crop} = EF \times AP_{crop} \times A_{crop}$$

where:

$Tillage_{crop}$ = Annual PM_{10} emissions from tilling each crop type (lbs)
EF = Tillage emission factor (lbs PM_{10}/acre-pass)
AP_{crop} = Number of tillage passes per crop (passes)
A_{crop}= Number of tilled acres for each crop type parcel (acres)

One option to estimate daily crop-specific tilling emissions is to divide the annual emissions by the estimated days per year of tillage operation for each crop (shown below in Table 3-1), which are based on the assumption that tillage activities occur seven days

[15] Calculated from "Summary of Silt and Moisture Analyses of Soil Samples from Pinal County, Arizona, Collected on May 8th, 2013," JBR Environmental Consultants, June 26, 2013

Table 3-1 Tillage Operation Assumptions		
Crop	Number of Tillage Passes Per Year	Tillage Operations (days/yr)
Alfalfa	5.1	91
Corn	7.3	152
Cotton	8.8	364
Grain	3.1	243
Vegetable	14	182
Hay	5.1	91
Melon	14	182
Orchard	5	91

per week during the months of tillage operations. This approach spreads the annual emissions uniformly over the period of time when they can occur. The reality, however, is much different—tillage occurs during a limited number of days and the number of acres impacted is a function of the equipment available to individual farms (either directly owned or leased or through contracted operations) and the power requirements of the operation. The TSD addressed this issue by dividing the year into tilling periods (e.g., March-May) and assuming that tilling was normally distributed throughout the period. This resulted in an estimate of a 1% chance of activity on a particular day, roughly paralleling the approach of distributing annual emissions over the period in which they can occur.

Since tillage operations are unlikely to occur more than once per day on the same acre of land, an alternate approach would be to estimate the number of acres that could be actively tilled in a day on an average farm. Assuming an average tilling rate of 36 acres/day (3 acres per hour over a 12-hour day) and 2 tractors/farm,[16] roughly 72 acres can be actively tilled in a day. According to the 2007 Census of Agriculture,[17] the average farm size in Pinal County is 1,334 acres; thus, it would take 19 days to complete one operation over the entire farm. Since multiple operations are required, roughly 100 days per year would be required to complete the tillage operations specified in Table 3-1 for most crops. A review of the time allotted to tilling operations in the Pinal County Crop Calendar[18] indicates that the time allotted to tillage operations is considerably smaller than the values cited in Table 3-1, and discussions with Pinal County farmers has indicated that values in Table 3-1 are overstated. Presented below is a comparison of

[16] These assumptions, which are recognized as rough, given variations in farm size, tillage practices, soil organic content, etc., were confirmed in a discussion with the Pinal County Extension Agent Rick Gibson, 7/16/13.

[17] *http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Arizona/cp04021.pdf*

[18] Email from Kate Edwards, Pinal County Air Quality Control District, 2008 Crop Calendar Corrected, 4/04/13. The Crop Calendar was derived from information presented in the Arizona Agricultural Statistics Bulletin.

alfalfa emission estimates associated with distributing emissions over the available tillage days (Method 1) and a bottom-up estimate of the number of acres per farm that can be tilled on a typical day (Method 2) for an average farm in Pinal County.

Method 1: (3.21 lbs/acre pass x 5.1 acre passes x 1,334 acres)/91 days = 240 lbs/day

Method 2: 3.21 lbs/acre pass x 72 acres/day = 224 lbs/day

Given the uncertainty in the assumptions, the difference in the emission estimates is minimal for alfalfa; the more significant difference is that the Method 1 value would be spread out over 1,334 acres and the Method 2 value would be spread out over 72 acres or 5.4% of an average farm (72/1,334) per day. The differences between the methods will vary among crops, depending on the number of operations and number of days available for tillage. The most extreme example is cotton, where Method 1 would produce an emission estimate that is less than half the Method 2 value (104 lbs/day versus 224 lbs/day). Given the potential difference in emissions between the methods and the dominance of cotton cultivation, Method 2 estimates have been chosen for use in estimating design day emissions.

Several alternatives were considered in determining where field activities occur within the modeling domain.

Since field operations do not occur on all fields within the modeling domain at the same time, a decision was required regarding where to allocate the activity. After considering alternatives (e.g., allocating activity to parcels closest to the monitor, allocating activity farthest from the monitor, etc.), a decision was made to spread activity across each parcel in the domain. Thus, emissions were calculated for 5.4% of each crop parcel with tilling activity.

Initial discussions with farmers indicated that tilling and harvesting activity was limited to daylight hours. More recent discussions with farmers, however, found that 50% of cotton farmers were performing tilling at night in 2008 and this practice continues to today. This information was used to prepare crop-specific diurnal activity profiles. Two values are presented for cotton—the first is for tilling and second is for harvesting. These values, presented in Table 3-2, can be used to distribute daily emission estimates by crop to hourly values. As can be seen, with the exception of cotton, all crop-specific activity is evenly distributed over the 12 daytime hours (i.e., 6:00 am to 6:00 pm) on the design days.

Table 3-2 Percent of Daily Activity Conducted During Each Clock Hour								
Hour	Alfalfa	Corn	Cotton	Grain	Vegetable	Hay	Melon	Orchard
1	0	0	2.8/0	0	0	0	0	0
2	0	0	2.8/0	0	0	0	0	0
3	0	0	2.8/0	0	0	0	0	0
4	0	0	2.8/0	0	0	0	0	0
5	0	0	2.8/0	0	0	0	0	0
6	0	0	2.8/0	0	0	0	0	0
7	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
8	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
9	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
10	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
11	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
12	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
13	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
14	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
15	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
16	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
17	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
18	8.3	8.3	5.6/8.3	8.3	8.3	8.3	8.3	8.3
19	0	0	2.8/0	0	0	0	0	0
20	0	0	2.8/0	0	0	0	0	0
21	0	0	2.8/0	0	0	0	0	0
22	0	0	2.8/0	0	0	0	0	0
23	0	0	2.8/0	0	0	0	0	0
24	0	0	2.8/0	0	0	0	0	0

Harvesting – Annual PM_{10} emissions associated with harvesting activities are estimated using the following equation, which utilizes crop-specific emission factors:[19]

$$Harvest_{Crop} = EF_{Crop} \times A_{Crop} \times (1 \text{ ton}/2{,}000 \text{ lbs})$$

where:

$Harvest_{crop}$ = harvest emissions for each crop type (tons PM_{10}/yr)
EF_{crop} = harvest emission factor (lbs PM_{10}/acre)
A_{crop} = number of harvested acres for each crop specific parcel per year

[19] Area-wide Source Methodologies, Section 7.5 Agricultural Harvest Operations, revised January 2003. California Air Resources Board, 2003. *http://www.arb.ca.gov/ei/areasrc/index7.htm*

The issue of how to allocate annual harvest emissions to a specific day parallels the tilling allocation challenge. In the case of harvest emissions, however, fewer assumptions are needed because meetings with Pinal County farmers indicated that they could only harvest 80–100 acres of cotton/day. Choosing the upper limit of 100 acres/day, it was determined that only 100 acres/1,334-acre farm—or 7.5% of an average farm—could be harvested per day. Stated another way, it could be assumed that on any given day, at most 7.5% of the cotton parcels identified in the selected modeling domains could be actively harvested (because farms typically cultivate more than one crop).

Thus, for an average farm, harvest emissions for cotton would be calculated as follows:

$$\begin{aligned} \text{Harvest emissions}_{\text{cotton}} &= 3.4 \text{ lbs/acre} \times 100 \text{ acres/day} \\ &= 340 \text{ lbs/day} \end{aligned}$$

Distributing these emissions must still be addressed—either they can be spread across all the 1,334 acres of an average farm (which is not identified in any of the available parcel data), they can be distributed proportionately to each parcel by crop, or they can be allocated closer and farther from the monitor through bounding scenarios. The approach adopted to address this issue for tilling will be used for addressing the allocation of harvest activity.

Hourly crop-specific tilling emissions can be calculated using the assumptions discussed above under the tillage discussion; activity is evenly distributed over the 12 daytime hours (i.e., 6:00 am to 6:00 pm) on the design days. Therefore, the diurnal variation for harvesting operations during the design days is identical to that shown in Table 3-3.

Table 3-3
Harvest Operation Assumptions

Crop	Emission Factor (lbs/acre-yr)[a]	Harvesting Operations (days/yr)[b]
Alfalfa	0	294
Corn	1.68	91
Cotton	3.4	143
Grain	5.8	60
Vegetable	0.08	116
Hay	1.68	294
Melon	0.08	116
Orchard	0.08	188

a. The EF (lbs/acre-yr) is extracted from the CARB, 2003 study.
b. Crop operation schedule is extracted from the MAG 2012 5% Plan.

Design Day Calculations – As noted earlier, October 29, 2008, was selected to represent stagnation conditions at Cowtown, Pinal County Housing, and Stanfield. A review of the Crop Calendar found that no planting activity occurs at this time of year. Instead, most crops are either being harvested, or have already been harvested. Discussions and correspondence with Pinal County farmers found harvest activity on this date is primarily limited to alfalfa, cotton, and hay. Using this information, crop distributions were quantified for each of the modeling domains. The distributions, presented in Table 3-4, show land use shares for each of the three harvested crops, the remaining CRPC crops not being harvested, fallow land, and Other Agricultural Land.[20]

Table 3-4
Crop Distribution for Stagnation Design Day Modeling Domains
(%)

Crop Category	Cowtown	Pinal County Housing	Stanfield
Alfalfa	20.5	22.3	42.7
Cotton	5.1	33.6	15.9
Hay	0.0	0.5	0.0
Remaining Crops	21.6	29.7	27.7
Fallow	5.8	10.3	0.5
Other Ag Lands	47.0	3.6	13.2
Ag Land Share (%) of the Domain	67.2	83.4	81.1

Separate emission estimates were calculated for each agricultural land parcel in each modeling domain for the three actively harvested crops shown in Table 3-4. No activity or emissions were assumed to occur for the remaining crops, fallow land, or for Other Agricultural Lands.

3.1.2 Concentrated Animal Feeding Operations (CAFO)

Literature Search – The identification of an appropriate PM_{10} emission factor for use in assessing design day and future emission levels from feedlot operations near the Cowtown monitor began with a limited literature search of feedlot emission monitoring studies. The search identified seven peer-reviewed studies of feedlot PM_{10} emissions

[20] A review of the information presented in the shapefiles provided by ADEQ/PCAQCD and CRPC found CRPC did not identify crops for all agricultural parcels within its 6 km domain (i.e., within the overlap of the two shapefiles for each modeling domain). In addition, there are agricultural parcels located within the stagnant modeling domains that are outside of the CRPC 6 km domain that have no crop information. The overall portion of these Other Agricultural Lands varies by monitor

published between 1994 and 2012. Emission factors reported in these studies ranged from 0.0092[21] to 0.063 lb[22] PM_{10}/head-day. Most of the studies reported emission factors on an annual-average-day basis only, intended for use in compilation of annual emission inventories. Understanding that feedlot emissions vary significantly from hour to hour based on specific activities such as animal feeding schedules, the use of an annual-average-day value was deemed to be too limiting in attempting to characterize the contributions of feedlots to hourly air quality impacts for a 24-hour attainment demonstration at the Cowtown site.

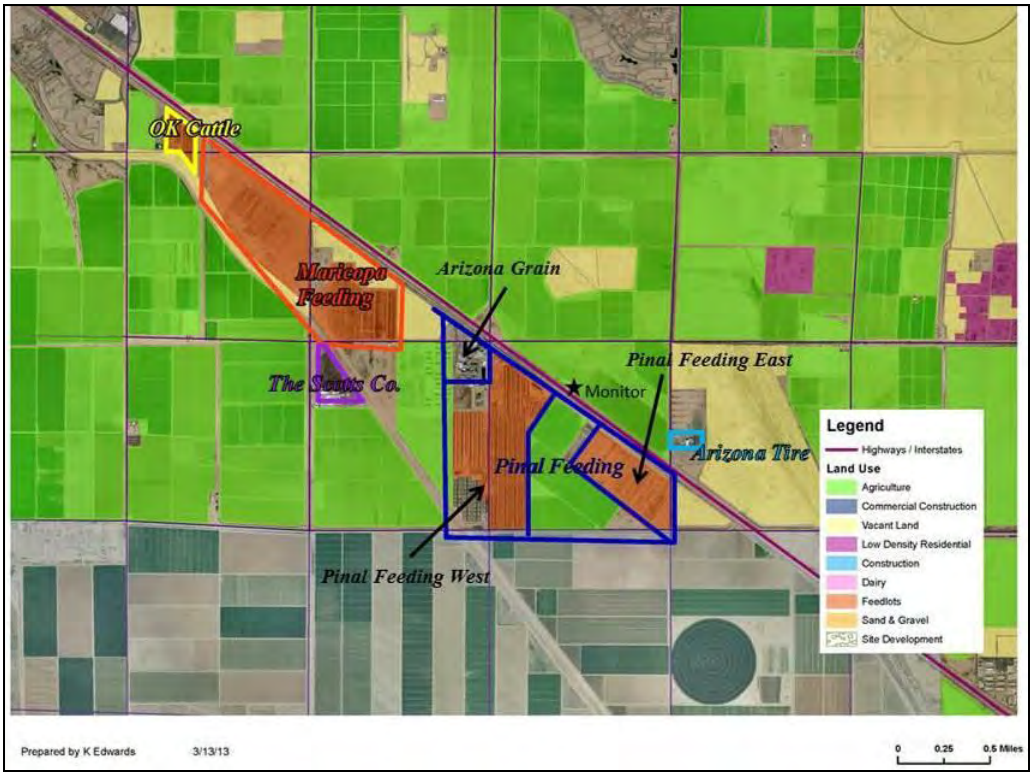
The most robust study gleaned from the literature search, one that included seasonal and diurnal profiles of emissions from two feedlots over a two-year period, was a study conducted in Kansas by Bonifacio et al.[23] Because feedlot pen emissions were demonstrated in the study to be proportional to ambient temperatures and resulting evapotranspiration (ET) rates, and because temperatures and ET rates are higher in Pinal County than in Kansas, the representativeness of these factors to Cowtown feedlots was questionable. Because the Cowtown feedlots were located 0.17 to 2.44 miles from the Cowtown monitoring station, and because the monitoring station has been in operation since 2001 recording hourly PM_{10} and meteorological data, an analysis of these data using the reverse dispersion modeling methodology described in the Bonifacio study was undertaken to produce potentially more representative emission factors for these facilities.

Feedlot Emission Isolation – In 2008, the Cowtown source complex consisted of seven feedlot pen areas, a grain mill, a tire recycling facility, a composting facility, and an ethanol plant. A map of these facilities and the monitoring station is presented in Figure 3-1. The feedlot pens closest to the monitoring station are operated by Pinal Feeding Company. In the 2008 baseline year, the company operated a feedlot 0.28 miles from the monitor in a south to southeasterly direction. This pen area, known as Pinal Feeding East (PFE), lay along one of the axes of prevailing low velocity nocturnal winds impacting the monitor and thus was identified as potentially significantly influencing PM_{10} concentrations at the monitor. Additionally, wind trajectories passing over the PFE pens to the monitoring station did not transport emissions from any of the other feedlot pens or other industrial facilities to the Cowtown monitor. These qualities suggested that the PFE pens represented the best feedlot source to analyze using reverse dispersion modeling techniques.

Although this approach did succeed in isolating the PFE emissions from those of other Cowtown industrial facilities, including other feedlots, non-industrial sources of PM_{10} near to and upwind of the PFE pens were recognized as also impacting the monitor and

[21] Parnell, S.E., B.J. Lesikar, J.M. Sweeten and R.E. Lacey. 1994. "Determination of the Emission Factor for Cattle Feedyards by Applied Dispersion Modeling," presented at the June 19-22, 1994 International Summer Meeting, Paper No. 944042 (revised). ASAE, 2950 Niles Road, St. Joseph, MI 49085
[22] Bonifacio, H.F, R.G. Maghirang, B.W. Auvermann, E.B. Razote, J.P. Murphy, and J.P. Harner III, "Particulate matter emission rates from beef cattle feedlots in Kansas – Reverse dispersion modeling," JAW&MA 62(3)350-361, 2012.
[23] Ibid.

Figure 3-1
Cowtown Monitor, Feedlots, and Other Industrial Sources



causing increased cumulative impacts when wind velocities were high enough to produce windblown PM_{10} emissions from disturbed soil surfaces. To eliminate this interference, the analysis of 2008 impacts was limited to hours in which wind speeds were below the threshold for soil entrainment, which was estimated to be 12 mph on an hourly average basis. During low wind hours, however, such sources as paved and unpaved road travel, locomotive exhaust, and agricultural operations were assumed to cumulatively add to PFE emission impacts as measured at the Cowtown monitor. During preliminary discussions with staff of the Pinal County Air Quality Control District (PCAQCD) on approaches to quantify the impacts of these other sources, Sierra Research learned that the PFE pens had been closed and demolished in the spring of 2010.[24] Since the monitoring record at Cowtown included hourly monitoring data for 2011 and 2012—years in which these other sources continued to operate in the absence of the PFE pens—the demolition of the PFE pens provided an opportunity to separately quantify the impacts of these other sources. The differences between the 2008 and the 2011/2012 impacts at the monitor represented the sole contributions from the PFE pens during 2008. This added benefit of selecting the PFE pens for feedlot emission analysis was believed to further reduce the confounding impact of other sources.

[24] Conference telecon with Sierra Research staff and contractor, Pinal County Air Quality Control District staff, and Arizona Department of Environmental Quality staff, June 13, 2013.

Basic Analytical Approach – In a reverse dispersion modeling analysis, air quality monitoring data are used to compute the emission rate of an upwind source in a process that is the reverse of typical source impact analysis. In source impact analysis, emissions from a source are estimated, and these emissions—together with stack information and meteorological data—are entered into a run file for a plume dispersion computer model. The source file is run by the model, resulting in estimates of pollutant concentrations occurring at specified downwind receptor sites. If, instead, an existing air quality monitor is designated as a downwind receptor site, and the pollutant concentrations measured at the monitor are assumed under appropriate wind directions to be due solely to emissions from an existing upwind source, the dispersion model can be used to back-calculate the emission strength of the source. The source emission rate in initial modeling is typically fixed over time at a unit value—such as 1 gm/sec—and the model is run to determine, hour by hour, the pollutant concentrations occurring at the monitor/receptor. The meteorological dataset used in this type of modeling is derived from locally collected hourly data covering one or more years. The dataset is filtered to include only those hours during which the wind direction requirements are satisfied. The resultant hourly pollutant concentrations forecasted by the model to occur at the monitor/receptor are then compared to the actual pollutant concentrations measured at the monitoring site, and the ratio of monitored concentration to modeled concentration is then multiplied by the unit emission rate assigned to the source to compute the estimated emission rate of the source. The basic equation that is used to perform this final step is shown below.

$$E' = E_0 \cdot (\xi'/\xi_0)$$

where:

E' = Back-calculated emission rate of source, g/sec
E_0 = Initial emission rate of source, g/sec
ξ' = Monitored pollutant concentration, $\mu g/m^3$
ξ_0 = Modeled pollutant concentration from source at initial emission rate, $\mu g/m^3$

Base Year Modeling – The modeling of PFE PM_{10} emission impacts at the Cowtown monitor was conducted using AERMOD, an EPA-approved model recommended for use with point and area industrial sources.[25] Meteorological files used by AERMOD were constructed using 2008 surface meteorological data collected at the Cowtown station and the Maricopa AZMET station,[26] and upper air data collected at Tucson, the closest site of measured upper air data that is approximately 80 miles to the southeast of Cowtown. The coordinates of the PFE pen perimeter and the Cowtown monitoring station were identified from the online Google Earth program. From these coordinates, the total pen

[25] Environmental Protection Agency, 2005, 40 CFR 51 Vol. 70, No. 216, pg. 68218, *http://www.epa.gov/scram001/guidance/guide/appw_05.pdf*

[26] The Cowtown meteorological data were not continuous through 2008. Data collected at the Maricopa AZMET station were used to fill in gaps in the Cowtown record for the periods of February 19 through April 25, 2008, and May 15 through September. 5, 2008. (Email from Scott DiBiase, PCAQCD, to Bob Dulla, Sierra Research, July 8, 2013.)

area of the PFE facility was calculated to be 292,667 m^2. A unit PM_{10} emission rate of 1.0 g/sec was assigned to the PFE facility, which converted to a unit-area emission rate of 3.417 $\mu g/m^2$-sec, and these emissions were assumed to be distributed uniformly across the facility and constant for every hour of 2008. From the Bonifacio study, the release height of PM_{10} emissions from livestock movement and on-site unpaved road travel was assumed to be 2.3 meters. Estimated hourly average PM_{10} concentrations at the Cowtown monitor were calculated by AERMOD for each hour of 2008 from this single area source. These data, together with the hourly meteorological PM_{10} data recorded at the monitor in 2008, were imported into a spreadsheet and merged into a single dataset by date and time stamp for analysis.

Initial Emission Factor Analysis – PM_{10} emissions from PFE pen activities significantly impact the Cowtown monitor when wind speeds are low and when wind directions carry these emissions directly from the pens to the monitor. Previous analysis of the relationships between PM_{10} concentrations and wind speeds at the monitoring stations designated for attainment demonstrations in the Inventory Preparation Plan indicated that wind entrainment of dust commenced in 2008 at a wind speed of approximately 12 mph (5.4 m/sec). To avoid the confounding impacts of windblown dust from upwind arrays of disturbed soil surfaces, an upper limit wind speed of 3.0 m/sec was selected for use in identifying hourly meteorological and PM_{10} monitoring data during which mechanically generated emission impacts, such as those generated by operation of the PFE facility, dominate PM_{10} concentrations measured at the Cowtown monitor.

Cowtown monitoring data collected in 2008 were further screened for hourly average wind directions associated with PFE emission impacts. Measurements taken from a Google Earth aerial photograph indicated that the boundaries of the PFE facility subtended a compass arc, as measured from the Cowtown monitor, ranging from 135 to 180 degrees. The dataset of 2008 monitoring data and modeled impacts was further filtered to include only this range of wind directions, and hours with missing data were removed. The remaining dataset was found to contain 1,802 hours that satisfied the specified meteorological conditions. During a series of sensitivity analyses, this dataset was further disaggregated into five different subsets based on various wind direction arcs. A map of the PFE facility and the five different wind arcs is shown in Figure 3-2.

The Bonifacio paper and information received from Pinal Feeding Company representatives revealed that PM_{10} emission rates from feedlots varied dramatically from hour to hour on a diurnal basis. Maximum PM_{10} emissions rates are associated with peaks in cattle movement, which typically occurs within a few hours of feeding times. At the PFE facility, cattle were fed between 6:00 am and 3:00 pm, and significant in-pen movement occurred between 4:00 and 8:00 pm as cattle responded to digested feed energy release and the desire to find relief from peak daily temperatures.[27] Because of these significant fluctuations in hourly emissions, and the need to develop diurnal emission profiles for the 24-hour PM_{10} standard attainment demonstration, the filtered

[27] Conference call with Bas Aja/Arizona Cattle Feeders Association and staff of the Arizona Department of Environmental Quality and Pinal County Air Quality Control District, May 13, 2013.

Figure 3-2
Cowtown Monitor, PFE Facility, and Wind Arcs

Legend (colors refer to lines perpendicular to wind directions):
Base Wind Arc Blue, 135-180 degrees (Table 3-5)
Narrow Wind Arc Red, 142.5-172.5 degrees (Table 3-6)
West Wind Arc Orange, 157.5-180 degrees (Table 3-7)
East Wind Arc Lt. Green, 135-157.5 degrees (Table 3-8)
East+ Dk. Green, 135-162.5 degrees (Table 3-9)

monitoring and modeling data were analyzed on an hour-of-day basis. The Bonifacio paper reported that hourly feedlot emissions rates over an annual period were not normally (i.e., bell curve) distributed, and that average values were best calculated using median instead of mean values. On the basis of the Bonifacio report, the analyses of the Cowtown monitoring and PFE modeling data used median values in the development of statistical relationships.

The results of the initial comparison between monitored and modeled PM_{10} concentrations in 2008 at the Cowtown monitor are displayed in Table 3-5. The tables show that modeled PM_{10} concentrations are less, with one exception, than monitored PM_{10} concentrations. This indicates that the actual PM_{10} emission rate of the PFE facility is greater than the 1.0 g/sec default rate used in the modeling analysis. The grouping of higher PM_{10} values at night in both the monitored and modeled data confirm the influence of low mixing heights during nocturnal hours. The higher values shown in the monitoring data for the hours of 1900 to 2200 compared to values shown for the hours of 2300 through 0700 suggests that PFE emissions are substantially higher during this period than during the other hours of the night. This ratio is especially in contrast to

Table 3-5
Hour of the Day Percentiles of 2008 Monitored and Modeled PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Direction is between 135 and 180 Degrees (Base Arc) ($\mu g/m^3$)

Hour of the Day Percentiles of 2008 Cowtown Monitored PM10 When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 180 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	21	22	21	23	32	37	21	26	37	28	19	15	14	15	8	16	12	12	29	38	37	23	20	21
20%	32	36	42	51	58	71	67	43	47	36	25	21	23	19	13	23	15	22	39	95	62	44	40	40
30%	53	72	70	83	89	111	111	88	68	48	27	24	28	22	18	27	24	31	68	120	101	70	75	64
40%	85	125	91	104	116	152	135	165	93	62	36	31	30	25	22	30	37	39	107	247	183	99	105	115
50%	136	179	154	128	146	183	202	195	122	81	42	42	34	31	26	32	51	60	112	567	251	144	161	182
60%	195	229	209	164	177	218	237	226	145	93	52	48	35	41	33	37	51	82	231	754	421	242	200	220
70%	241	268	244	205	210	288	271	274	172	100	74	55	42	54	39	41	52	85	399	1021	483	294	251	267
80%	320	326	306	292	253	355	333	304	216	154	97	79	54	62	46	44	54	88	1040	1524	943	360	302	324
90%	393	461	418	377	336	443	393	353	252	270	123	100	70	84	55	45	59	317	1924	1994	1882	625	454	387
100%	1414	864	838	810	889	740	710	621	559	860	139	134	81	175	63	47	63	547	2159	3853	5457	2128	1355	736

Hour of the Day Percentiles of Modeled PM10 Impacts in 2008 at the Cowtown Monitor from the PFE Pen Facility
At 1.0 g/sec Emission Rate When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 180 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	8	6	6	7	7	5	4	1	1	1	1	1	1	1	1	1	1	2	3	9	9	7	9	8
20%	12	11	10	10	10	8	6	2	2	2	1	1	1	1	1	2	1	2	9	12	17	14	15	13
30%	20	13	14	13	14	12	8	4	2	2	1	1	1	1	1	2	1	2	14	18	28	19	22	17
40%	26	18	18	19	19	14	11	4	2	3	2	2	1	1	1	2	1	2	19	35	46	33	31	23
50%	32	28	22	25	24	20	20	6	3	3	2	2	1	1	1	2	1	3	34	51	57	45	39	29
60%	49	39	30	31	31	28	34	8	4	3	3	2	1	2	1	3	2	4	101	61	68	59	51	37
70%	63	47	45	46	39	35	45	26	5	4	4	2	2	2	1	3	2	67	119	92	77	78	72	57
80%	86	69	59	76	77	59	62	58	9	6	5	3	2	2	2	4	2	130	119	153	109	95	100	75
90%	127	100	127	140	132	120	128	92	17	9	6	3	3	2	2	4	2	150	124	179	136	126	136	103
100%	179	197	205	237	241	236	189	212	141	20	11	6	3	2	2	5	2	169	145	222	214	174	197	288

Ratio of Modeled to Monitored PM10 Percentiles by Hour of the Day at the Cowtown Monitor in 2008
When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 180 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	38.9%	26.4%	28.5%	28.6%	23.1%	13.9%	16.8%	4.7%	3.0%	4.5%	4.4%	6.1%	5.5%	5.4%	7.3%	7.6%	9.5%	13.5%	8.9%	22.8%	24.5%	32.9%	42.9%	38.0%
20%	36.9%	29.2%	22.6%	18.7%	17.1%	11.6%	8.6%	5.3%	3.5%	5.1%	4.3%	5.5%	4.4%	4.7%	5.6%	7.3%	8.2%	8.4%	23.1%	12.5%	27.6%	31.6%	37.9%	31.8%
30%	38.6%	18.4%	19.4%	15.4%	15.8%	10.5%	6.9%	4.0%	3.1%	3.9%	4.7%	6.0%	4.0%	4.9%	4.7%	7.0%	5.6%	6.1%	20.9%	14.8%	27.9%	26.9%	29.1%	26.2%
40%	30.2%	14.6%	19.4%	17.8%	16.6%	9.5%	8.2%	2.7%	2.6%	4.3%	4.4%	5.1%	3.8%	5.4%	4.1%	6.6%	3.6%	4.8%	18.0%	14.1%	25.3%	33.3%	29.8%	20.1%
50%	23.3%	15.5%	14.2%	19.3%	16.7%	11.2%	10.0%	3.0%	2.4%	3.5%	5.4%	4.1%	4.1%	4.5%	3.7%	6.2%	2.7%	4.9%	30.2%	9.1%	22.6%	31.4%	24.4%	15.9%
60%	25.0%	17.2%	14.3%	18.9%	17.7%	13.0%	14.2%	3.4%	2.7%	3.4%	6.0%	4.1%	4.2%	3.8%	3.5%	7.3%	3.0%	4.9%	43.8%	8.1%	16.1%	24.3%	25.5%	16.9%
70%	26.0%	17.4%	18.6%	22.4%	18.7%	12.1%	16.8%	9.6%	3.2%	4.1%	5.0%	4.1%	4.4%	3.1%	3.4%	8.1%	3.4%	79.3%	29.8%	9.0%	15.9%	26.6%	28.9%	21.4%
80%	26.8%	21.2%	19.2%	26.2%	30.6%	16.5%	18.7%	19.2%	4.0%	3.6%	5.4%	3.6%	3.9%	2.7%	3.2%	8.8%	3.4%	149%	11.4%	10.0%	11.6%	26.5%	33.1%	23.3%
90%	32.4%	21.7%	30.4%	37.0%	39.2%	27.2%	32.6%	26.0%	6.8%	3.3%	5.1%	3.2%	3.9%	2.3%	3.1%	9.5%	3.2%	47.2%	6.5%	9.0%	7.2%	20.2%	30.0%	26.5%
100%	12.6%	22.8%	24.5%	29.3%	27.1%	31.9%	26.7%	34.1%	25.3%	2.3%	7.7%	4.8%	3.8%	1.3%	3.0%	10.2%	3.0%	30.9%	6.7%	5.8%	3.9%	8.2%	14.5%	39.1%
Count	154	155	155	139	131	143	108	92	72	46	28	23	18	12	5	5	5	6	9	29	74	120	126	147
	1802	Total																						

the ratio of nocturnal values for the same hourly periods shown in the modeled data table. The suggestion of elevated emissions from the PFE facility during the middle evening conforms to the feedlot activity information provided by Pinal Feeding Company representatives.

Wind Direction Arc Sensitivity Analysis – Initial comparisons of median PM_{10} monitored concentrations by hour of the day for the 2008 and 2011/2012 years indicated that emissions from sources other than the PFE facility were significant in 2008 and contributed to approximately 40% of PM_{10} recorded at the monitor. In an attempt to determine the relative location of these other contributing sources, and also to test the consistency of the results shown in Table 3-5 and the sensitivity of these results to the selection of other wind direction arcs, three other wind direction arcs were initially analyzed in the 2008 Cowtown dataset.

In the first sensitivity analysis, the wind direction arc was reduced from a spread of 45 degrees (i.e., 135 to 180 degrees) to a spread of 30 degrees (i.e., 142.5 to 172.5 degrees). This reduced—or "Narrow"—arc was designed to reduce the influence of sources that abutted the edges of the PFE facility with respect to wind direction. Such sources would produce plumes that would overlap that of the PFE facility given the roughly 15 degree spread of emission plumes when dispersing downwind. By reducing the PFE wind direction arc by 7.5 degrees on each side, the intent was to reduce the influence area sources adjacent to the PFE pens.

Table 3-6 presents the results of the comparison between monitored and modeled PM_{10} concentrations in 2008 at the Cowtown monitor using hourly data filtered to this narrower wind direction arc. The tabular values in Table 3-6 are generally very similar to those shown in Table 3-5, except that the values for percentiles between the 10th and 50th[28] in the modeled data are higher by factors ranging from a few to over 200 percent. This result is somewhat expected as the wind direction arcs that were removed from consideration are those that lie over the east and west corners of the PFE facility where the pen areas contributing emissions are small in comparison to the area bounded by the center 30 degree wind direction arc. The percentiles of PM_{10} impacts from the narrower but deeper (on average) emission area should be higher, over the range of wind directions modeled, than those of the wider but less deep (on average) emission area used in the baseline analysis. In the absence of results dramatically different from this general trend, we can assume that there were no significant area sources operating in the wind directions adjacent to those of the PFE facility used in the baseline analysis.

[28]Percentiles, as used in this analysis, represent the positions—in units of percent—of individual numbers in a series of numbers ranked from lowest to highest. The 10th percentile value of a set of numbers, for example, is the number that is larger than 10% of the numbers in the set and smaller than 90% of the numbers. The median, or 50th percentile, is the number that is larger than 50% of the numbers in a set and smaller than the other 50%. All percentiles were calculated using the Excel percentile.inc function.

Table 3-6
Hour of the Day Percentiles of 2008 Monitored and Modeled PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Direction is between 142.5 and 172.5 Degrees (Narrow Arc) ($\mu g/m^3$)

Hour of the Day Percentiles of 2008 Cowtown Monitored PM10 When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 142.5 and 172.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	24	20	26	25	32	49	23	29	30	29	24	14	15	19	8	34	11	10	27	131	41	22	21	21
20%	38	33	45	66	57	81	62	72	40	39	27	18	22	25	12	35	14	18	37	247	85	43	43	41
30%	61	56	74	84	80	119	110	109	56	54	31	23	28	34	17	36	16	26	50	285	121	67	81	78
40%	115	125	91	104	112	160	135	170	86	76	36	32	31	39	22	38	24	32	93	627	187	99	129	173
50%	163	176	133	126	134	192	182	202	122	89	43	46	35	44	26	39	34	39	183	922	277	137	169	210
60%	203	221	175	163	168	216	218	252	130	96	54	49	41	53	34	41	44	56	307	1021	435	195	206	246
70%	250	260	229	186	209	279	269	288	190	113	78	55	44	60	41	42	52	73	467	1651	644	288	259	280
80%	332	311	279	272	251	340	321	308	219	173	93	94	56	62	48	44	56	83	1315	1854	1006	360	302	331
90%	400	417	410	368	341	431	408	365	246	259	108	103	75	72	56	45	60	85	1953	2457	1879	689	456	389
100%	1414	764	766	739	889	740	710	621	559	860	137	134	81	87	63	47	63	88	2159	3853	5457	2128	1355	736

Hour of the Day Percentiles of Modeled PM10 Impacts in 2008 at the Cowtown Monitor from the PFE Pen Facility
At 1.0 g/sec Emission Rate When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 142.5 and 172.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	11	12	9	10	9	7	4	2	2	2	1	1	1	1	1	4	1	2	3	17	13	13	13	13
20%	19	15	14	14	13	11	7	4	2	2	2	1	1	1	1	4	1	2	7	37	25	25	23	19
30%	25	22	17	18	17	14	9	4	2	2	2	1	1	1	1	4	1	2	15	55	48	36	31	26
40%	30	29	21	24	21	20	18	6	3	3	2	2	1	2	1	4	1	2	30	61	58	47	39	33
50%	41	39	26	30	28	25	30	7	4	3	3	2	1	2	1	4	2	2	76	79	69	61	51	45
60%	54	45	41	43	39	31	44	9	5	3	3	2	2	2	2	4	2	53	118	95	76	78	68	62
70%	67	62	55	56	67	45	58	47	6	4	4	2	2	2	2	4	2	105	119	151	98	86	92	75
80%	86	78	91	97	92	90	78	65	10	5	5	3	2	2	2	5	2	138	119	169	126	111	121	88
90%	130	131	143	146	138	139	137	122	22	8	6	4	3	2	2	5	2	153	127	182	150	133	148	147
100%	179	197	205	237	241	236	189	212	141	20	11	6	3	2	2	5	2	169	145	222	214	174	197	288

Ratio of Modeled to Monitored PM10 Percentiles by Hour of the Day at the Cowtown Monitor in 2008
When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 142.5 and 172.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	46.5%	59.6%	33.4%	39.4%	28.7%	14.7%	16.6%	8.3%	5.4%	6.4%	5.8%	6.2%	7.1%	6.5%	13.8%	11.2%	9.9%	15.8%	9.4%	13.2%	31.8%	60.1%	59.5%	62.1%
20%	51.3%	47.1%	30.0%	20.7%	23.0%	13.7%	11.0%	4.9%	5.3%	4.9%	6.0%	7.6%	5.2%	5.6%	9.3%	11.1%	8.8%	9.7%	18.7%	15.1%	29.9%	57.9%	53.2%	46.6%
30%	41.4%	39.8%	23.4%	20.9%	21.2%	11.5%	8.0%	3.9%	4.3%	4.6%	6.4%	6.6%	4.4%	4.2%	7.3%	10.9%	8.0%	7.3%	31.1%	19.5%	39.6%	54.0%	38.9%	32.9%
40%	26.3%	22.8%	22.7%	23.4%	19.1%	12.6%	13.1%	3.3%	3.3%	3.6%	6.5%	4.9%	4.3%	3.8%	6.1%	10.8%	6.0%	5.8%	32.0%	9.7%	30.9%	47.2%	30.5%	19.2%
50%	25.3%	22.4%	19.8%	24.0%	20.8%	12.8%	16.7%	3.3%	3.2%	3.2%	6.5%	4.2%	4.1%	3.8%	5.3%	10.7%	4.7%	4.8%	41.4%	8.6%	24.9%	44.3%	30.0%	21.4%
60%	26.6%	20.5%	23.7%	26.4%	23.4%	14.4%	20.3%	3.6%	3.8%	3.4%	6.0%	4.2%	4.3%	3.2%	4.5%	10.6%	3.9%	94.8%	38.5%	9.3%	17.4%	39.7%	33.2%	25.3%
70%	26.7%	23.9%	23.8%	30.2%	31.8%	16.0%	21.5%	16.1%	3.3%	3.5%	5.1%	4.1%	4.6%	2.9%	3.9%	10.5%	3.5%	143%	25.4%	9.1%	15.3%	30.0%	35.5%	26.9%
80%	26.0%	24.9%	32.7%	35.8%	36.6%	26.4%	24.4%	21.2%	4.7%	2.9%	5.3%	3.3%	4.2%	3.1%	3.5%	10.4%	3.3%	166%	9.1%	9.1%	12.5%	30.7%	39.9%	26.5%
90%	32.5%	31.5%	34.9%	39.6%	40.6%	32.2%	33.7%	33.2%	8.8%	3.0%	5.6%	3.6%	3.7%	2.8%	3.2%	10.3%	3.1%	180%	6.5%	7.4%	8.0%	19.2%	32.4%	37.9%
100%	12.6%	25.8%	26.8%	32.1%	27.1%	31.9%	26.7%	34.1%	25.3%	2.3%	7.8%	4.8%	3.8%	2.6%	3.0%	10.2%	3.0%	193%	6.7%	5.8%	3.9%	8.2%	14.5%	39.1%
Count	123	108	110	97	97	95	76	62	47	34	16	19	9	7	3	2	4	5	8	17	58	89	99	94
	1279	Total																						

In the second and third sensitivity analyses, the wind direction arc bounding the PFE facility was split in half and the two complementary arcs were analyzed separately. The analysis began by splitting the baseline wind direction arc of 135 to 180 degrees in half along an azimuth of 157.5 degrees. The western portion of the PFE pens was represented by a wind direction arc of 157.5 to 180 degrees, and the eastern portion of the pens was represented by a wind direction arc of 135 to 157.5 degrees.

The results of the western half percentile analysis are presented in Table 3-7. One difference between the tabular values in the "West" arc analysis compared to those of the "Base" arc highlights a problem that occurs when there are very few database values found within a bin, such as occurs in 1600 hour bin. Within the "West" arc, the 2008 monitoring data contained only one hour in the 1600 hour subset that satisfied the prescribed meteorological conditions. With only one value in the subset, the percentile values from 10th percentile to 100th percentile do not change—all percentiles in this case are equal to the single monitored or modeled value represented by that hour. Ignoring this singularity, the other percentiles in the modeled "West" table are generally lower than those in the modeled "Base" table in Table 3-5, suggesting that some portion of high PM_{10} concentrations were recorded at the monitor when the wind direction was within the "East" half of the PFE arc.

The results of the eastern half percentile analysis are presented in Table 3-8. Within this wind direction arc, the 2008 dataset contained no hours in the 1700 hour column that satisfied meteorological conditions used in this analysis. In this situation, the tabular data simply reports "N/A" for all percentile values in this column. Comparison of the modeled-to-monitored ratios in Table 3-8 to the corresponding values in Table 3-7 suggests differences in source emissions within the "East" and "West" wind direction arcs. The ratio values in the "East" arc are higher than those of the "West" arc during the hours from 2200 through 1600, suggesting that lower non-PFE emissions are generated within the "East" arc during these hours in comparison to PFE emissions than occur in the "West" arc. As an example, to illustrate this relationship, during the 0100 hour, at the 50th percentile PM_{10} concentration recorded at the monitor during low wind conditions, the estimated emission rate of the sources within the "East" arc—when attributed entirely to the PFE pens—were 3.13 g/sec (= 1.0 gm/sec x 1/31.9%). However, in the "West" arc at the same time, the estimated emission rate when attributed entirely to the PFE pens was 5.52 g/sec (= 1.0 gm/sec x 1/18.1%). If the emission rate is uniform across the PFE pens at this hour of the early morning, as is suggested from discussions with Pinal Feeding Company representatives, then emissions from sources within the "West" arc other than the PFE facility are producing greater emissions than are estimated for other sources in the "East" arc.

Table 3-7
Hour of the Day Percentiles of 2008 Monitored and Modeled PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Direction is between 157.5 and 180 Degrees (West Arc) ($\mu g/m^3$)

Hour of the Day Percentiles of 2008 Cowtown Monitored PM10 When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 157.5 and 180 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	24	29	33	25	31	45	49	54	35	24	21	21	28	14	18	9	12	13	37	30	39	22	22	25
20%	36	51	60	64	68	80	99	96	47	33	32	22	31	17	20	9	15	24	41	111	57	47	49	46
30%	59	89	80	89	101	147	133	170	73	38	38	24	34	19	22	9	24	35	56	249	100	71	84	99
40%	118	133	98	104	117	180	174	207	96	42	43	25	38	21	24	9	37	48	81	513	185	95	131	163
50%	151	172	157	149	146	213	207	224	123	60	49	29	43	29	26	9	51	60	105	763	230	133	161	210
60%	193	195	198	166	168	243	257	261	138	91	61	39	53	38	34	9	51	73	108	929	305	224	188	255
70%	228	260	233	230	187	340	306	290	153	149	78	47	62	43	41	9	52	82	111	1049	695	312	232	295
80%	290	314	299	283	259	394	355	308	207	239	102	55	67	70	48	9	54	84	521	1299	1825	380	273	352
90%	394	404	373	339	331	486	429	361	234	273	137	90	74	113	56	9	59	86	1340	1792	2624	821	354	395
100%	1414	864	838	739	889	740	710	621	559	860	139	95	81	175	63	9	63	88	2159	2550	5457	2128	610	736

Hour of the Day Percentiles of Modeled PM10 Impacts in 2008 at the Cowtown Monitor from the PFE Pen Facility
At 1.0 g/sec Emission Rate When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 157.5 and 180 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	7	3	5	5	5	4	2	1	1	1	1	1	1	1	1	1	1	1	2	5	6	6	8	5
20%	11	5	7	7	8	5	4	1	1	1	1	1	1	1	1	1	1	2	3	9	10	13	14	10
30%	17	10	10	11	13	8	4	2	2	1	1	1	1	1	1	1	1	2	5	14	15	17	20	16
40%	23	14	15	14	16	13	7	2	2	2	1	1	1	1	1	1	1	2	10	19	23	27	27	25
50%	27	20	19	18	19	20	9	3	2	2	1	1	1	1	1	1	1	2	16	34	41	41	36	32
60%	34	28	21	23	24	24	21	5	3	3	1	2	1	1	1	1	2	2	57	44	50	56	49	38
70%	51	37	27	27	35	31	46	7	4	3	2	2	1	2	1	1	2	15	98	55	65	70	59	59
80%	64	45	39	52	48	43	60	31	7	3	3	2	1	2	1	1	2	53	119	65	76	81	84	72
90%	80	68	61	78	92	65	79	81	10	4	4	2	1	2	1	1	2	92	119	84	95	93	101	89
100%	142	114	161	175	151	173	130	167	47	19	11	3	1	2	1	1	2	130	119	100	135	122	152	151

Ratio of Modeled to Monitored PM10 Percentiles by Hour of the Day at the Cowtown Monitor in 2008
When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 157.5 and 180 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	28.9%	11.7%	15.3%	19.5%	16.1%	8.0%	4.3%	1.3%	1.8%	2.8%	3.5%	4.2%	2.5%	5.7%	3.1%	8.3%	9.5%	11.7%	6.5%	18.2%	16.5%	25.3%	37.3%	22.1%
20%	30.2%	10.9%	12.1%	10.5%	11.5%	6.6%	3.6%	0.9%	2.3%	2.5%	2.7%	4.0%	2.5%	5.1%	3.3%	8.3%	8.2%	6.9%	6.3%	7.8%	17.3%	27.3%	27.6%	22.0%
30%	28.8%	11.6%	12.2%	12.0%	13.0%	5.1%	3.0%	0.9%	2.1%	3.4%	2.5%	3.9%	2.3%	4.7%	3.5%	8.3%	5.6%	5.1%	9.4%	5.6%	14.7%	24.4%	24.0%	16.5%
40%	19.1%	10.4%	15.6%	13.2%	13.5%	7.0%	3.9%	1.1%	1.8%	4.2%	2.5%	4.8%	2.3%	4.6%	3.6%	8.3%	3.6%	3.9%	12.9%	3.7%	12.4%	28.4%	20.4%	15.4%
50%	18.1%	11.9%	12.1%	12.4%	13.3%	9.2%	4.4%	1.3%	1.8%	3.8%	2.6%	5.0%	2.3%	4.1%	3.7%	8.3%	2.7%	3.1%	14.8%	4.4%	17.9%	30.8%	22.3%	15.1%
60%	17.4%	14.6%	10.5%	13.8%	14.6%	9.7%	8.3%	1.7%	2.1%	2.9%	2.3%	4.0%	2.0%	3.8%	3.2%	8.3%	3.0%	2.6%	52.7%	4.8%	16.5%	25.2%	25.9%	15.0%
70%	22.5%	14.3%	11.6%	11.9%	18.8%	9.0%	15.0%	2.5%	2.9%	1.9%	2.6%	3.6%	1.8%	3.8%	2.8%	8.3%	3.4%	17.9%	88.8%	5.3%	9.3%	22.6%	25.5%	19.9%
80%	22.2%	14.3%	13.0%	18.5%	18.5%	11.0%	16.9%	10.2%	3.1%	1.2%	2.5%	3.4%	1.6%	2.4%	2.6%	8.3%	3.4%	63.3%	22.8%	5.0%	4.2%	21.2%	30.6%	20.4%
90%	20.2%	16.9%	16.3%	22.9%	27.7%	13.3%	18.5%	22.3%	4.4%	1.4%	2.8%	2.5%	1.5%	1.6%	2.4%	8.3%	3.2%	107%	8.9%	4.7%	3.6%	11.3%	28.6%	22.5%
100%	10.0%	13.2%	19.3%	23.7%	16.9%	23.3%	18.4%	26.8%	8.5%	2.2%	7.7%	3.2%	1.4%	1.1%	2.2%	8.3%	3.0%	149%	5.5%	3.9%	2.5%	5.7%	25.0%	20.5%
Count	79	76	70	65	63	68	49	38	37	16	15	12	7	8	3	1	5	4	5	15	38	67	70	76
	887	Total																						

Table 3-8
Hour of the Day Percentiles of 2008 Monitored and Modeled PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Direction is between 135 and 157.5 Degrees (East Arc) ($\mu g/m^3$)

Hour of the Day Percentiles of 2008 Cowtown Monitored PM10 When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 157.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	20	20	18	21	38	27	21	20	38	31	20	14	10	24	7	28	N/A	75	87	61	54	32	20	21
20%	35	32	41	51	65	63	53	35	51	43	23	29	16	25	11	30	N/A	127	162	95	79	43	32	49
30%	48	63	67	76	89	95	106	70	73	57	25	42	21	26	15	32	N/A	180	236	110	135	73	63	63
40%	72	136	87	94	117	133	125	109	108	79	27	47	27	33	19	34	N/A	232	307	123	243	122	96	103
50%	130	196	159	118	160	170	153	168	127	83	28	51	30	43	23	38	N/A	285	376	219	405	171	175	139
60%	203	259	214	162	197	195	230	200	152	93	40	55	33	52	27	41	N/A	337	445	509	431	242	226	189
70%	253	285	253	188	223	269	269	262	194	100	61	71	35	59	31	44	N/A	390	628	790	469	283	302	234
80%	331	344	308	292	256	321	309	298	225	123	90	103	35	60	34	45	N/A	442	1040	1545	703	352	371	299
90%	392	483	432	380	339	402	366	335	313	239	108	111	44	62	38	46	N/A	494	1453	2185	1419	411	477	339
100%	1144	809	766	810	515	527	548	527	474	324	117	134	73	63	42	47	N/A	547	1865	3853	3206	1181	1355	699

Hour of the Day Percentiles of Modeled PM10 Impacts in 2008 at the Cowtown Monitor from the PFE Pen Facility
At 1.0 g/sec Emission Rate When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 157.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	10	11	9	9	8	9	6	3	2	2	2	1	1	1	1	2	N/A	21	19	11	22	11	9	9
20%	15	12	12	12	11	11	8	4	2	2	2	2	1	1	1	2	N/A	37	26	25	37	17	15	13
30%	25	17	15	18	15	13	9	5	2	2	3	2	1	1	1	2	N/A	53	32	45	53	31	25	17
40%	30	25	19	26	23	17	19	6	3	3	4	2	2	1	1	2	N/A	70	51	68	65	42	34	22
50%	41	39	28	33	27	23	26	7	3	3	4	2	2	2	1	3	N/A	86	76	122	71	46	42	26
60%	61	47	45	45	38	32	35	11	5	4	5	2	2	2	1	3	N/A	103	101	157	75	66	55	35
70%	85	66	56	57	55	40	44	41	5	5	5	3	2	2	2	4	N/A	119	121	172	124	106	104	55
80%	107	83	97	116	83	97	84	58	7	7	6	3	3	2	2	4	N/A	136	129	182	129	126	136	78
90%	140	154	148	156	151	139	146	84	17	9	7	3	3	2	2	4	N/A	152	137	193	154	145	162	132
100%	179	192	205	237	241	236	189	212	81	20	8	5	3	2	2	5	N/A	169	145	222	214	174	197	193

Ratio of Modeled to Monitored PM10 Percentiles by Hour of the Day at the Cowtown Monitor in 2008
When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 157.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	48.2%	55.5%	47.9%	41.1%	22.1%	32.1%	30.2%	16.6%	5.5%	6.0%	7.8%	10.3%	13.7%	5.4%	13.2%	6.9%	N/A	27.4%	22.3%	18.8%	40.0%	33.7%	45.8%	45.8%
20%	41.6%	37.9%	28.9%	23.2%	16.7%	17.6%	15.5%	11.5%	4.7%	4.4%	8.6%	5.6%	8.8%	5.4%	9.5%	6.6%	N/A	29.1%	15.8%	26.3%	46.8%	40.1%	47.2%	27.0%
30%	52.4%	26.5%	23.1%	24.0%	16.9%	13.6%	8.7%	6.7%	3.4%	4.1%	11.6%	4.4%	6.8%	5.3%	7.7%	6.3%	N/A	29.8%	13.4%	40.7%	38.9%	42.2%	39.5%	27.1%
40%	42.0%	18.1%	21.4%	28.1%	19.4%	13.1%	15.1%	5.3%	2.7%	3.6%	13.6%	4.4%	5.9%	4.4%	6.7%	6.8%	N/A	30.1%	16.5%	55.1%	27.0%	34.1%	35.7%	21.1%
50%	31.9%	20.0%	17.8%	28.0%	17.1%	13.6%	17.0%	4.1%	2.7%	3.8%	13.2%	4.3%	6.2%	3.6%	6.0%	7.5%	N/A	30.4%	20.2%	55.6%	17.4%	26.6%	24.2%	18.5%
60%	30.2%	18.0%	21.1%	27.7%	19.5%	16.5%	15.1%	5.7%	3.1%	4.4%	12.8%	4.2%	6.5%	3.1%	5.5%	8.1%	N/A	30.5%	22.8%	30.9%	17.4%	27.5%	24.1%	18.4%
70%	33.7%	23.2%	22.0%	30.5%	24.9%	14.7%	16.5%	15.6%	2.8%	5.1%	8.9%	3.8%	6.2%	2.9%	5.1%	8.6%	N/A	30.7%	19.3%	21.7%	26.5%	37.3%	34.5%	23.3%
80%	32.3%	24.2%	31.5%	39.7%	32.2%	30.3%	27.3%	19.6%	3.3%	5.5%	6.5%	3.1%	7.6%	3.1%	4.9%	9.2%	N/A	30.8%	12.4%	11.8%	18.4%	35.9%	36.8%	26.1%
90%	35.7%	31.8%	34.1%	41.0%	44.5%	34.5%	40.0%	24.9%	5.4%	3.9%	6.2%	3.1%	6.3%	3.3%	4.7%	9.7%	N/A	31%	9.4%	8.8%	10.9%	35.3%	34.0%	38.9%
100%	15.6%	23.8%	26.8%	29.3%	46.7%	44.8%	34.6%	40.1%	17.1%	6.2%	6.7%	4.1%	4.2%	3.5%	4.5%	10.2%	N/A	31%	7.8%	5.8%	6.7%	14.7%	14.5%	27.6%
Count	73	77	82	74	65	75	57	52	33	29	13	10	11	4	2	4	0	2	4	14	34	52	54	66
	887	Total																						

One of the implications of this finding relates to the question of what caused elevated PM_{10} concentrations during the early morning hours of October 29, 2008, the low wind design day for the Cowtown monitor. One theory is that PM_{10} suspended in the air to a height of a quarter mile by an emissions spike at the PFE facility during the period of highest livestock movement on the previous late afternoon/early evening, settled out of the air during these later hours (0100 to 0400 hours) to impact the Cowtown monitor at far higher PM_{10} concentrations than would result from the very low emissions rates estimated to be generated at feedlots and other nearby area sources at this time of day. If the elevated concentrations recorded during the 0100 to 0400 hours on the morning of October 29, 2008—and several other early mornings found in the monitoring record—were due to deposition of suspended PM_{10} entrained in a cloud above the Cowtown area, then the contributions from this other "source" to impacts from the "West" and "East" portions of the PFE facility should be roughly equal. Since there are substantial differences in the contributions of non-PFE sources when winds blow from the "West" arc versus the "East" arc during these early morning hours, the differences cannot be due to the somewhat uniform impacts of deposition from an area-wide cloud of PM_{10}.[29] The differences in source strength between the "West" and "East" halves of the PFE pens plus nearby area sources discounts the possibility that the deposition of suspended PM_{10} would be responsible for any significant portion of these non-PFE impacts during these hours.

The lower emissions impact estimated for the "East" half of the PFE facility suggests that within the wind direction arc spanning this area, the contributions of other area sources are lower than those within the other wind direction arcs analyzed. Therefore, the correlation between monitored PM_{10} and modeled PM_{10} within this wind direction arc is more representative of emissions from the PFE facility and is less influenced by emissions from other sources. On this basis, the wind direction arc subtended by the "East" half of the PFE facility was tentatively selected for use in estimating diurnal feedlot emissions factors.

The monitoring dataset for this preferred wind direction arc suffers, however, from an absence of data representing hour 1700 during the 2008 inventory year. Using a dataset with this type of deficiency to compute diurnal emissions factors is problematical. As a result, an analysis of the wind directions recorded during hour 1700 at Cowtown when meteorological bounds were satisfied was conducted. Hourly monitoring data meeting these requirements are shown in Table 3-9.

[29] Additional research is needed to confirm the extent of deposition.

Table 3-9 Monitoring Data for Cowtown Hours in 2008 When Wind Speed < 3.0 m/sec, Wind Direction is Between 135 and 180 degrees, and Hour of the Day = 1700							
				WSpd	WDir	PM_{10} Concentrations	
Year	Month	Day	Hour	(m/sec)	(degrees)	Monitored	Modeled
2008	1	23	1700	2.1	172	63.4	1.9
2008	8	16	1700	2.1	172	50.5	1.1
2008	9	31	1700	1.5	162	9.1	1.8
2008	9	7	1700	1.1	162	16.9	1.3
2008	10	17	1700	1.8	174	51.9	1.4

This tabulation reveals that two hours of data representing the 1700 hour of the day could be included in the preferred wind direction arc dataset if the arc is extended from 135 to 162.5 degrees. This selection was made and the resulting wind direction arc is referred to as the "East+" PFE facility arc.

A comparison of 2008 monitored versus modeled PM_{10} percentiles at the Cowtown monitor using the "East+" wind direction arc as a filter is shown in Table 3-10. The tabular values for this arc are very similar to those for the "East" arc shown in Table 3-8, with the exceptions that hour 1700 is populated with non-zero values and the percentile values between the 10th and 50th in hour 1800 are considerably higher than those found in the "East" arc. This latter difference may be due entirely to the fact that the "East" arc includes two hours from the hour 1800 column while the "East+" arc includes three hours in this column. In percentile analysis, large changes can occur when data subsets are small (i.e., $n << 10$) and the number of elements (n) is modified.

<u>Calculation of Feedlot Emission Rates Unadjusted for Other Source Emissions</u> – PM_{10} emissions from the PFE facility were calculated from the ratios of 50th percentile values derived from the monitored and modeled PM_{10} concentrations at the Cowtown monitor under the five wind direction arc scenarios discussed above. For each scenario, the ratios of 50th percentiles for each hour in the diurnal profile were inverted and multiplied by the unit emission factor used in the modeling analysis to compute gross hourly emissions factors. "Gross emissions factors" in this sense refers to emission factors attributed to feedlot sources but unadjusted for the emissions contributions from other area sources within the same wind direction arc. The adjustment to eliminate these contributions from other unknown sources will be discussed later in this section.

In each of the "ratio" tables in Tables 3-5 through 3-10, the percent values represent the fractions of *monitored* PM_{10} concentrations represented by the impacts of *modeled* PM_{10} emissions generated at a unit emission rate (i.e., 1.0 g/sec) by the PFE facility during the same hours and under the same meteorological conditions recorded at the monitoring station. For example, if the 50th percentile ratio at 1200 hours under the Base wind direction arc scenario is reported to be 4.1% (see Table 3-5), then the modeling results

are suggesting that the PFE facility produces 4.1% of the average PM_{10} concentration recorded at the Cowtown monitor during this time of day and under the range of meteorological conditions specified, when the facility is generating PM_{10} emissions at the constant rate of 1.0 g/sec. The unit emission rate can be multiplied by the inverse of the 50th percentile ratio, equal to 24.4 (= 1/0.041), to estimate the emission rate which the PFE facility would have to achieve in order to be responsible for 100% of the average PM_{10} concentration recorded at the monitor. This equivalent emission factor would be 24.4 g/sec (= 24.4 x 1.0 g/sec).

A table of the 50th percentile values of monitored PM_{10} in 2008 for each hour of the day under the meteorological conditions specified, the modeled PM_{10} impacts reported by the AERMOD model from the PFE facility operating at a unit emission rate, the ratios of these two sets of values, and the inverses of these ratios, are presented in Table 3-11 for each of the five wind direction arc scenarios analyzed.

The lowermost table in Table 3-11 reports unadjusted 50th percentile emission rates by hour of the day at the PFE facility in 2008 under the different scenarios analyzed. The highest emissions rates are attributed to the "West" half of the facility, and are considerably higher from 0100 to 2100 hours than either the "East" or "East+" portions of the facility. The "East+" portion is shown to have lower emissions rates than any other scenario with the exception of the "East" scenario, which has roughly equivalent emissions but continues to contain a data gap in hour 1700 for reasons discussed earlier. Because we are assuming that emissions across the PFE pens are roughly uniform, based on information received from company representatives, the lower rates shown for the "East+" portion suggest lower contributions at the Cowtown monitor from other sources lying within the same wind direction arc. For this reason, this wind direction arc is tentatively selected to represent unadjusted feedlot emission rates in the remainder of the analysis.

Other Source Emissions Analysis – Hourly meteorological and PM_{10} data collected at the Cowtown monitoring station in 2011 and 2012 were analyzed in the same manner as the 2008 data to determine the impacts of other sources within the 5 different wind direction arcs at a time when the PFE facility was closed and demolished. According to historical aerial photographs available through the Google Earth program, the PFE facility was torn down in the spring of 2010, so no feedlot emissions were being transported in 2011 and 2012 by winds blowing from azimuths between 135 to 180 degrees to the monitor.

PM_{10} concentration percentile values recorded at the Cowtown monitor in 2011 under the meteorological conditions specified for each wind direction arc scenario are displayed by hour of the day in Table 3-12. The patterns in each scenario are somewhat similar to each other and are also similar to the corresponding percentile tables for 2008, with the exception that the 2011 values are generally lower than those in the 2008 tables. The last table in Table 3-12 shows the 50th percentile PM_{10} concentrations by hour of the day for each of the 5 scenarios.

Table 3-10
Hour of the Day Percentiles of 2008 Monitored and Modeled PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Direction is between 135 and 162.5 Degrees (East+ Arc) ($\mu g/m^3$)

Hour of the Day Percentiles of 2008 Cowtown Monitored PM10 When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 162.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	21	20	18	22	36	27	20	24	38	29	21	13	10	20	11	28	10	35	28	69	31	20	19	20
20%	32	34	34	47	67	64	38	34	48	43	24	15	16	23	19	30	11	48	43	99	63	42	34	36
30%	48	66	56	79	89	94	106	68	69	54	26	19	21	24	27	32	11	61	152	112	103	67	61	57
40%	71	152	75	96	118	135	131	100	92	79	27	30	27	26	34	34	12	74	261	160	207	102	90	102
50%	128	196	128	124	148	172	201	157	121	85	36	46	30	31	42	38	13	88	376	422	397	148	152	145
60%	194	259	197	156	183	207	228	190	146	95	46	49	33	38	46	41	14	179	490	717	430	220	218	208
70%	244	284	232	183	213	254	266	252	199	102	76	55	35	43	51	44	15	271	1178	999	470	271	267	253
80%	319	341	289	231	253	318	316	294	219	142	95	84	35	53	55	45	15	363	1865	1447	777	352	329	298
90%	388	470	403	370	337	393	368	332	273	256	113	107	44	60	59	46	16	455	2012	2044	1782	442	440	337
100%	1414	809	766	810	889	527	642	527	474	324	137	134	73	63	63	47	17	547	2159	3853	5457	1181	1355	699

Hour of the Day Percentiles of Modeled PM10 Impacts in 2008 at the Cowtown Monitor from the PFE Pen Facility
At 1.0 g/sec Emission Rate When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 162.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	11	11	9	9	9	9	6	3	2	2	1	2	1	1	1	2	1	29	24	12	20	11	9	10
20%	16	13	13	12	12	12	7	4	2	2	2	2	1	1	1	2	1	55	34	33	29	18	15	13
30%	25	18	17	18	16	14	9	4	3	3	2	2	1	1	1	2	1	80	76	49	51	33	25	19
40%	31	26	22	25	21	19	16	6	3	3	2	2	2	1	1	2	2	105	118	61	63	43	36	24
50%	47	36	27	30	27	24	25	7	4	3	3	2	2	2	1	3	2	130	119	87	71	52	46	30
60%	62	44	43	40	38	33	36	13	5	4	4	3	2	2	2	3	2	138	119	148	83	80	58	40
70%	79	62	55	52	60	45	46	50	6	5	5	3	2	2	2	4	2	146	119	165	122	101	102	57
80%	108	81	95	109	90	96	76	66	11	6	5	3	3	2	2	4	2	153	119	177	131	121	132	86
90%	139	145	145	151	147	145	138	119	22	9	6	5	3	2	2	4	2	161	132	192	154	141	152	142
100%	179	197	205	237	241	236	189	212	141	20	8	6	3	2	2	5	2	169	145	222	214	174	197	288

Ratio of Modeled to Monitored PM10 Percentiles by Hour of the Day at the Cowtown Monitor in 2008
When Wind Speed is Less than 3.0 m/sec and Wind Direction is Between 135 and 162.5 Degrees

%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	54.0%	55.1%	48.9%	40.2%	24.2%	33.9%	27.6%	12.8%	5.6%	6.4%	6.7%	11.4%	13.7%	6.1%	8.6%	6.9%	13.8%	82.8%	83.7%	17.0%	64.7%	54.9%	47.0%	47.5%
20%	51.1%	36.7%	39.4%	25.3%	17.5%	18.3%	18.8%	10.7%	5.0%	4.8%	6.6%	12.0%	8.8%	5.9%	5.6%	6.6%	13.3%	113%	77.8%	33.6%	45.1%	42.1%	44.8%	36.9%
30%	52.8%	27.9%	31.2%	23.0%	18.2%	14.8%	8.3%	6.5%	3.7%	4.9%	8.1%	10.7%	6.8%	5.9%	4.4%	6.3%	12.8%	130%	49.9%	43.4%	49.0%	49.2%	40.8%	33.4%
40%	43.6%	17.3%	28.6%	25.7%	18.1%	14.1%	11.9%	5.8%	3.2%	3.6%	8.8%	7.2%	5.9%	5.4%	3.8%	6.8%	12.4%	141%	45.2%	38.0%	30.2%	41.9%	40.1%	23.2%
50%	36.6%	18.4%	21.2%	24.5%	18.5%	14.1%	12.6%	4.7%	3.1%	3.8%	8.9%	5.0%	6.2%	4.9%	3.3%	7.5%	12.1%	149%	31.6%	20.6%	17.8%	35.5%	30.4%	20.8%
60%	32.2%	16.9%	21.7%	25.6%	21.0%	16.0%	15.6%	7.0%	3.4%	4.2%	8.1%	5.4%	6.5%	4.4%	3.2%	8.1%	11.8%	76.9%	24.3%	20.7%	19.4%	36.4%	26.4%	19.4%
70%	32.2%	21.8%	23.6%	28.7%	28.0%	17.7%	17.1%	19.8%	3.1%	4.9%	6.7%	5.6%	6.2%	3.9%	3.2%	8.6%	11.5%	53.7%	10.1%	16.5%	25.9%	37.4%	38.2%	22.7%
80%	33.8%	23.6%	32.9%	47.1%	35.5%	30.2%	23.9%	22.6%	4.9%	4.1%	5.7%	3.8%	7.6%	3.5%	3.1%	9.2%	11.2%	42.3%	6.4%	12.2%	16.9%	34.4%	40.2%	29.0%
90%	35.9%	30.9%	36.1%	40.8%	43.7%	36.9%	37.5%	35.9%	8.0%	3.5%	5.6%	4.7%	6.3%	3.4%	3.0%	9.7%	11.0%	35.4%	6.6%	9.4%	8.6%	31.9%	34.6%	42.3%
100%	12.6%	24.4%	26.8%	29.3%	27.1%	44.8%	29.5%	40.1%	29.8%	6.2%	5.7%	4.8%	4.2%	3.5%	3.0%	10.2%	10.8%	30.9%	6.7%	5.8%	3.9%	14.7%	14.5%	41.2%
Count	100	98	103	94	86	91	77	66	42	34	17	13	11	8	3	4	2	3	6	16	45	67	72	88
	1146	Total																						

Table 3-11
Unadjusted PFE Emission Factors by Hour of the Day Based on 50th Percentiles of 2008 Monitored and Modeled PM_{10} at Cowtown Monitor Under Five Different Wind Direction Arc Calculation Scenarios

	2008 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios, ug/m3																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	136	179	154	128	146	183	202	195	122	81	42	42	34	31	26	32	51	60	112	567	251	144	161	182
Nrrw	163	176	133	126	134	192	182	202	122	89	43	46	35	44	26	39	34	39	183	922	277	137	169	210
West	151	172	157	149	146	213	207	224	123	60	49	29	43	29	26	9	51	60	105	763	230	133	161	210
East	127	189	146	118	143	170	144	157	119	82	28	48	30	43	23	38	N/A	285	376	219	340	160	152	119
East+	128	196	128	124	148	172	201	157	121	85	36	46	30	31	42	38	13	88	376	422	397	148	152	145

	2008 50th Percentile Values of Modeled PM10 at Unit Emissions Rates by Hour of the Day for Different Wind Arc Scenarios, ug/m3																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	32	28	22	25	24	20	20	6	3	3	2	2	1	1	1	2	1	3	34	51	57	45	39	29
Nrrw	41	39	26	30	28	25	30	7	4	3	3	2	1	2	1	4	2	2	76	79	69	61	51	45
West	27	20	19	18	19	20	9	3	2	2	1	1	1	1	1	1	1	2	16	34	41	41	36	32
East	41	39	28	33	27	23	26	7	3	3	4	2	2	2	1	3	N/A	86	76	122	71	46	42	26
East+	47	36	27	30	27	24	25	7	4	3	3	2	2	2	1	3	2	130	119	87	71	52	46	30

	Ratios of 2008 50th Percentile Modeled PM10 to Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	23%	15%	14%	19%	17%	11%	10%	3%	2%	3%	5%	4%	4%	4%	4%	6%	3%	5%	30%	9%	23%	31%	24%	16%
Nrrw	25%	22%	20%	24%	21%	13%	17%	3%	3%	3%	6%	4%	4%	4%	5%	11%	5%	5%	41%	9%	25%	44%	30%	21%
West	18%	12%	12%	12%	13%	9%	4%	1%	2%	4%	3%	5%	2%	4%	4%	8%	3%	3%	15%	4%	18%	31%	22%	15%
East	33%	21%	19%	28%	19%	14%	18%	4%	3%	4%	13%	4%	6%	4%	6%	8%	N/A	30%	20%	56%	21%	28%	28%	22%
East+	37%	18%	21%	24%	18%	14%	13%	5%	3%	4%	9%	5%	6%	5%	3%	8%	12%	149%	32%	21%	18%	35%	30%	21%

	Unadjusted PM10 Emissions Rates for PFE Facility by Hour of the Day for Different Wind Arc Scenarios, g/sec																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	4.3	6.5	7.1	5.2	6.0	9.0	10.0	33.2	41.6	28.8	18.5	24.2	24.4	22.5	26.8	16.0	36.7	20.5	3.3	11.0	4.4	3.2	4.1	6.3
Nrrw	4.0	4.5	5.1	4.2	4.8	7.8	6.0	30.1	31.0	30.8	15.4	23.8	24.6	26.5	18.7	9.3	21.4	20.8	2.4	11.7	4.0	2.3	3.3	4.7
West	5.5	8.4	8.3	8.0	7.5	10.9	22.5	75.3	54.7	26.6	38.6	19.9	44.2	24.2	26.8	12.0	36.7	32.3	6.8	22.6	5.6	3.2	4.5	6.6
East	3.1	4.8	5.2	3.6	5.2	7.4	5.5	22.6	34.4	26.1	7.6	22.2	16.2	27.9	16.7	13.3	N/A	3.3	4.9	1.8	4.8	3.5	3.6	4.6
East+	2.7	5.4	4.7	4.1	5.4	7.1	7.9	21.3	32.1	26.2	11.2	20.2	16.2	20.6	30.0	13.3	8.3	0.7	3.2	4.9	5.6	2.8	3.3	4.8

Table 3-12
Hour of the Day Percentiles of 2011 Monitored PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Directions Are Defined by the Five Wind Direction Arc Scenarios ($\mu g/m^3$)

	2011 Base - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	20	18	18	12	17	17	23	52	28	23	19	18	13	10	9	15	21	10	32	47	42	29	26	23
20%	30	27	28	21	22	28	40	63	48	37	23	20	20	16	18	18	25	20	60	76	59	46	42	38
30%	41	34	35	33	33	36	48	72	67	48	27	26	25	17	23	21	34	26	73	97	71	56	58	47
40%	49	44	41	37	40	45	60	86	82	59	35	34	30	18	25	22	48	38	117	116	93	70	73	57
50%	58	52	49	46	45	57	72	100	102	65	39	38	33	27	27	22	56	61	136	157	130	87	90	67
60%	66	61	55	54	53	68	91	114	118	78	45	42	34	32	34	31	65	92	156	189	159	107	103	84
70%	79	68	66	70	66	83	111	136	133	95	53	54	45	37	44	39	68	124	192	403	203	124	125	102
80%	93	83	83	92	83	110	150	159	162	107	72	67	59	49	50	48	91	154	222	916	258	185	158	132
90%	128	116	105	157	124	140	217	220	209	133	103	124	124	72	70	60	127	209	252	1325	478	259	212	169
100%	708	346	262	658	543	546	943	396	353	386	238	203	191	92	112	73	134	283	724	2393	1421	1075	589	825
Count	158	147	159	147	164	156	148	133	130	94	50	41	30	18	16	7	9	14	23	36	75	95	125	156
	2131	Total																						

	2011 Narrow - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	19	17	18	17	17	21	22	52	35	25	20	20	13	11	11	19	20	6	24	47	44	27	24	31
20%	33	26	28	22	23	28	40	64	48	41	24	23	19	15	22	21	33	16	33	76	58	47	40	41
30%	40	32	36	33	35	36	46	77	62	51	27	33	21	16	25	22	47	21	60	85	70	56	57	47
40%	47	44	42	42	41	44	60	91	75	60	32	35	29	17	26	22	54	25	65	110	89	70	74	57
50%	55	53	49	49	47	56	70	103	94	72	38	38	32	25	27	29	62	31	93	122	105	85	93	65
60%	63	61	55	60	54	65	86	119	111	82	45	42	34	31	32	37	67	40	119	168	162	105	105	81
70%	76	68	69	73	66	81	108	138	129	96	51	52	38	33	41	44	69	70	130	189	202	123	123	96
80%	90	87	89	94	84	103	140	152	144	112	82	80	55	39	44	51	103	127	154	706	250	156	150	134
90%	122	122	126	152	114	128	206	200	182	134	104	137	124	49	50	62	128	159	248	1185	470	218	204	167
100%	369	346	201	345	543	546	706	281	353	386	238	203	191	74	70	73	134	283	259	2393	1298	1075	589	825
Count	99	104	111	102	126	101	94	90	94	62	35	30	20	10	12	6	8	10	16	21	51	74	96	113
	1485	Total																						

	2011 West - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	27	24	26	16	16	21	19	58	50	23	17	12	14	15	9	21	22	15	76	66	47	29	27	34
20%	37	28	34	23	23	35	42	68	90	34	27	19	21	16	10	24	33	23	111	107	57	45	48	41
30%	46	41	41	32	38	44	48	77	108	53	33	28	27	17	18	28	43	30	144	130	65	54	66	47
40%	48	46	45	37	41	56	62	98	117	61	38	34	31	18	21	31	48	43	159	159	94	78	80	64
50%	56	53	63	51	54	68	76	115	123	74	52	38	34	24	34	34	51	74	174	185	145	98	97	86
60%	65	67	69	66	67	90	88	139	133	91	68	43	35	31	44	37	54	131	192	651	179	119	125	121
70%	102	74	84	88	75	108	100	163	144	100	74	50	48	31	44	41	57	158	208	1013	223	202	166	148
80%	126	87	94	113	124	136	119	230	189	112	91	66	58	37	70	44	61	191	220	1295	400	263	195	176
90%	199	178	101	178	201	195	159	246	245	134	101	103	144	46	70	47	64	239	274	1683	547	306	240	191
100%	708	268	191	345	543	546	599	326	353	237	238	203	191	92	112	51	67	283	724	2393	1421	1075	589	825
Count	39	39	33	52	41	35	33	50	53	44	23	23	21	11	11	2	4	9	10	20	42	35	49	51
	730	Total																						

Table 3-12 (cont.)
Hour of the Day Percentiles of 2011 Monitored PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Directions Are Defined by the Five Wind Direction Arc Scenarios (µg/m^3)

	2011 East - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	18	17	17	12	17	16	23	48	21	28	21	20	16	8	25	15	25	12	20	44	36	32	27	22
20%	30	26	25	21	22	28	40	62	41	40	23	21	18	13	25	19	26	19	32	59	67	46	40	38
30%	39	32	34	34	32	36	49	71	53	44	25	23	19	16	26	21	35	27	51	78	82	56	54	46
40%	50	43	40	39	40	42	59	83	66	55	28	33	22	25	26	22	52	37	64	85	92	67	72	56
50%	58	51	47	43	45	52	70	94	73	61	36	38	31	37	26	22	69	47	108	99	105	84	84	63
60%	66	60	52	52	52	65	95	107	91	70	40	41	32	45	27	28	91	67	126	122	133	101	98	76
70%	77	66	60	64	58	79	115	119	109	83	45	54	38	55	27	34	114	87	137	178	179	118	113	87
80%	89	82	76	71	73	103	157	140	136	103	49	100	51	67	32	44	127	102	201	282	232	146	134	116
90%	108	104	109	134	105	123	226	170	176	133	75	141	66	72	41	59	131	112	252	443	294	214	176	139
100%	369	346	262	658	223	407	943	396	248	386	222	175	67	74	50	73	134	122	259	706	1174	621	302	337
Count	119	108	126	96	123	121	116	84	77	50	27	18	9	7	5	5	5	5	13	16	33	60	76	105
	1404	Total																						
	2011 East+ - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	19	17	18	12	16	18	23	50	27	20	22	20	13	11	18	15	25	14	22	46	39	27	27	22
20%	30	26	27	21	22	28	40	64	45	37	23	22	17	15	25	19	32	20	32	73	60	44	40	38
30%	38	33	34	34	33	36	47	71	57	44	27	27	19	16	25	21	50	24	59	83	71	56	56	46
40%	49	44	41	39	40	43	59	85	71	56	31	34	24	16	26	22	61	33	68	101	93	67	71	57
50%	57	52	47	45	45	58	71	97	84	64	38	38	32	27	26	22	67	41	93	119	115	84	83	64
60%	64	60	52	53	53	67	95	108	102	72	44	40	33	37	27	28	68	57	121	155	153	100	99	77
70%	77	66	61	67	63	81	115	120	123	85	49	59	39	41	31	34	80	92	136	174	184	119	115	92
80%	89	80	76	79	82	106	156	144	136	107	67	73	54	55	41	44	114	112	180	292	228	144	138	119
90%	108	103	112	137	124	134	224	172	176	133	105	145	65	71	47	59	129	170	251	571	308	210	189	148
100%	369	346	262	658	543	546	943	396	248	386	238	203	67	74	50	73	134	283	259	1185	1174	621	589	337
Count	128	120	134	116	141	129	126	94	92	58	32	26	12	10	7	5	7	8	14	20	49	66	96	117
	1607	Total																						
	2011 50th Percentile Values by Hour of the Day for Different Calculation Methodologies																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	58	52	49	46	45	57	72	100	102	65	39	38	33	27	27	22	56	61	136	157	130	87	90	67
Nrrw	55	53	49	49	47	56	70	103	94	72	38	38	32	25	27	29	62	31	93	122	105	85	93	65
West	56	53	63	51	54	68	76	115	123	74	52	38	34	24	34	34	51	74	174	185	145	98	97	86
East	58	51	47	43	45	52	70	94	73	61	36	38	31	37	26	22	69	47	108	99	105	84	84	63
East+	57	52	47	45	45	58	71	97	84	64	38	38	32	27	26	22	67	41	93	119	115	84	83	64

Table 3-13 contains parallel tables of PM_{10} percentile values for 2012 that were constructed under the same approach as those of 2011. The 2012 values are similar to those for 2011, as can be seen by comparing the 50th percentile tables in Tables 3-12 and 3-13. In hours 0800-0900 and 1700-2100, 50th percentile values are slightly higher in 2011 than in 2012 under each scenario, but in the remainder of hours the values are roughly equivalent.

The slightly higher values in 2011 over 2012, when compared with the 2008 values, show a declining trend in PM_{10} concentrations at the Cowtown monitor over this period of time for the meteorological conditions specified. In comparing each of these two latter years to 2008, it would appear that the 2011 values better represent emissions from sources other than the PFE facility in 2008 than would the monitoring values from the 2012 dataset.

The 50th percentile of PM_{10} concentrations monitored at the Cowtown station by hour of the day and by scenario for 2008, 2011, and 2012 are displayed in the top three tables in Table 3-14. The ratios of the values from each of the 2011 and 2012 tables to the values shown in the 2008 50th percentile table are computed and presented in the two bottom tables in Table 3-14. Inspection of the ratio tables shows periodic irregularities in both the diurnal trends reading horizontally and the scenario trend reading vertically. These irregularities are primarily caused by the presence of very few hours of data in one or more arc scenarios during the late afternoon hours (i.e., 1600 to 1900 hours) when the wind roses for the Cowtown monitor show very low frequencies of wind blowing in the wind direction arcs subtending the PFE facility.

The 50th percentile values of PM_{10} impacting the Cowtown monitor from the PFE facility in 2008, by hour of the day and by arc scenario, could have been computed by deducting the fractional contributions of emissions from other sources, as shown in the two bottom tables in Table 3-14, from the 2008 50th percentile values of PM_{10} recorded at the monitor under each scenario. To do so, hour by hour, however, would have resulted in negative 50th percentile values for each hour and scenario combination that reported a value greater than 100% in either of the two ratio tables at the bottom of Table 3-14. Values above 100% in these tables result from the post-PFE shutdown PM_{10} concentrations monitored at the Cowtown station in 2011 or 2012 being higher than the pre-shutdown values for the same hour and scenario in 2008. Again, this anomaly is due to having too few hours (i.e. datapoints) in an hour-of-the-day column to produce a meaningful and representative percentile distribution.

The presence of these irregularities was overcome by computing hour-of-the-day average 50th percentile PM_{10} concentration and intra-year ratios for use in adjusting the 2008 data. Because the irregularities were present in hour-of-the-day columns with few datapoints, computing an hour-of-the-day average as an average of the 50th percentile values for each hour would have allowed the inordinately high—and sometimes low—values in the columns with irregularities to skew the result. To reduce the impact of these anomalous values, the 50th percentile PM_{10} values and ratios were weighted by the numbers of datapoints (hours) within that hour of the day count. This makes sense as the objective is

Table 3-13
Hour of the Day Percentiles of 2012 Monitored PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Directions Are Defined by the Five Wind Direction Arc Scenarios (µg/m^3)

	2012 Base - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	28	20	18	20	19	23	26	27	28	24	13	9	9	7	2	7	9	16	23	32	37	30	26	25
20%	42	31	28	26	25	33	38	47	38	40	20	14	11	13	9	9	16	32	30	57	75	52	53	35
30%	51	39	37	34	38	42	51	59	51	46	25	20	13	14	10	15	23	33	36	77	106	70	72	51
40%	59	46	46	41	42	49	59	71	70	61	35	27	16	18	18	16	26	35	53	104	114	91	86	64
50%	68	52	56	45	49	56	69	80	81	66	47	37	18	20	22	18	27	39	78	135	145	108	93	73
60%	76	61	64	52	59	61	79	90	92	72	52	42	23	23	25	23	34	44	107	348	169	120	102	83
70%	86	72	79	61	65	72	89	112	107	82	64	52	38	27	28	29	37	48	131	433	196	140	114	99
80%	102	83	92	69	79	90	114	134	135	95	84	70	43	32	41	34	44	52	172	513	225	168	144	116
90%	147	107	124	91	124	139	158	207	184	114	112	84	49	63	80	36	53	136	367	617	343	230	169	176
100%	488	338	328	206	414	601	634	395	253	201	195	101	126	74	125	43	53	191	402	1087	1376	1099	303	385
Count	164	181	169	163	161	155	152	140	99	81	68	41	24	23	23	16	9	12	19	28	74	108	136	171
	2217	Total																						
	2012 Narrow - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	28	20	18	21	19	22	21	27	27	34	11	10	9	12	1	11	8	14	21	37	45	40	30	21
20%	42	31	27	29	23	32	31	41	37	44	17	14	11	14	5	14	9	28	28	66	78	55	53	35
30%	49	43	37	39	35	41	49	57	55	55	23	23	12	15	9	15	12	32	34	86	104	77	67	54
40%	58	47	45	44	42	46	57	71	70	63	31	27	16	17	10	16	16	35	41	128	119	92	85	66
50%	68	54	55	48	49	55	65	81	84	68	45	35	21	19	12	16	21	39	75	185	145	107	95	76
60%	76	66	64	53	59	59	76	104	92	75	52	43	29	22	22	18	23	43	103	372	179	118	103	88
70%	84	73	80	61	65	71	89	119	107	85	61	51	42	26	24	22	26	47	128	491	195	136	116	100
80%	102	86	94	69	79	86	112	137	135	97	84	70	44	28	26	30	32	50	184	567	212	169	144	116
90%	154	142	124	93	119	127	148	214	185	112	101	84	56	64	28	35	43	66	371	680	360	231	169	162
100%	371	338	328	206	370	601	634	321	250	196	165	101	126	73	125	37	53	191	402	1087	1376	1099	303	314
Count	115	121	118	108	113	95	93	97	70	57	43	25	20	12	13	7	5	10	17	22	51	77	102	103
	1494	Total																						
	2012 West - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	28	21	22	20	18	30	21	30	34	19	17	10	7	7	7	7	23	32	29	30	57	39	28	18
20%	37	27	32	33	22	34	33	47	40	26	24	15	10	13	9	9	25	33	35	53	81	53	45	26
30%	49	39	42	40	31	44	48	66	63	39	31	17	14	19	10	15	26	33	52	118	111	79	56	32
40%	52	45	51	48	38	52	60	74	86	48	36	22	16	20	18	21	29	38	76	238	133	108	76	42
50%	66	56	56	52	46	59	72	83	98	59	48	26	16	21	26	24	32	46	78	438	148	116	85	56
60%	75	71	67	55	64	67	82	99	107	66	51	33	26	23	28	28	34	48	88	485	171	136	101	67
70%	87	73	82	62	73	78	94	126	136	72	57	45	39	27	29	33	38	50	116	528	212	160	124	91
80%	103	82	123	76	79	102	114	174	184	85	64	60	43	31	54	34	43	52	158	585	289	214	153	123
90%	130	120	171	100	113	184	155	209	211	99	100	73	48	69	91	36	48	108	230	708	343	311	198	178
100%	217	226	224	173	249	304	533	395	250	196	192	101	126	74	125	37	53	191	363	1087	1376	888	303	385
Count	47	39	32	38	37	34	40	52	36	39	27	20	12	12	18	10	4	7	9	17	31	45	38	49
	693	Total																						

Table 3-13 (cont.)
Hour of the Day Percentiles of 2012 Monitored PM_{10} at Cowtown Monitor When Wind Speed is Less Than 3.0 m/sec and Wind Directions Are Defined by the Five Wind Direction Arc Scenarios (µg/m^3)

	2012 East - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	29	21	17	20	19	22	27	27	27	42	14	9	11	9	2	8	8	13	23	51	25	24	25	30
20%	42	32	27	26	26	33	40	48	34	47	18	13	11	13	3	14	9	14	26	65	49	55	57	47
30%	54	40	35	32	38	41	51	59	49	61	24	30	14	14	7	15	13	19	32	67	100	70	77	60
40%	62	46	45	39	43	46	58	71	66	66	35	37	17	15	14	16	20	28	42	77	111	86	87	69
50%	68	52	55	44	49	55	69	78	73	71	46	39	21	16	21	16	26	37	79	81	124	98	93	78
60%	77	60	64	51	56	59	78	88	82	78	54	49	22	22	21	16	31	39	118	106	161	110	102	88
70%	86	71	78	60	63	71	88	107	94	87	67	58	33	27	21	18	36	40	136	134	191	126	113	100
80%	98	83	88	69	79	88	113	128	117	102	85	74	42	32	22	19	41	62	202	233	203	150	139	115
90%	160	107	113	85	122	137	158	183	146	125	129	84	48	40	23	31	47	103	386	341	283	171	167	162
100%	488	338	328	206	414	601	634	317	253	201	195	101	126	68	25	43	53	145	402	378	886	1099	250	314
Count	117	143	137	125	124	121	113	88	63	42	41	21	12	11	5	6	5	5	10	11	43	63	98	122
	1526	Total																						
	2012 East+ - Hour of the Day																							
%tile	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
10%	28	20	17	21	19	22	27	27	26	26	12	9	10	10	3	8	9	14	18	58	30	27	30	30
20%	42	32	27	26	25	32	40	47	34	44	18	11	11	14	5	14	10	18	25	67	56	57	57	47
30%	52	40	37	34	38	41	52	59	48	56	24	25	13	15	8	15	15	29	32	79	95	70	78	59
40%	62	47	46	41	43	46	58	70	66	64	34	34	18	17	14	16	21	35	45	106	111	87	86	67
50%	68	53	56	44	50	53	68	79	76	69	42	38	21	21	21	16	23	37	75	135	124	103	95	77
60%	78	62	63	51	58	59	77	92	91	76	52	44	29	23	21	16	26	39	115	233	154	115	103	87
70%	87	72	76	59	63	71	88	110	104	85	66	54	42	27	22	18	32	43	139	360	184	125	114	98
80%	104	83	88	69	78	89	111	132	120	101	84	72	49	30	23	19	38	50	280	392	201	159	143	113
90%	159	107	120	87	119	138	152	203	147	124	112	84	95	38	24	31	46	89	380	512	273	177	167	162
100%	488	338	328	206	414	601	634	317	253	201	195	101	126	68	25	43	53	145	402	580	886	1099	303	314
Count	128	156	152	144	139	137	127	105	79	55	48	23	15	14	7	6	6	7	13	16	47	74	114	133
	1745	Total																						
	2012 50th Percentile Values by Hour of the Day for Different Calculation Methodologies																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	68	52	56	45	49	56	69	80	81	66	47	37	18	20	22	18	27	39	78	135	145	108	93	73
Nrrw	68	54	55	48	49	55	65	81	84	68	45	35	21	19	12	16	21	39	75	185	145	107	95	76
West	66	56	56	52	46	59	72	83	98	59	48	26	16	21	26	24	32	46	78	438	148	116	85	56
East	68	52	55	44	49	55	69	78	73	71	46	39	21	16	21	16	26	37	79	81	124	98	93	78
East+	68	53	56	44	50	53	68	79	76	69	42	38	21	21	21	16	23	37	75	135	124	103	95	77

Table 3-14
50th Percentile PM_{10} Concentrations Monitored at the Cowtown Station by Hour of the Day and By Wind Direction Arc Scenario for 2008, 2011, and 2012 ($\mu g/m^3$)

	2008 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	136	179	154	128	146	183	202	195	122	81	42	42	34	31	26	32	51	60	112	567	251	144	161	182
Nrrw	163	176	133	126	134	192	182	202	122	89	43	46	35	44	26	39	34	39	183	922	277	137	169	210
West	151	172	157	149	146	213	207	224	123	60	49	29	43	29	26	9	51	60	105	763	230	133	161	210
East	127	189	146	118	143	170	144	157	119	82	28	48	30	43	23	38	N/A	285	376	219	340	160	152	119
East+	128	196	128	124	148	172	201	157	121	85	36	46	30	31	42	38	13	88	376	422	397	148	152	145

	2011 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	58	52	49	46	45	57	72	100	102	65	39	38	33	27	27	22	56	61	136	157	130	87	90	67
Nrrw	55	53	49	49	47	56	70	103	94	72	38	38	32	25	27	29	62	31	93	122	105	85	93	65
West	56	53	63	51	54	68	76	115	123	74	52	38	34	24	34	34	51	74	174	185	145	98	97	86
East	58	51	47	43	45	52	70	94	73	61	36	38	31	37	26	22	69	47	108	99	105	84	84	63
East+	57	52	47	45	45	58	71	97	84	64	38	38	32	27	26	22	67	41	93	119	115	84	83	64

	2012 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	68	52	56	45	49	56	69	80	81	66	47	37	18	20	22	18	27	39	78	135	145	108	93	73
Nrrw	68	54	55	48	49	55	65	81	84	68	45	35	21	19	12	16	21	39	75	185	145	107	95	76
West	66	56	56	52	46	59	72	83	98	59	48	26	16	21	26	24	32	46	78	438	148	116	85	56
East	68	52	55	44	49	55	69	78	73	71	46	39	21	16	21	16	26	37	79	81	124	98	93	78
East+	68	53	56	44	50	53	68	79	76	69	42	38	21	21	21	16	23	37	75	135	124	103	95	77

	Ratio of 2011 to 2008 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	43%	29%	32%	36%	31%	31%	35%	51%	83%	81%	92%	90%	97%	87%	102%	68%	112%	100%	121%	28%	52%	60%	56%	37%
Nrrw	34%	30%	37%	39%	35%	29%	38%	51%	77%	80%	89%	83%	89%	56%	102%	74%	183%	80%	51%	13%	38%	62%	55%	31%
West	37%	31%	40%	35%	37%	32%	36%	51%	100%	123%	107%	131%	79%	83%	130%	383%	102%	123%	165%	24%	63%	73%	60%	41%
East	46%	27%	32%	37%	31%	31%	49%	60%	61%	74%	127%	80%	102%	86%	116%	58%	N/A	17%	29%	45%	31%	52%	55%	53%
East+	45%	26%	37%	36%	30%	34%	35%	62%	70%	75%	106%	83%	104%	85%	62%	58%	515%	47%	25%	28%	29%	56%	55%	44%

	Ratio of 2012 to 2008 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	50%	29%	36%	35%	34%	30%	34%	41%	66%	82%	111%	87%	54%	65%	81%	57%	54%	65%	69%	24%	58%	75%	58%	40%
Nrrw	42%	31%	41%	38%	37%	28%	36%	40%	69%	76%	105%	76%	58%	44%	47%	42%	61%	100%	41%	20%	52%	78%	56%	36%
West	43%	33%	36%	35%	31%	27%	35%	37%	80%	98%	98%	89%	38%	73%	97%	272%	62%	75%	74%	57%	64%	87%	53%	27%
East	54%	27%	37%	37%	35%	32%	48%	50%	61%	86%	165%	82%	67%	39%	93%	42%	N/A	13%	21%	37%	37%	61%	61%	65%
East+	53%	27%	44%	36%	34%	31%	34%	51%	63%	82%	115%	83%	68%	68%	50%	42%	180%	43%	20%	32%	31%	69%	62%	53%

to compute the average change in PM_{10} concentration over all of the datapoints recorded, and not discount the contributions of large numbers of datapoints by virtue of their densities within the hours of the day recording high frequencies of winds blowing toward the monitor.

The hour-of-the-day average 50th percentile PM_{10} concentrations for each arc scenario in each of 2011 and 2012, using an unweighted average-of-hour-percentile method and an hourly count-weighted method for averaging, are displayed in Table 3-15.

Table 3-15
Hour of the Day Average 50th Percentile PM_{10} Concentration

Arc Scenario	Unweighted Avg. ($\mu g/m^3$)	Weighted Avg. ($\mu g/m^3$)	Fraction of Weighted 2008 Value
2008 Monitored PM_{10}			
Base	136	162	N/A
Narrow	155	162	N/A
West	146	172	N/A
East	142	149	N/A
East+	143	159	N/A
2011 Monitored PM_{10}			
Base	67	69	42%
Narrow	62	66	41%
West	77	82	48%
East	60	62	41%
East+	61	64	40%
2012 Monitored PM_{10}			
Base	62	67	41%
Narrow	63	69	43%
West	75	77	45%
East	58	65	44%
East+	60	66	41%

Focusing on the "East+" data, the contributions of non-PFE sources to PM_{10} concentrations recorded at the Cowtown monitor in 2008 under the specified meteorological conditions were computed to be 40% in 2011, the year in which sources emitting within the prescribed arc most resembled those impacting the monitor in 2008. Applying this reduction factor to the weighted average 50th percentile PM_{10} concentration of 159 $\mu g/m^3$ for the "East+" scenario produces an adjusted monitored 50th percentile PM_{10} concentration at the Cowtown monitor of 95.4 $\mu g/m^3$ resulting solely from PFE facility emissions in 2008 under the specified meteorological conditions.

For 24-hour attainment demonstration purposes, the hour-of-the-day PM_{10} emission rates for the PFE facility were calculated using this general approach. The 50th percentile PM_{10} concentrations monitored in 2008 at the Cowtown station and computed on an hour-of-the-day basis under the different arc scenarios were reduced by the weighted fractions shown in Table 3-15 for the 2011 monitored data. The weighted fractions were applied uniformly across all hours of the day, in the absence of accurate hour-specific reduction fractions, and the resulting adjusted 2008 monitoring data were compared to the 2008 modeling results for the PFE facility configured with a unit emission rate. The resulting ratios between modeled 50th percentiles and adjusted-monitored 50th percentiles were inverted and multiplied by the unit emission rate (1.0 gm/sec) to derive hour of the day 50th percentile emission rates for the PFE facility in 2008. The results of these calculations are presented in Table 3-16.

The first table in Table 3-16 shows the 50th percentile values of all 2008 monitored PM_{10} concentrations that remained after filtering for the specified meteorological conditions in each arc scenario. The second table shows the same data reduced by the weighted fractions of 2011 to 2008 monitored PM_{10} data by arc scenario shown in Table 3-15. The third table in Table 3-16 presents the 50th percentile PM_{10} concentrations reported by the modeling of PFE emissions when configured with a unit emission rate. The fourth table displays the ratios of the 50th percentiles of PFE modeled impacts to adjusted 2008 monitoring PM_{10} concentrations. Finally, the fifth table shows the unit emission rate multiplied by the inverse of the ratios contained in the fourth table. These data in the fifth table represent the 50th percentile PM_{10} emissions rates by hour of the day under each of the five wind arc scenarios for the PFE facility in 2008. A diurnal plot of the hourly PM_{10} emissions rates in different groupings of wind arc scenarios is shown in the upper half of Figure 3-3.

The 50th percentile PM_{10} emissions rates by hour of the day were converted to daily emissions factors by averaging the hourly values over the 24-hour diurnal period, converting the 24-hour average from units of g/sec to g/day, and then dividing the 24-hour emission rate by the number of cattle housed in the PFE facility in 2008. The number of cattle housed in 2008 was reported by Pinal Feeding Company representatives to have been 18,900 head. The resulting PFE PM_{10} emissions rates in units of pounds of PM_{10} emitted per head-day are tabulated in Table 3-17.

Given the close correspondence of the annual per-head-day emission rate calculated under the East and East+ scenarios in this analysis to that published by Bonifacio, use of either of these factors is recommended for attainment demonstration purposes in western Pinal County. Because of the apparent lower interference of non-PFE area sources in the East versus East+ scenario analyses, the East scenario factor of 0.064 lb/head-day was selected for use in modeling at the Cowtown monitor.

Table 3-16
Calculation of Adjusted PFE Facility PM_{10} Emissions Rates in 2008 by Hour of the Day and by Wind Direction Arc Scenario

	2008 50th Percentile Values of Monitored PM10 by Hour of the Day for Different Wind Arc Scenarios, ug/m3																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	136	179	154	128	146	183	202	195	122	81	42	42	34	31	26	32	51	60	112	567	251	144	161	182
Nrrw	163	176	133	126	134	192	182	202	122	89	43	46	35	44	26	39	34	39	183	922	277	137	169	210
West	151	172	157	149	146	213	207	224	123	60	49	29	43	29	26	9	51	60	105	763	230	133	161	210
East	127	189	146	118	143	170	144	157	119	82	28	48	30	43	23	38	N/A	285	376	219	340	160	152	119
East+	128	196	128	124	148	172	201	157	121	85	36	46	30	31	42	38	13	88	376	422	397	148	152	145

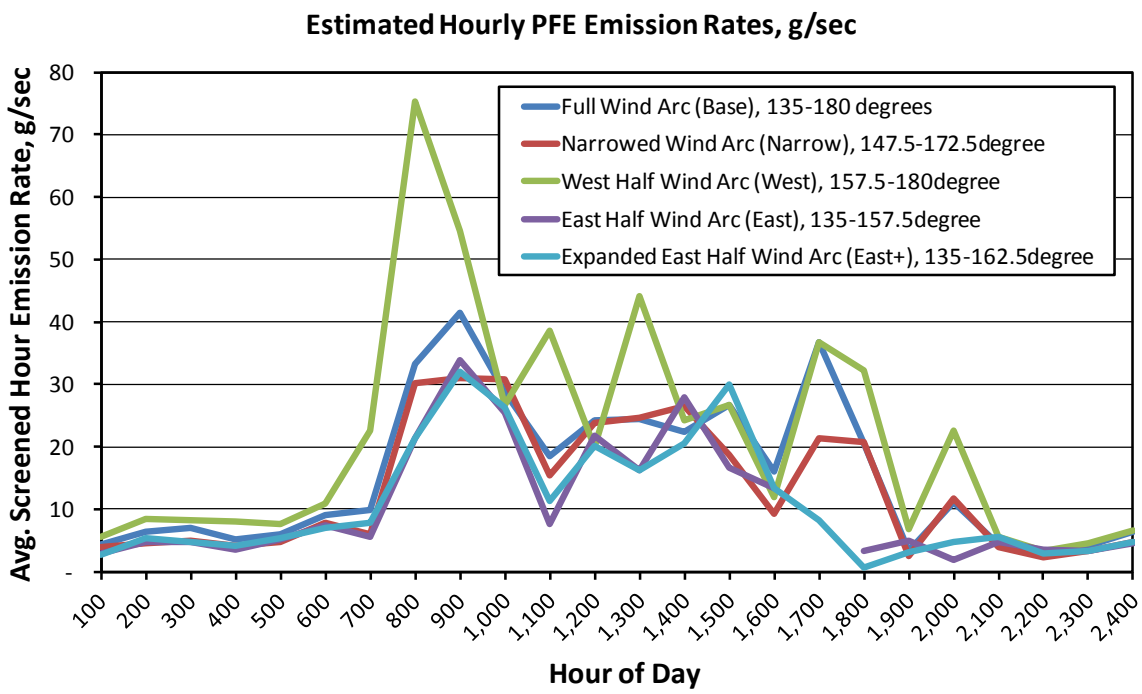
	2008 50th Percentile Values of Monitored PM10 by Hour of the Day Adjusted for Other Source Emissions Under Different Wind Arc Scenarios, ug/m3																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	78	103	89	74	84	105	116	112	71	47	24	24	19	18	15	19	29	35	65	327	144	83	93	105
Nrrw	96	104	78	74	79	113	107	120	72	53	25	27	21	26	16	23	20	23	108	544	163	81	100	124
West	79	89	82	78	76	111	108	117	64	31	25	15	22	15	14	5	26	32	55	398	120	69	84	109
East	74	111	86	69	84	99	84	92	70	48	16	28	18	25	13	22	N/A	167	220	128	199	94	89	70
East+	77	117	77	74	88	103	120	94	72	51	22	28	18	19	25	23	8	52	225	252	238	89	91	87

	2008 50th Percentile Values of Modeled PM10 at Unit Emissions Rates by Hour of the Day for Different Wind Arc Scenarios, ug/m3																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	32	28	22	25	24	20	20	6	3	3	2	2	1	1	1	2	1	3	34	51	57	45	39	29
Nrrw	41	39	26	30	28	25	30	7	4	3	3	2	1	2	1	4	2	2	76	79	69	61	51	45
West	27	20	19	18	19	20	9	3	2	2	1	1	1	1	1	1	1	2	16	34	41	41	36	32
East	41	39	28	33	27	23	26	7	3	3	4	2	2	2	1	3	N/A	86	76	122	71	46	42	26
East+	47	36	27	30	27	24	25	7	4	3	3	2	2	2	1	3	2	130	119	87	71	52	46	30

	Ratio of 2008 Modeled to Adjusted Monitored 50th Percentile PM10 Values by Hour of the Day for Different Wind Arc Scenarios																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	40%	27%	25%	34%	29%	19%	17%	5%	4%	6%	9%	7%	7%	8%	6%	11%	5%	8%	52%	16%	39%	54%	42%	28%
Nrrw	43%	38%	33%	41%	35%	22%	28%	6%	5%	5%	11%	7%	7%	6%	9%	18%	8%	8%	70%	15%	42%	75%	51%	36%
West	35%	23%	23%	24%	25%	18%	9%	3%	4%	7%	5%	10%	4%	8%	7%	16%	5%	6%	28%	8%	34%	59%	43%	29%
East	56%	35%	33%	48%	33%	23%	31%	8%	5%	7%	23%	8%	11%	6%	10%	13%	N/A	52%	35%	95%	35%	48%	48%	37%
East+	61%	31%	35%	41%	31%	24%	21%	8%	5%	6%	15%	8%	10%	8%	6%	13%	20%	249%	53%	34%	30%	59%	51%	35%

	Adjusted PM10 Emissions Rates for PFE Facility by Hour of the Day for Different Wind Arc Scenarios, g/sec																							
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Base	2.5	3.7	4.1	3.0	3.4	5.2	5.7	19.2	24.0	16.6	10.7	14.0	14.1	13.0	15.4	9.2	21.2	11.8	1.9	6.4	2.5	1.8	2.4	3.6
Nrrw	2.3	2.6	3.0	2.5	2.8	4.6	3.5	17.8	18.3	18.2	9.1	14.0	14.5	15.7	11.0	5.5	12.7	12.3	1.4	6.9	2.4	1.3	2.0	2.8
West	2.9	4.4	4.3	4.2	3.9	5.7	11.7	39.3	28.5	13.9	20.2	10.4	23.1	12.6	14.0	6.3	19.2	16.8	3.5	11.8	2.9	1.7	2.3	3.5
East	1.8	2.8	3.0	2.1	3.1	4.3	3.2	13.2	20.1	15.3	4.4	13.0	9.5	16.3	9.8	7.8	N/A	1.9	2.9	1.1	2.8	2.1	2.1	2.7
East+	1.6	3.3	2.8	2.4	3.2	4.2	4.7	12.7	19.2	15.7	6.7	12.1	9.7	12.3	17.9	8.0	4.9	0.4	1.9	2.9	3.4	1.7	2.0	2.9

Figure 3-3
Plots of Adjusted PFE Facility PM_{10} Emissions Rates in 2008 by Hour of the Day and by Diurnal Profile Method



Estimated Hourly PFE Emission Rates, g/sec
Best Wind Direction Arc Scenario and ACFA Activity-Based Estimates

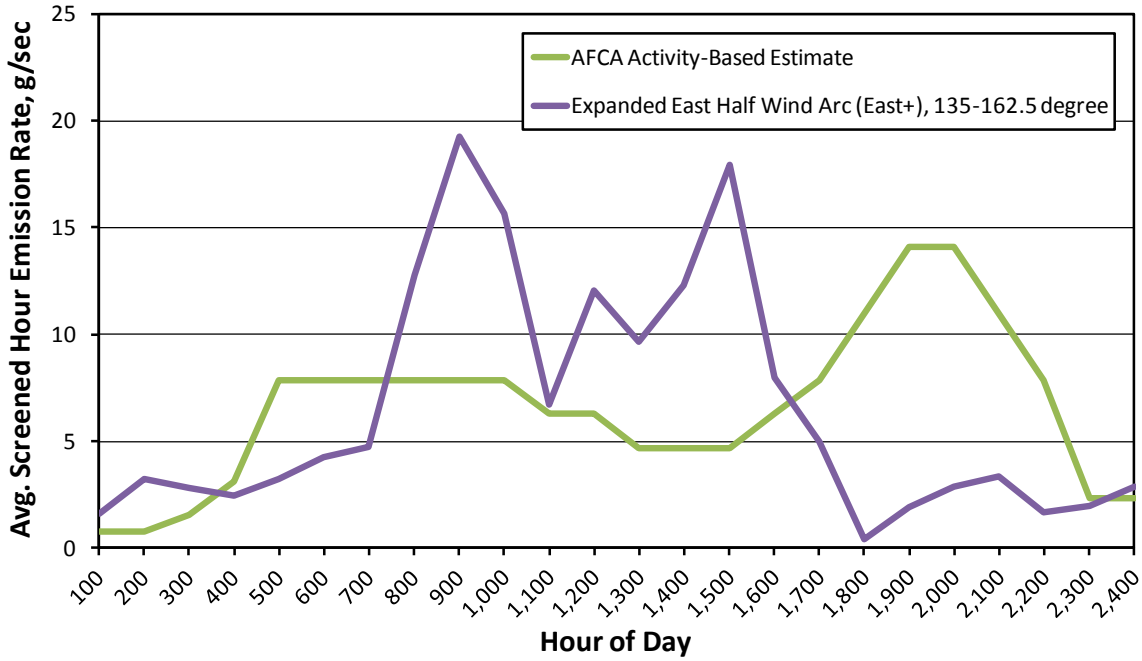


Table 3-17 2008 PFE PM_{10} Emissions Rates by Wind Arc Scenario				
Scenario	PM_{10} Emission Rate or Factor			Fraction of Bonifacio E.F.
	g/sec	lb/day	lb/head-day	
Base	9.0	1,708.8	0.090	144%
Narrow	7.8	1,486.0	0.079	125%
West	11.1	2,120.1	0.112	179%
East	6.3	1,204.4	0.064	101%
East+	6.5	1,243.5	0.066	105%

All of the wind direction arc scenarios evaluated produced somewhat anomalous median values of monitored and modeled data in the hour-of-the-day bins from 1500 through 1900 hours because of the paucity of days (e.g., n = 3 to 6) in 2008 during which the selected meteorological conditions were satisfied during these hours. As a result, concern was expressed by representatives of the Arizona Cattle Feeders Association (ACFA) with respect to the diurnal profile of hourly feedlot emission rates produced by this analysis.

In response to a request for an alternative profile recommended by the industry, the Association provided a diurnal profile that is shown in Table 3-18.[30] The ACFA profile is based on Pinal Feeding Company records of operations in 2008, visual observations by facility staff during 2008, and the technical judgment of ACFA staff. For comparison purposes, the profile produced by the East+ scenario is also shown in Table 3-18.

Because the diurnal profiles that were calculated from the Cowtown monitoring data analysis suffered from statistical uncertainty due to the small numbers of datapoints in the 1500 through 1900 hour bins, the activity-based diurnal profiles of feedlot PM_{10} emissions recommended by ACFA were used in the attainment demonstration modeling at the Cowtown monitor and at other monitors where feedlots were found in affiliated modeling domains. A comparison of the hourly emission rates for the PFE facility using the ACFA and the reverse dispersion modeling diurnal profiles appears in the lower half of Figure 3-3.

[30] "Estimate of Approximate Hourly Percentage Activity in Pinal County Feed Yards, Late October", Bas Aja, Arizona Cattle Feeders Association, August 27, 2013, as amended by Bas Aja in telecom on October 23, 2013.

Table 3-18 Diurnal Profiles of Feedlot PM_{10} Emissions (Percent of Daily Emissions)		
Hour	Initial ACFA Activity-Based Assessment	Cowtown Monitoring Data Assessment
0100	1.0%	1.0%
0200	1.0%	2.1%
0300	1.0%	1.8%
0400	2.0%	1.6%
0500	5.0%	2.1%
0600	5.0%	2.7%
0700	5.0%	3.0%
0800	5.0%	8.1%
0900	5.0%	12.3%
1000	5.0%	10.0%
1100	4.0%	4.3%
1200	4.0%	7.7%
1300	3.0%	6.2%
1400	3.0%	7.8%
1500	3.0%	11.4%
1600	4.0%	5.1%
1700	5.0%	3.2%
1800	7.0%	0.3%
1900	8.0%	1.2%
2000	8.0%	1.9%
2100	7.0%	2.1%
2200	5.0%	1.1%
2300	2.0%	1.3%
2400	2.0%	1.8%

The hourly emission rates for feedlots were also disaggregated into hourly rates for each of four contributory emission sources or activities deemed in the literature to constitute the vast majority of facility emissions. These contributory sources or activities are identified by the Governor's Agricultural Best Management Practices Committee (BMP Committee) as:

a) unpaved access connections;
b) unpaved roads or feed lanes;
c) animal waste handling and transportation; and
d) arenas, corrals, and pens.[31]

[31] Agricultural Best Management Practices for Livestock Operations, Governor's Agricultural Best Management Practices Committee, July 27, 2010.

This report also cites the San Joaquin Valley Air Pollution Control District (San Joaquin Valley) as the source of emission factors for these individual sources. The San Joaquin Valley report that is identified in the BMP Committee citation is the 2006 technical support document evaluating control measures for all agricultural and feedlot operations regulated by the Valley's Rule 4550 (Conservation Management Practices).[32] This report identified the four contributory emission sources or activities as:

a) unpaved areas;
b) unpaved roads;
c) overall management/feeding; and
d) pens/manure handling.

The San Joaquin Valley also estimated the fractional contributions of these sources to total facility emissions as follows: unpaved areas – 5%, unpaved roads – 15%, overall management/feeding – 5%, and pens/manure handling – 75%. These fractions were estimated from visual observations of feedlots operations and engineering judgment.

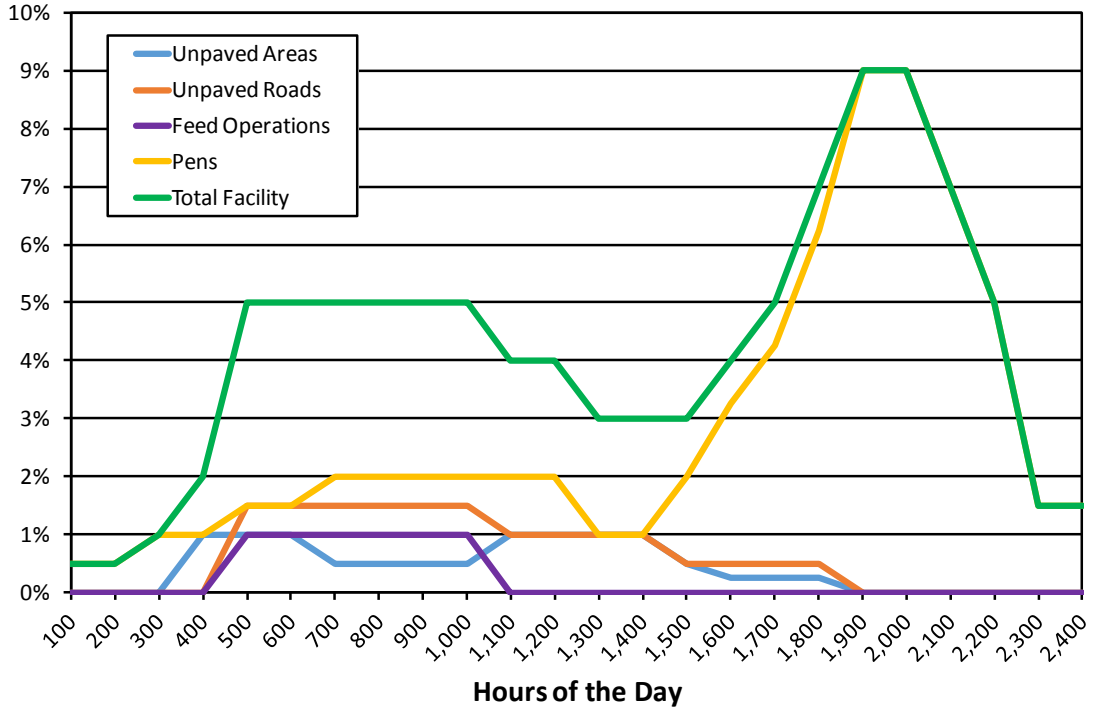
Information from the BMP Committee's report, the San Joaquin Valley report, and discussions with ACFA representatives was used to estimate hourly emission profiles for the four contributory sources. The emission profiles were initially designed to sum to the 24-hour total emission contribution fractions estimated in the San Joaquin Valley report, but the resulting hourly emission totals for the four sources—using the San Joaquin Valley source groups and underlying assumptions of activity—did not reconcile with the hourly activity-based emission profile for a whole facility as initially estimated by ACFA representatives. In a subsequent analysis, emission profiles for the four contributory sources were adjusted to reconcile with the ACFA whole facility profile without regard to the fractional contributions estimated by San Joaquin Valley. The results of this analysis were shared with an ACFA representative and, with minor adjustments, were accepted on behalf of ACFA as approximating the hourly profiles of the sources or activities contributing to total feedlot PM_{10} emissions on an average day in October, the month represented by the Cowtown stagnation design day. The adjustments suggested by ACFA reduced activity estimates in hours 0100, 0200, 2300, and 2400, and increased activity estimates in hours 1900 and 2000. A tabulation of the hourly fractional contributions of these sources to daily total feedlot emissions, together with the hourly profile of total feedlot emissions, recommended by ACFA is presented in Table 3-19. Note in the "Total" row at the bottom of Table 3-19 that the individual sources contribute the following fractions of 24-hour total facility emissions: unpaved areas – 10.25%, unpaved roads – 15.00%, feed operations – 6.00%, and pens – 68.75%. A plot of the diurnal profiles of the contributory source emission factors (in g/sec-head) and of the total facility emission factors is shown in Figure 3-4.

[32] Conservation Management Practices Program Report for 2005, San Joaquin Valley Air Pollution Control District, January 19, 2006.

Table 3-19
Diurnal Profiles of Contributory Sources and Total Feedlot PM_{10} Emissions
(Percent of Total Daily Facility Emissions)

Hour	Final ACFA Activity-Based Estimate				
	Unpaved Areas	Unpaved Roads	Feed Operations	Pens	Total
0100	0.00%	0.00%	0.00%	0.50%	0.50%
0200	0.00%	0.00%	0.00%	0.50%	0.50%
0300	0.00%	0.00%	0.00%	1.00%	1.00%
0400	1.00%	0.00%	0.00%	1.00%	2.00%
0500	1.00%	1.50%	1.00%	1.50%	5.00%
0600	1.00%	1.50%	1.00%	1.50%	5.00%
0700	0.50%	1.50%	1.00%	2.00%	5.00%
0800	0.50%	1.50%	1.00%	2.00%	5.00%
0900	0.50%	1.50%	1.00%	2.00%	5.00%
1000	0.50%	1.50%	1.00%	2.00%	5.00%
1100	1.00%	1.00%	0.00%	2.00%	4.00%
1200	1.00%	1.00%	0.00%	2.00%	4.00%
1300	1.00%	1.00%	0.00%	1.00%	3.00%
1400	1.00%	1.00%	0.00%	1.00%	3.00%
1500	0.50%	0.50%	0.00%	2.00%	3.00%
1600	0.25%	0.50%	0.00%	3.25%	4.00%
1700	0.25%	0.50%	0.00%	4.25%	5.00%
1800	0.25%	0.50%	0.00%	6.25%	7.00%
1900	0.00%	0.00%	0.00%	9.00%	9.00%
2000	0.00%	0.00%	0.00%	9.00%	9.00%
2100	0.00%	0.00%	0.00%	7.00%	7.00%
2200	0.00%	0.00%	0.00%	5.00%	5.00%
2300	0.00%	0.00%	0.00%	1.50%	1.50%
2400	0.00%	0.00%	0.00%	1.50%	1.50%
Total	10.25%	15.00%	6.00%	68.75%	100.00%

Figure 3-4
Feedlot Total and Contributory Source Hourly Fractions of Daily Emission Total (%)



3.1.3 On-Road Mobile Source Emissions Modeling for Paved Roads

As part of a larger emissions inventory effort for the Pinal County PM_{10} SIP modeling project, on-road mobile source emissions were modeled for five episode days in the year 2008. Episodic emissions are created from MOVES 2010b simulations in the emission rates mode using county-wide inputs configured with local data where available. The PM_{10} emission rates for exhaust, tire, and brake were then integrated into a lookup table in a spreadsheet containing link-specific Travel Demand Model (TM) outputs from the Arizona Travel Demand Model versions 2 (AZTDM2)[33] for Pinal County in 2008. Emissions due to fugitive dust and bow wake were also calculated for these links based on formulas used in the Maricopa Association of Government's 2007 and 2012 Five Percent Plans.[34,35] In addition to the exhaust, brake, and tire emissions, the paved-road vehicle emissions were distributed spatially to specific links within the different dispersion modeling domains. Configuration of the MOVES model for this work

[33] "Development of the Arizona Statewide Travel Demand Model: Phase 2 (AZTDM2)" by Parsons Brinckerhoff for Arizona Department of Transportation, September 19, 2011. Accessed from f*tp://ftp.azdot.gov/AZTDM2/AZTDM2 Model Documentation v8.pdf* on July 23, 2013.
[34] "Cost-Effectiveness of Selected PM_{10} Control Measures," prepared for Maricopa Association of Governments by Sierra Research, June 2006 p. 26.
[35] "MAG 2012 Five Percent Plan For PM-10 for the Maricopa County Nonattainment Area," Maricopa Association of Governments, March 2012, Appendix A, section 5.3, p. 117-119.

required formatting of the data to a MOVES compatible format and extrapolation of the available data sources. These operations are detailed in the following sections.

MOVES Configuration – Described below are the inputs used in configuring the MOVES model for the creation of episode-specific emission rates tables.

Average Speed Distribution – MOVES requires speed distribution information organized by vehicle types, road types, and hours. Speed must be translated into one of 16 speed bins in the process of creating this input field. Table 3-20[36] shows the relationship between the 16 speed bins and the average speed and speed ranges.

Table 3-20
MOVES Speed Bins

Speed Bin ID	Average Bin Speed	Speed Bin Range
1	2.5	speed < 2.5 mph
2	5	2.5 mph <= speed < 7.5 mph
3	10	7.5 mph <= speed < 12.5 mph
4	15	12.5 mph <= speed < 17.5 mph
5	20	17.5 mph <= speed < 22.5 mph
6	25	22.5 mph <= speed < 27.5 mph
7	30	27.5 mph <= speed < 32.5 mph
8	35	32.5 mph <= speed < 37.5 mph
9	40	37.5 mph <= speed < 42.5 mph
10	45	42.5 mph <= speed < 47.5 mph
11	50	47.5 mph <= speed < 52.5 mph
12	55	52.5 mph <= speed < 57.5 mph
13	60	57.5 mph <= speed < 62.5 mph
14	65	62.5 mph <= speed < 67.5 mph
15	70	67.5 mph <= speed < 72.5 mph
16	75+	72.5 <= speed

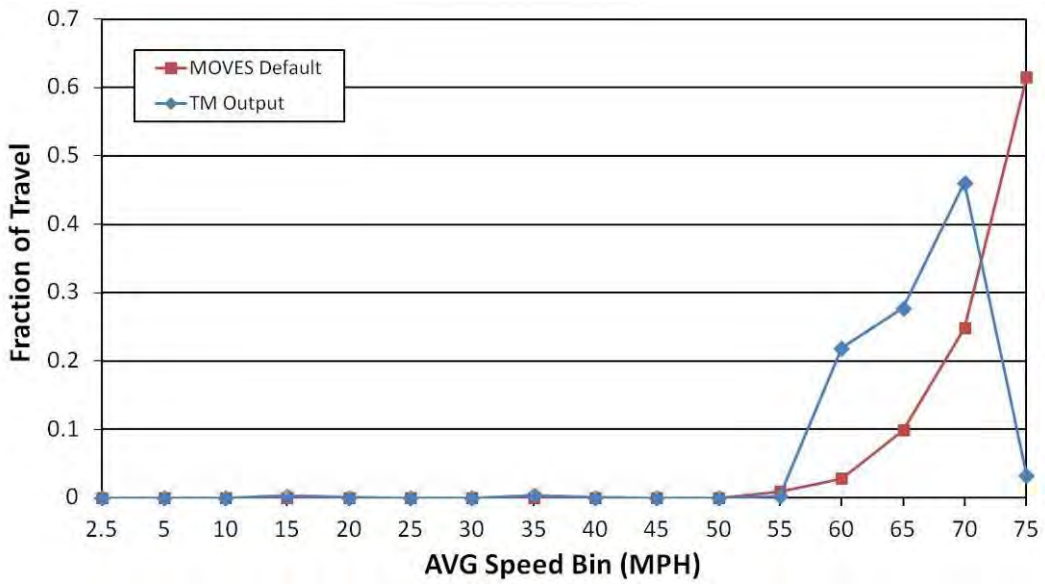
Outputs from the travel demand model were used to determine hourly, road-type specific speed distributions for Pinal County. ADOT provided a spreadsheet summarizing the speed fractions on four different road types between 2.5 and 65 mph for each hour

[36] This table was reproduced from the Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity, Transportation and Regional Programs Division Office of Transportation and Air Quality U.S. Environmental Protection Agency, EPA-420-B-09-042 December 2009, page 26, Table 3.6.

calculated on a VMT basis.[37] This sheet was modified to capture the speed data contained in the travel model out to 75 mph and to use VMT-based calculations for the speed fractions. For Pinal County, these same speed profiles were used across both weekends and weekdays for all vehicle source types.

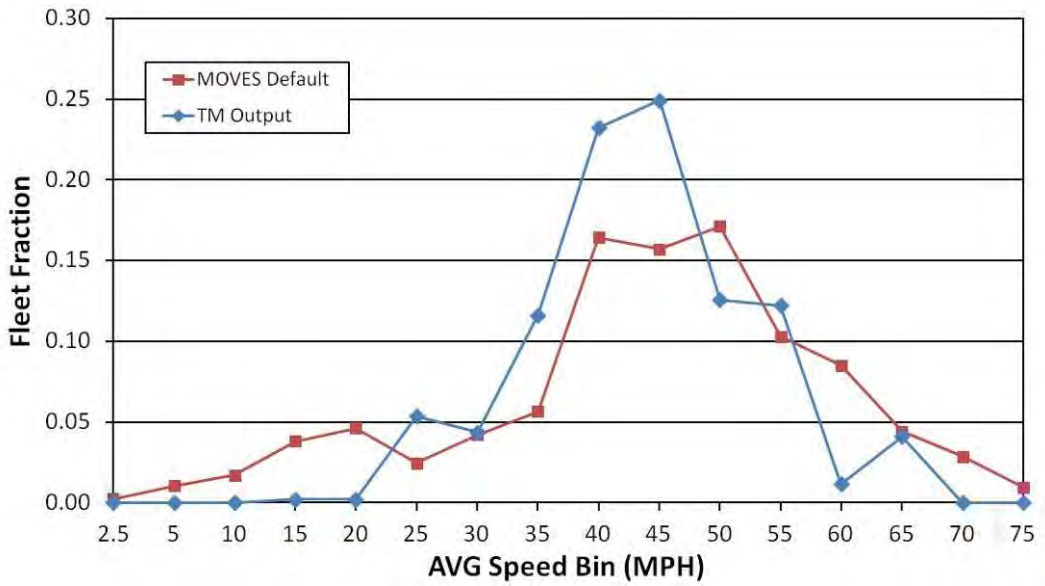
Comparisons were made among the travel model developed speed distribution fields and MOVES default values. The MOVES model contains default speed distributions that are representative of average national trends, but may fail to capture local conditions. Figures 3-5 and 3-6 plot the speed distributions for rural restricted (Figure 3-4) and rural unrestricted (Figure 3-5) peak PM traffic hours across all vehicle types.

Figure 3-5
Distribution of Speeds on Rural Restricted Roads for MOVES Default and TM Outputs for Pinal County



[37] Spreadsheet "ADOT Speed Calculator for Pinal.xlsx" was downloaded on March 6, 2013, from ftp://ftp.azdot.gov/MPDAirQuality/Sierra Research/ADOT MOVES Calculation for Pinal/.
A revised spreadsheet "ADOT Speed Calculator for Pinal_fixed.xlsx" was accessed on May 7, 2013.

Figure 3-6
Distribution of Speeds on Rural Unrestricted Roads for MOVES Default and TM Outputs for Pinal County



The TM output speed distribution for the restricted rural roads (interstates) appears to show slightly slower maximum speeds thanthe MOVES defaults during peak hours. However, the MOVES defaults and TM appear to generally show agreement for both of the rural restricted and unrestricted. Because the TM speed distribution outputs are link specific, they were ultimately favored over the MOVES defaults, which do not capture link-level activity. In order to best model the activity in the modeling domains, the link-level activity is necessary but it is unavailable from MOVES.

VMT Calculations – Total countywide Vehicle Miles Traveled (VMT) was supplied in a spreadsheet from ADOT that split out the VMT data into Functional Classes of roads. TM output VMT data was converted to Highway Performance Monitoring System (HPMS) Vehicle Type IDs using vehicle registration data.[38] As an example, the TM group "auto" contains both motorcycles and passenger cars. The total VMT for auto was split into HPMS Vehicle types 10 and 20 based on the population totals for motorcycles and passenger cars. The TM did not contain any VMT data for buses, meaning that HPMS vehicle type 40 is empty in the daily VMT splits from the TM. The AZTDM2 model accounts for travel generated within the county and outside of the county: intrastate, interstate, and international.[39]

[38] Spreadsheet "VMT_Summary_2008_with_FunctionalClass.xlsx" was attached in an e-mail correspondence from Ashim Garg (*AGarg@azdot.gov*) to Beverly Chenausky (*bchenausky@azdot.gov*) on February 14, 2013, and forwarded to Bryan Paris (*Paris.Bryan@azdeq.gov*) on February 15, 2013.
[39] "Development of the Arizona Statewide Travel Demand Model: Phase 2 (AZTDM2)" by Parsons Brinckerhoff for Arizona Department of Transportation, September 19, 2011, p 108. Accessed from *ftp://ftp.azdot.gov/AZTDM2/AZTDM2 Model Documentation v8.pdf* on July 23, 2013.

Table 3-21 shows the different stages of calculation used to develop the HPMS Vehicle Type annual VMT input for the MOVES model. The column titled "Daily VMT Splits" shows the final numbers for each of these vehicle types. The column titled "Daily VMT HPMS Normalized" shows the data from the TM that was normalized to the HPMS county VMT totals with one exception. The bus VMT was calculated to be a population-based fraction of the total HPMS VMT as presented in Table 7 of the *sourcetypepopulation* section. The total VMT was then normalized to the HPMS daily VMT. The VMT for each of the vehicle types was then normalized to the HPMS VMT total and multiplied by 365 to calculate the annual totals.

Table 3-21
VMT Input Calculations for MOVES
Daily VMT HPMS Normalized

HPMSVtypeID	Description	Daily VMT Splits (TM & Pop)	Daily VMT HPMS Normalized	Annual VMT
10	Motorcycle	371,732	352,027	128,489,979
20	Passenger Cars	6,907,913	6,541,738	2,387,734,442
30	Other 2 axle-4 tire Vehicles	276,466	261,811	95,561,076
40	Buses	0	25,141	9,176,297
50	Single Unit Trucks	339,733	321,725	117,429,583
60	Combination Trucks	226,480	214,475	78,283,250
Total		8,122,324	7,716,917	2,816,674,626

Hourly Fractions – Hourly VMT fractions were calculated using TM output data supplied by ADOT.[40] The temporal resolution of TM outputs is coarser than that required by MOVES. TM activity data are lumped in AM (morning peak), MD (midday off-peak), PM (afternoon peak), and NT (night and early morning off-peak) while MOVES requires hour specific data. VMT data for an hour group are translated into a MOVES hour ID using the default hourly VMT fractions in MOVES. As an example for a given hour in the AM group, the calculation would proceed as follows:

$$F_{hr} = \frac{VMT_{AM}}{VMT_{DAY}} * \frac{F(default)_{hr}}{\sum_{7}^{9} F(default)_{i}}$$

[40] Spreadsheet "ADOT Hourly VMT Calculator for Pinal.xlsx" was downloaded on March 6, 2013, from ftp://ftp.azdot.gov/MPDAirQuality/Sierra Research/ADOT MOVES Calculation for Pinal/.

where:

F_{hr} = hourly VMT fraction for an hour in the AM group
$F(default)_{hr}$ = default fractional hourly VMT at a given hour in MOVES
i = ranges from the start to end hour ID of an hour group containing hr
VMT_{AM} = VMT for the AM time group from the TM
VMT_{DAY} = VMT summed for the entire day from the TM

The mapping between the TM hour groups, MOVES hour ID, and actual time of day is shown in Table 3-22. For example, the first hour in the AM group is MOVES hour ID 7 which covers 6AM to 9AM in real time.

Table 3-22
Mapping of Travel Model Hour Groups to MOVES Hour ID

Travel Model Hour Groups	MOVES Hour ID	Time of Day
AM	7 – 9	6AM to 9AM
MD	10 – 15	9AM to 3PM
PM	16 – 18	3PM to 6PM
NT	19 – 24 ; 1 – 6	6PM to 12AM; 12AM to 6AM

In Table 3-23, the VMT fractions for each MOVES hour ID are shown along with the fractions that hour contributes to its given hour group from the TM. The hour group fractions show the hourly VMT fractions within one of the four TM hour groups. The hourVMTFraction column should sum to 1.0 for a given day while the Hour Group Fractions sum to 1.0 over each of the hour groups.

Table 3-23 Hourly VMT Fractions by TM Hour Groups			
hourID	hourVMTFraction	TM Hour Group	Hour Group Fractions
1	0.007866	NT	0.03373
2	0.007409	NT	0.031769
3	0.007318	NT	0.031376
4	0.008964	NT	0.038436
5	0.017014	NT	0.07295
6	0.055951	NT	0.239906
7	0.072766	AM	0.380673
8	0.064408	AM	0.336947
9	0.053977	AM	0.28238
10	0.052518	MD	0.147729
11	0.056603	MD	0.159219
12	0.059132	MD	0.166332
13	0.055533	MD	0.15621
14	0.058159	MD	0.163596
15	0.073559	MD	0.206914
16	0.089866	PM	0.408254
17	0.084430	PM	0.383559
18	0.045827	PM	0.208187
19	0.035582	NT	0.152568
20	0.028173	NT	0.120799
21	0.024148	NT	0.103542
22	0.017745	NT	0.076088
23	0.013172	NT	0.056478
24	0.009879	NT	0.042358

Road Type Distribution – A spreadsheet containing HPMS data broken down into functional class for Arizona and individual counties was used to calculate the road type distribution for Pinal County. Table 3-24 shows HPMS functional classes mapped to MOVES Road Type ID. The RoadTypeDistribution input values are determined by the sum of the VMT fractions the Functional Classes (FCs) that fall under a given RoadTypeID. For example the roadTypeVMTFraction of roadTypeID 5 (urban unrestricted access) would be the sum of FC14, FC16, FC17 and FC19 divided by the total VMT over all functional classes. These VMT fractions are reported across all sourceTypeIDs and so the roadtypeVMTfractions do not vary by vehicle types.

Table 3-24 Functional Class to Road Type Mapping			
Functional Class (FC)	FC Description	Road Type ID	Road Type Description
FC1	Rural Principal Arterial - Interstate	2	Rural Restricted Access
FC2	Rural Principal Arterial - Other	3	Rural Unrestricted Access
FC6	Rural Minor Arterial	3	Rural Unrestricted Access
FC7	Rural Major Collector	3	Rural Unrestricted Access
FC8	Rural Minor Collector	3	Rural Unrestricted Access
FC9	Rural Local	3	Rural Unrestricted Access
FC11	Urban Principal Arterial- Interstate	4	Urban Restricted Access
FC12	Urban Principal Arterial- Other Fwys & Expwys	4	Urban Restricted Access
FC14	Urban Principal Arterial - Other	5	Urban Unrestricted Access
FC16	Urban Minor Arterial	5	Urban Unrestricted Access
FC17	Urban Collector	5	Urban Unrestricted Access
FC19	Urban Local	5	Urban Unrestricted Access

Table 3-25 shows the final distributions of road types on a VMT basis.

Table 3-25 Road Type VMT Distributions		
roadTypeID	roadTypeVMTFraction	Road Type Description
1	0.0000	Off-network
2	0.3792	Rural Restricted
3	0.3457	Rural Unrestricted
4	0.0837	Urban Restricted
5	0.1913	Urban Unrestricted

Source Type Population – ADOT supplied vehicle registration information broken down by Source Type ID.[41] This information was used as is for the MOVES importer inputs. As shown in Table 3-26, the total population count for 2008 is 272,530.

[41] Spreadsheet "ADOT MVD_Registration Converter for Pinal.xlsx" was downloaded on March 6, 2013, from ftp://ftp.azdot.gov/MPDAirQuality/Sierra Research/ADOT MOVES Calculation for Pinal/.

Table 3-26 Vehicle Population for Pinal County 2008			
yearID	sourceTypeID	Source Description	sourceTypePopulation
2008	11	Motorcycle	8,243
2008	21	Passenger Car	153,180
2008	31	Passenger Truck	81,887
2008	32	Light Commercial Truck	26,447
2008	41	Intercity Bus	17
2008	42	Transit Bus	52
2008	43	School Bus	819
2008	51	Refuse Truck	28
2008	52	Single Unit Short-haul Truck	952
2008	53	Single Unit Long-haul Truck	72
2008	54	Motor Home	80
2008	61	Combination Short-haul Truck	430
2008	62	Combination Long-haul Truck	324
TOTAL			272,530

Source Type Age Distribution – Vehicle age distributions were supplied by ADOT from vehicle registration data for the year 2012 in Pinal County, broken out by specific vehicle classes.[42] These vehicle classes were mapped into MOVES source type IDs and the age distributions were calculated as fractions of registered vehicles for a given year divided by the sum total of vehicles in that class over all years. The years were translated into an equivalent ageID as dictated by the MOVES formatting requirements. The ageID is defined as the difference between the registration year and the year being modeled (2008 – registration year). The MOVES model requires age fractions for the age IDs between 0 and 30. It is assumed that the same source type age distribution will be maintained between the years 2008 and 2012.

Meteorology – The met conditions were imported as hourly temperature and relative humidity data from Casa Grande for each of the model episodes: January 1, April 27, October 27, October 29, and November 20.[43]

Monthly VMT Fractions – MOVES 2010b default values were used for this input field.

Fuel Supply – MOVES 2010b default values were used for this input field.

[42] Original spreadsheet "MOBILE6 REG DIST CALC 2008 for Pinal.xlsx" was downloaded on March 6, 2013, from ftp://ftp.azdot.gov/MPDAirQuality/Sierra Research/ADOT MOVES Calculation for Pinal/. An updated spreadsheet "August_2012.xls" was provided in an e-mail correspondence from Beverly Chenausky (*bchenausky@azdot.gov*) on May 28, 2013.
[43] These data were downloaded from ftp://ftp.ncdc.noaa.gov/pub/data/noaa/2008/ on July 3, 1013.

Fuel Formulation – MOVES 2010b default values were used for this input field.

I/M Programs – MOVES 2010b default values were used for this input field.

AVFT – MOVES 2010b default values were used for this input field.

Ramp Fractions – MOVES 2010b default values were used for this input field.

Emissions Calculations – The calculation of emissions due to exhaust, brake, tire, fugitive dust, and bow wake from paved road vehicle activity is explained below.

Onroad Exhaust, Brake, and Tire – Following the execution of the MOVES model for an episode day, the emission rate tables were extracted from the output database. The rate per distance (RPD) and rate per vehicle (RPV) tables were both exported from MySQL into Excel spreadsheets. The RPD table contains information on the vehicle emission rates in grams per mile for different pollutants by process, source type, speed, road type, and hour. These variables were converted via a pivot table to a lookup table for use with the travel model outputs. Travel model outputs contain VMT organized by link, hour-groups, speed, vehicle-type groups and facility type. Emission rates were selected from the lookup table based on a link's hour, speed and vehicle-type groups and then multiplied by the VMT of the vehicle-type group to give the emissions on that link for each vehicle-type group. The emissions were then summed over the vehicle-type groups to give the total emissions on a link due to exhaust, brake and tire.

The travel model uses four categories of vehicles—AUT, SUT, MUT, and TRK—as described in Table 3-27. With the exception of buses, the entire fleet is accounted for by the AUT, SUT, and MUT categories, and the TRK group is a combination of the SUT and MUT groups. The MOVES lookup tables have to be converted to these vehicle categories by taking population-weighted averages of the emissions rates across the MOVES vehicle types for a given travel model vehicle type. Table 3-27 shows Travel Model vehicle types mapped to the MOVES vehicle categories.

The emission rates for each TM vehicle category were then organized into a look-up table by hour, speed bin, and road type. Table 3-28 shows a sample segment of this final table over the first hour and first two speed bins and the four road types. The emission rates are given for PM_{10} summed over exhaust, brake and tire in grams per mile for the vehicle groups used by the TM. The emission rate for each vehicle group is then chosen based on the hour group, speed bin and road type, and multiplied by the VMT for that vehicle group. The total exhaust, brake, and tire PM_{10} is then summed across the three vehicle groups according to the following equation. Note that ER in the equation below stands for the emission rate of a given vehicle group.

Table 3-27 Travel Model Vehicle Groups Mapped to MOVES Vehicle Type IDs		
Travel Model Vehicle Types	MOVES Vehicle Type IDs	Description
AUT	11, 21	Motorcycles and Passenger cars
SUT	31, 32	Other two-axle, four-tire vehicles
MUT	51, 52, 53, 54, 61, 62	Single Unit, Combination Trucks
(N/A)	41, 42, 43	Buses

Table 3-28 MOVES Emission Rates Lookup Table					
Hour	avgSpeedBinID	roadTypeID	AUT PM_{10} (g/mi)	SUT PM_{10} (g/mi)	MUT PM_{10} (g/mi)
1	1	2	0.193563	0.539385	4.939788
1	1	3	0.200251	0.550764	4.599754
1	1	4	0.194939	0.537089	4.941009
1	1	5	0.198902	0.551916	4.603039
1	2	2	0.106547	0.29452	2.508547
1	2	3	0.111094	0.296764	2.394027
1	2	4	0.107235	0.293371	2.509163
1	2	5	0.110419	0.297341	2.395669

$$PM_{10} = VMT_{AUT} \times ER_{AUT} + VMT_{SUT} \times ER_{SUT} + VMT_{MUT} \times ER_{MUT}$$

Table 3-28 shows the MOVES emission rates organized by hour, speed bin, and road type, as well as total PM_{10} total for exhaust, brake and tire, summed by vehicle group. The table presented here is only a portion of the complete lookup table—only the first two speed bins on the first hour are presented below as a sample, whereas the full lookup table contains 24 hours and 16 speed bins. These rates were calculated using inputs for the entire county on the given episode days. The rates output table can be applied to any spatial domain desired given that speed bin, road type, and vehicle type VMT data is available.

Fugitive Dust – Paved-road vehicle emissions of fugitive dust were calculated using VMT and emission rates that vary by the silt loading of a given road. These rates are derived from an AP-42 equation shown below and described in detail in MAG's 2012 Five Percent Plan.[44]

[44] "MAG 2012 Five Percent Plan For PM-10 for the Maricopa County Nonattainment Area," Maricopa Association of Governments, March 2012 Appendix A, section 5.3, p. 117-119.

$$E = k \times sL^{0.91} \times W^{1.02} \times (1 - \frac{P}{4N})$$

where:

E = emission factor on an annual average basis

k = particle size allocation factor (1.0 for PM_{10} particles and 0.25 for $PM_{2.5}$)

sL= silt loading for road surface type (freeways are 0.02 g/m^2, high-traffic arterials are 0.067 g/m^2, low-traffic arterials are 0.23 g/m^2)

W = vehicle weight averaged over specific road ways (freeway vehicle averages are 3.53 tons and arterial vehicle averages are 2.65 tons)

P = number of days in a year with precipitation over 0.254 mm (0.01 in) and determined to be 31 days for 2008

N = the number of days in the year 2008 (366 days).

The values assigned to the variables described above were assigned to values used in MAG's Five Percent Plan in order to provide consistent and defensible assumptions for the Pinal County PM_{10} SIP modeling work.

Table 3-29 shows emission rates for a given road type ID and volume.

Table 3-29
PM_{10} Emission Rates for Paved Road Fugitive Dust

Road Type ID	Emission Rate	Road Description
2,4	0.1 (g/mi)	Freeways
3,5 (Low Traffic)	0.69 (g/mi)	Low Traffic Arterials (weekday counts < 10,000)
3,5 (High Traffic)	0.22 (g/mi)	High Traffic Arterials (weekday counts ≥ 10,000)

Values from the travel model were used to determine whether a specific link falls into the low or high traffic count category for arterials. The VMT values were summed over three of the four vehicle categories from the TM as the AUT, SUT, and MUT. Total link VMT for each hour group was multiplied by the emission rate for that link based on the road type and daily traffic count.

Bow Wake Emissions – PM_{10} generated from the bow wake of large trucks traveling on roads with unpaved shoulders was calculated from the following emissions rate formula:[45]

$$0.03 * (SPEED/55\ MPH)^2 = PM_{10}\ (lbs/VMT)$$

The variable SPEED is the link-specific speed from the travel model. Only the VMT from the large multi and single unit trucks (SUT category) was used in this calculation. To determine whether a particular road has paved or unpaved shoulders, a map was generated by ADOT that labeled some of the major roadways in the county with one of eight shoulder categories. Per the guidance of ADOT personnel, only shoulders labeled as gravel would be considered unpaved based on their maps.[46] Some of the shoulders that remained uncategorized were assigned to paved or unpaved based on guidance from Pinal County personnel.

Summary – Total PM_{10} emissions were summed across the exhaust, brake, tire, fugitive dust, and bow wake subtotals for a given link in a given hour group. Since the dispersion model requires an input of hourly emissions for the links, the PM_{10} emissions for an hour group are distributed to individual hours based on hourly VMT fractions. Table 3-23 above shows the hour group fractions used to allocate from each hour group to an individual hour. Emissions can then be pulled only from links in one of the modeling domains to be used as inputs for the dispersion modeling.

Supplemental Data – The full runspec and importer input files for these emission rate runs are provided in additional .mrs and .xml files, as listed below and available from Sierra Research upon request. These files can be opened in a text editor such as Notepad.

RunSpec_PINAL_2008_rates_v2_jan01.mrs
RunSpec_PINAL_2008_rates_v2_apr27.mrs
RunSpec_PINAL_2008_rates_v2_oct27.mrs
RunSpec_PINAL_2008_rates_v2_oct29.mrs
RunSpec_PINAL_2008_rates_v2_nov20.mrs

Pinal_importer_v2_jan01.xml
Pinal_importer_v2_apr27.xml
Pinal_importer_v2_oct27.xml
Pinal_importer_v2_oct29.xml
Pinal_importer_v2_nov20.xml

[45] "Cost-Effectiveness of Selected PM_{10} Control Measures," prepared for Maricopa Association of Governments by Sierra Research, June 2006, p. 26.
[46] PDF images—PinalCnty.pdf , PinalCnty_CasaGrande.pdf and PinalCnty_ApacheJunction.pdf—were provided in two separate e-mail correspondences from Beverly Chenausky (bchenausky@azdot.gov) on May 6, 2013.

Listed below are the spreadsheets used in calculating the MOVES 2010b inputs.

agedist_avft_calcs.xlsx
avgSpeedDist_ADOT_fixed_final.xlsx
roadtypedist_VMT_Summary_2008_with_FunctionalClass.xls
SourceTypePop_Jan08_final.xls
HPMS_TDM_CALCS.xlsx
ADOT_Hourly_frac_calculator_Pinal_final.xlsx

3.1.4 Unpaved Road Fugitive Dust Emissions

Fugitive dust emissions from unpaved roads were calculated by applying AP-42 emission factors to unpaved road VMT estimates. The unpaved road particulate emission factors were derived from the following AP-42 equation[47] for publicly accessible unpaved roads:

$$E = \left[\frac{k\left(\frac{s}{12}\right)^{1}\left(\frac{S}{30}\right)^{0.5}}{\left(\frac{M}{0.5}\right)^{0.2}} - C \right]\left(1 - \frac{P}{N}\right)$$

where:

E = annual average PM emission factor (lb/mile);

k = particle size multiplier for particle size range (1.8 lb/mile for PM_{10}) (AP-42 emission factors);

s = surface material silt content, which varies depending on the different types of roads, calculated based on a field study[48] (Appendix 2, Pinal County Field Sampling and Analysis for the Silt Characterization of Unpaved Road Dust and Agricultural Soil, conducted by ADEQ and PCAQCD, in May 2013) (values are listed in Table 3-30 below);

S = mean vehicle speed (varies depending on the type of roads, as listed in Table 3-30 below);

M = surface material moisture content, which varies depending on type of roads, calculated based on a field study (Appendix 2, Pinal County Field Sampling and Analysis for the Silt Characterization of Unpaved Road Dust and Agricultural Soil, conducted by ADEQ and PCAQCD, in May 2013) (values listed in Table 3-30 below);

[47] Emission Factors & AP 42, Compilation of Air Pollutant Emission Factors, Chapter 13.2.2. Unpaved Roads. *http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf*

[48] The silt content values for AG road are calculated based on the average of both of the Ag roads samples collected in May 2013 and the Ag road samples collected in 2008, detailed in Appendix 2.

C = emission factor for 1980s vehicle fleet exhaust, brake wear, and tire wear (0.00047 lb/mile for PM_{10})[1];

P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (31 days in 2008)[49]; and

N = annual number of days (366 days in 2008).

Among these variables, "s" (surface material silt content), "S" (mean vehicle speed), and "M" (surface material moisture content) vary depending the type of road surface and road activity. The collection and analysis of the data used to determine these variables is detailed in "Analysis of Unpaved Roads in the Pinal County PM_{10} Nonattainment Area" (Traffic Analysis Report), authored by Kate Edwards of the PCAQCD (see Appendix 1). Four different types of roads (public dirt, private dirt, agriculture, and trail) are used to characterize the roads in Pinal County in the analysis[50]. For the public dirt roads, five different classes (A, B, C, D, and E) are used to represent the different traffic volumes and vehicle speeds associated with each public dirt road. For the private dirt roads, traffic volumes and vehicle speeds are represented by two different classes (A and B). A discussion of information provided by local farmers on speeds and ADT levels is presented separately below. The values for these variables and the calculated emission factors (lbs/VMT) are summarized in Table 3-30.

Table 3-30
Measurements Used to Characterize Unpaved Road Emission Factors in the Pinal County PM_{10} Nonattainment Area

Road Types	Public Dirt					Private Dirt		Agriculture[a]	Trail
	A	B	C	D	E	A	B		
S = mean speed (mph)	20	25	30	35	40	25	15	see Table 3-31	15
s = surface material silt content (%)	7.1	7.1	7.1	7.1	7.1	14.4	14.4	14.9	14.4
M= surface material moisture content (%)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.8	0.3
E (lbs/VMT)	0.86	0.96	1.05	1.14	1.22	1.95	1.51	1.77 – 1.81	1.51

a Due to variations in maintenance and harvest activities, speeds vary by crop type. The range of emission factors represents the bounds of the speed estimates displayed in Table 3-31.

[49] Based on precipitation data for Pinal County from the AZMET netw.ork, *http://ag.arizona.edu/azmet/az-data.htm*.

[50] A fifth category, entitled "Neighborhood Roads," was added to address unpaved roads surrounding the Stanfield and PCH monitors. A review of the unpaved road networks provided in the ADEQ and PCAQCD shapefiles found they were not identified. However, due to their close proximity to the monitors, their emissions could not be ignored. Discussions with PCAQCD staff determined that ADT levels were limited to 2 vehicles per day at both sites. Emission factors were calculated using private road silt and moisture values.

Subsequent to the preparation of the Traffic Analysis Report, ADEQ held meetings with local farmers and they provided information on agricultural road activity for non-harvest and harvest operations. This information is summarized in a series of notes prepared by ADEQ staff and is presented in Appendix 9. It shows that non-harvest operations can be characterized by single average ADT levels and speeds. However, harvest operation ADT and speeds vary by crop type. Therefore, those values vary based on the crop distribution found within each modeling domain. A summary of the values calculated for each stagnation and high wind domain is presented below in Table 3-31.

Table 3-31
Average Daily Traffic (ADT) and Speeds Calculated for Unpaved Agricultural Roads in the Pinal County PM10 Nonattainment Area

Modeling Domain	Monitoring Site	ADT	MPH
Stagnation	Cowtown	13.6	27.4
	PCH	16.9	27.4
	Stanfield	15.1	27.2
High-Wind Day, Low-Wind Hours	Cowtown	11.3	28.2
	PCH	11.3	28.2
	Stanfield	11.3	28.2
	Maricopa	13.2	27.7

The emissions (lbs/hour) for each road are calculated by multiplying the VMT-specific emissions (E; lbs/VMT in Table 3-30) by the hourly estimated link-specific VMT in the modeling domain. The hourly VMT for each road link is calculated from the Average Daily Traffic (ADT) value, the road link length, and the related diurnal profile. The ADT values for the major roads in each modeling domain were obtained via a traffic map prepared by PCAQCD. For the rest of the roads, the ADT value is derived from the assumptions described in the Traffic Analysis Report (see Appendix 1). The average ADT value and the total miles of each roadway type in each of the modeling domains[51] are summarized in Table 3-32 and Table 3-33, respectively.

As noted, the diurnal variation data for different types of public and private roads were derived from the traffic data collected from 20 separate road segments in Pinal County. The values for agricultural roads and trails were limited to daylight hours and distributed uniformly within that period. Table 3-34 summarizes the diurnal variation associated with each road type in Pinal County as an hourly fraction of the daily total ADT.

[51] The selections of the modeling domains are detailed in Chapter 2, Modeling Domain Revisions.

Table 3-32
Average Daily Traffic (ADT) Values Used for Unpaved Roads Located in the Pinal County PM_{10} Nonattainment Area

Modeling Domain	Monitoring Site	Public Dirt					Private Dirt [a]		Trail
		A	B	C	D	E	A	B	
Stagnation	Cowtown	29	90	127	186	N/A	17	6	2
	PCH	N/A	90	127	186	N/A	17	3	2
	Stanfield	29	90	127	186	N/A	15	3	2
High-Wind Day, Low-Wind Hours	Cowtown	29	90	127	186	N/A	17	6	2
	PCH	29	90	127	186	N/A	19	4	2
	Stanfield	29	90	127	186	N/A	17	4	2
	Maricopa	29	90	127	N/A	N/A	13	6	2

a. The private dirt roads were separated in the Traffic Analysis Report (Appendix 1) into three categories—Non-Irrigation, Principal Canal, and Secondary Canal Roads—based on the ADT level and driving speed. The average driving speed for Non-Irrigation and for Principal Canal roads is estimated at 25 mph. Because the ADT levels for each road are provided by the County with maps (Appendix 4), there is no benefit in separating these roads in the emission estimates. Therefore, Private Dirt "A" Roads listed in the table here represent Non-Irrigation, Principal Canal roads; Private Dirt "B" Roads represent Secondary Canal roads.

Table 3-33
Total Length (miles) of Each Type of Unpaved Roads Used for Each Modeling Domain in the Unpaved Road Emission Calculation

Modeling Domain	Monitoring Site	Public Dirt					Private Dirt		Agriculture	Trail
		A	B	C	D	E	A	B		
Low-Wind Modeling Domain	Cowtown	1.6	1.0	8.0	5.7	N/A	38.5	31.1	162.2	9.3
	PCH	N/A	10.1	5.1	2.3	N/A	18.7	3.2	62.8	2.6
	Stanfield	3.0	10.5	2.1	6.7	N/A	27.8	4.7	297.8	10.0
High-Wind Day, Low-Wind Hour Modeling Domain	Cowtown	0.6	2.0	9.4	6.9	N/A	33.6	24.9	148.2	8.9
	PCH	0.0	7.6	10.3	2.5	N/A	19.1	4.4	110.2	11.3
	Stanfield	1.0	10.7	6.7	8.4	N/A	29.2	5.8	290.2	8.1
	Maricopa	0.5	1.1	3.8	N/A	N/A	17.9	4.3	83.2	4.0

Table 3-34 Diurnal Variation for Each Unpaved Road Type in the Pinal County PM_{10} Nonattainment Area									
Hour Number	Public Dirt					Private Dirt		Agriculture	Trail
	A	B	C	D	E	A	B		
Hour 1	0.003	0.004	0.005	0.005	0.007	0.003	0.003	0.000	0.000
Hour 2	0.013	0.007	0.001	0.008	0.007	0.013	0.013	0.000	0.000
Hour 3	0.006	0.003	0.006	0.005	0.003	0.006	0.006	0.000	0.000
Hour 4	0.000	0.005	0.004	0.005	0.005	0.000	0.000	0.000	0.000
Hour 5	0.008	0.013	0.011	0.007	0.012	0.008	0.008	0.000	0.000
Hour 6	0.026	0.020	0.029	0.016	0.032	0.026	0.026	0.000	0.000
Hour 7	0.053	0.043	0.047	0.049	0.042	0.053	0.053	0.083	0.083
Hour 8	0.033	0.063	0.074	0.067	0.067	0.033	0.033	0.083	0.083
Hour 9	0.044	0.069	0.063	0.057	0.063	0.044	0.044	0.083	0.083
Hour 10	0.083	0.068	0.081	0.058	0.057	0.083	0.083	0.083	0.083
Hour 11	0.055	0.068	0.070	0.052	0.062	0.055	0.055	0.083	0.083
Hour 12	0.085	0.073	0.085	0.062	0.070	0.085	0.085	0.083	0.083
Hour 13	0.061	0.065	0.071	0.057	0.086	0.061	0.061	0.083	0.083
Hour 14	0.098	0.069	0.080	0.066	0.079	0.098	0.098	0.083	0.083
Hour 15	0.078	0.074	0.085	0.077	0.079	0.078	0.078	0.083	0.083
Hour 16	0.083	0.074	0.082	0.090	0.080	0.083	0.083	0.083	0.083
Hour 17	0.060	0.085	0.065	0.086	0.066	0.060	0.060	0.083	0.083
Hour 18	0.050	0.068	0.058	0.078	0.056	0.050	0.050	0.083	0.083
Hour 19	0.053	0.039	0.030	0.045	0.044	0.053	0.053	0.000	0.000
Hour 20	0.040	0.024	0.013	0.028	0.022	0.040	0.040	0.000	0.000
Hour 21	0.045	0.027	0.012	0.030	0.022	0.045	0.045	0.000	0.000
Hour 22	0.013	0.019	0.011	0.027	0.020	0.013	0.013	0.000	0.000
Hour 23	0.011	0.011	0.009	0.017	0.011	0.011	0.011	0.000	0.000
Hour 24	0.004	0.010	0.008	0.010	0.007	0.004	0.004	0.000	0.000

3.1.5 Non-Road Vehicle Emissions

With the exception of the locomotive and aircraft categories, all non-road combustion emissions presented in this analysis were calculated using Pinal County specific emissions[52] from EPA's NONROAD model,[53] which were then allocated to the modeling domains based on the methodologies described below. The NONROAD model calculates emissions from a varied assortment of equipment that is generally categorized as follows:

- Recreational vehicles (e.g., all-terrain vehicles and off-road motorcycles);

[52] Input files are included in Appendix 8.
[53] U.S. EPA NONROAD Model, Version 2008a, released July 2009.

- Logging equipment (e.g., chain saws);
- Agricultural equipment (e.g., tractors);
- Commercial equipment (e.g., welders and compressors);
- Construction and mining equipment (e.g., graders and backhoes);
- Industrial equipment (e.g., forklifts and sweepers);
- Residential and commercial lawn and garden equipment (e.g., leaf and snow blowers);
- Recreational and commercial marine vessels (e.g., powerboats and oil tankers);[54]
- Locomotive equipment (e.g., train engines and support equipment); and
- Aircraft (e.g., aircraft and ground support equipment).

It is important to note that with the exception of aircraft, none of the non-road vehicles and equipment listed above were federally regulated until the mid-1990s.

EPA utilizes a "top down" approach, and has based NONROAD default equipment populations on national averages, which are then scaled down to represent smaller geographic areas (i.e., statewide and countywide) on the basis of human population; employment and construction statistics; acres of harvested cropland; and proximity to recreational, industrial, and commercial facilities within each area. In the absence of equipment populations and activity estimates specific to the Pinal County region, the default NONROAD estimates for equipment population, growth rates, and annual and seasonal activity rates (all of which incorporate some degree of regional adjustment) were used for this analysis.

Note that the growth factors (developed for NONROAD in calendar year 2002) that determine future equipment population totals appear to accurately account for the rapid pre-2008 growth rates, but do not reflect the results of the economic downturn that affected the U.S. beginning in the 2007-2008 timeframe. Specifically, NONROAD assumes the following annual growth rates for construction equipment:

- CY 2000-2005: 10.5%
- CY 2006-2010: 9.8%
- CY 2011-2015: 8.9%

These rates agree reasonably well with the 2000-2008 Pinal County human population[55] growth rate of 11.9%, and with the averaged annual growth rate for the number of residential building permits[56] issued in Pinal County over the same time period (i.e., 12%). Because of this overall agreement, and because this relatively small emission source does not justify the time-consuming commensurate adjustments to NONROAD activity rates that would be required if a more precise growth factor were to be

[54] The NONROAD model is not capable of modeling emissions from oil tankers or other comparably large vessels, train engines, or aircraft.
[55] See http://censtats.census.gov/
[56] See http://censtats.census.gov/cgi-bin/bldgprmt/bldgdisp.pl

developed, the default NONROAD growth rates for construction equipment were used for the 2008 baseline inventory.

NONROAD Calculation Methodology – EPA's NONROAD emissions model calculates emissions from each source according to the methodology shown below. Note that this calculation yields emission results in grams per year, which the model then converts to tons.

$$\text{Emissions} = EF \times DF \times P \times LF \times \text{Hours} \times \text{Units}$$

where:

EF = emission factor in g/hp-hr
DF = deterioration factor (dimensionless)
P = power in horsepower
LF = load factor (dimensionless)
Hours = annual operating hours for each unit
Units = total population of engines operating in a given year

Pinal County Inputs – Total emissions estimates for Pinal County were determined for four specific months (January, April, October, and November)[57] during CY 2008[58] using average ambient temperatures specific to each.[59] Calendar year 2008 wintertime fuel parameters for both Diesel and gasoline, shown below in Table 3-35, were obtained from the 2008 North American fuel surveys published by the Alliance of Automobile Manufacturers (AAM), and were verified by staff at the PCAQCD; it is assumed that the fuel mix used in Phoenix during the four months of interest is delivered to all areas of Pinal County as well, because the fuel requirements are the same in both areas during this period.[60] Gasoline and Diesel parameters are based on values reported in the Phoenix area, which are the same as those for Pinal County fuel during the four months of interest.

[57] These are the months during which the design days occur.
[58] Although this baseline analysis is focused on these four specific months, the annual emissions inventory will include CY 2008 total based on a NONROAD model run for CY 2008.
[59] See http://www.weatherforyou.com/
[60] Confirmed via telephone conversion with Scott Dibiase at the PCAQCD.

Table 3-35 NONROAD Modeling Fuel Parameters Pinal County – CY 2008		
Fuel Parameter	NONROAD Default	Pinal County (2008)
Fuel RVP for gas	8.0	8.8
Oxygen Weight (%)	2.44	3.5
Gas Sulfur (%)	0.0339	0.0015
Diesel Sulfur (%)	0.0351	0.0006
CNG/LPG Sulfur (%)	0.003	0.003
Stage II Control (%)	0	0[a]
EtOH Blend Market (%)	75.1	100
EtOH Volume (%)	9.3	10

a. Note that while Stage II controls are required at the highest-volume stations in Pinal County's "Area A," we assumed zero Stage II coverage because none of the modeling domains are located within Area A boundaries.

Equipment Categories – With the exception of equipment in the "Pleasure Craft" and "Railway Maintenance" equipment categories, all NONROAD equipment categories were included in the analysis. These equipment categories were excluded due to the absence of recreational areas and rail yards in the modeling domains that would accommodate their use. Note that the NONROAD model estimates that 12.5% of CY 2008 Pinal County PM emissions are due to the operation of recreational equipment during three of the four months of interest. Shown in Table 3-36 are the equipment types with a Pinal County population greater than zero that NONROAD includes in this category, as well as the activity rates (in units of hours per year) assumed for each.

Table 3-36 Pinal County NONROAD Recreational Equipment		
Equipment Category	Equipment Description	Activity Rate (hrs/yr)
Recreational Equipment	Motorcycles: Off-Road	1600
	All Terrain Vehicles	1608
	Golf Carts	1080
	Specialty Vehicle Carts	65

Nonroad Emission Allocation Methodology – Several different methods were used to allocate the county-wide emission estimates to the low wind modeling domains. A description of each method is presented below.[61]

- *Recreational Equipment* – A population- and geographically based allocation approach was used for this equipment category. County-specific census block data were obtained and were used to distribute the NONROAD emissions for this equipment over each modeling domain. Emissions associated with this category were further allocated within each domain based on the percentage of total miles of off-road equipment trails (used by off-road motorcycles and ATVs) located within each domain, vs. the total miles of trail within Pinal County.

- *Industrial and Commercial Equipment* – A population-based allocation approach was used for this equipment category; NONROAD equipment emissions were distributed over the modeling domain in proportion to its human population, compared to the county-wide population total. Within each domain, the emissions were then further allocated to specific developed rural and urban area parcels, in proportions equivalent to the size of each parcel.

- *Residential and Commercial Lawn and Garden Equipment* – NONROAD emissions associated with this equipment category were allocated to the modeling domains using the methodology described for industrial and commercial equipment, which considered both human population and acreage of developed land within each area.

- *Construction Equipment* – NONROAD emission results were allocated to the modeling domain (none of which include more than one county) based on information obtained from county-specific construction permits, which include total acres involved in the construction activity. Specifically, emissions were allocated according to the total acres of construction activity within each domain compared to the total acres of construction activity in Pinal County.

- *Agricultural Equipment* – Agricultural equipment emissions include combustion emissions from the NONROAD model, combined with fugitive dust emissions that were calculated using harvested and tilled acreage specific to each modeling domain, as described in the Agricultural Activities section. The NONROAD combustion emissions were allocated to each modeling domain based on the total acres of agricultural land in each modeling domain vs. the countywide total of agricultural land. The emissions associated with each domain were then further allocated to individual parcels based on the percentage of harvesting and/or tillage activities associated with each parcel, compared to the total harvesting and/or tillage activities for the domain.

[61] Please see Section 3.1.11 for a description of how emissions were allocated to Indian Reservations.

3.1.6 Trackout Methodology

Surface loadings of material on roadways have many sources, including wind transport, spillage of transported material; trackout from industrial and construction sites with unpaved roads; and trackout from unpaved parking lots, driveways, and staging areas. These actions replenish material that is re-suspended by vehicles traveling across road surfaces. Locations with elevated silt loadings are referred to as "hotspots"—these typically occur where unpaved roads meet paved roads and there is regular vehicle activity to transport loose material onto adjacent paved road surfaces. Control of trackout has been found to be an effective particulate control measure in many communities.

Early on in the development of the emissions inventory, a decision was made by the ADEQ/PCAQCD advisory committee to adopt silt loadings used in calculating paved road fugitive dust in MAG's 2012 Five Percent Plan due to a lack of locally available silt loading data. Listed below are the values used for Pinal County (see the on-road emissions methodology discussion in Section 3.1.3).

- Freeways – 0.02 g/m^2
- High traffic arterials (≥ 10,000 vehicles/weekday) – 0.067 g/m^2
- Low traffic arterials (< 10,000 vehicles/weekday) – 0.23 g/m^2

In the MAG analysis, trackout was associated with silt measurements of 0.3+ g/m^2. Measurements were obtained from samples collected manually on selected roadways and back calculated from emission measurements collected by an instrumented vehicle (i.e., SCAMPER[62]) operated over a network of Salt River roads. Measurements incorporated into the MAG 2007 Five Percent Plan[63] included silt values ranging from 0.3-1.34 g/m^2 as representative of trackout. Higher values (up to 11 g/m^2) were reported in the Salt River TSD.[64]

Lacking any recent measurements of silt loadings on paved roads in Pinal County, particularly hotspots, but recognizing the potential exists for trackout because of the large number of unpaved roads with high activity levels, a request was made to PCAQCD staff to identify potential hotspot locations where high volume unpaved roads intersect with paved roads. The reasoning was that these locations were likely to have elevated silt levels because of the regular transfer to dry (and wet after rainfall) material to adjacent paved road surfaces. PCAQCD staff responded and identified potential hotspot locations for Cowtown, Pinal County Housing, and Stanfield. Locations for each monitor/domain are presented in Figures 3-7, 3-8 and 3-9.

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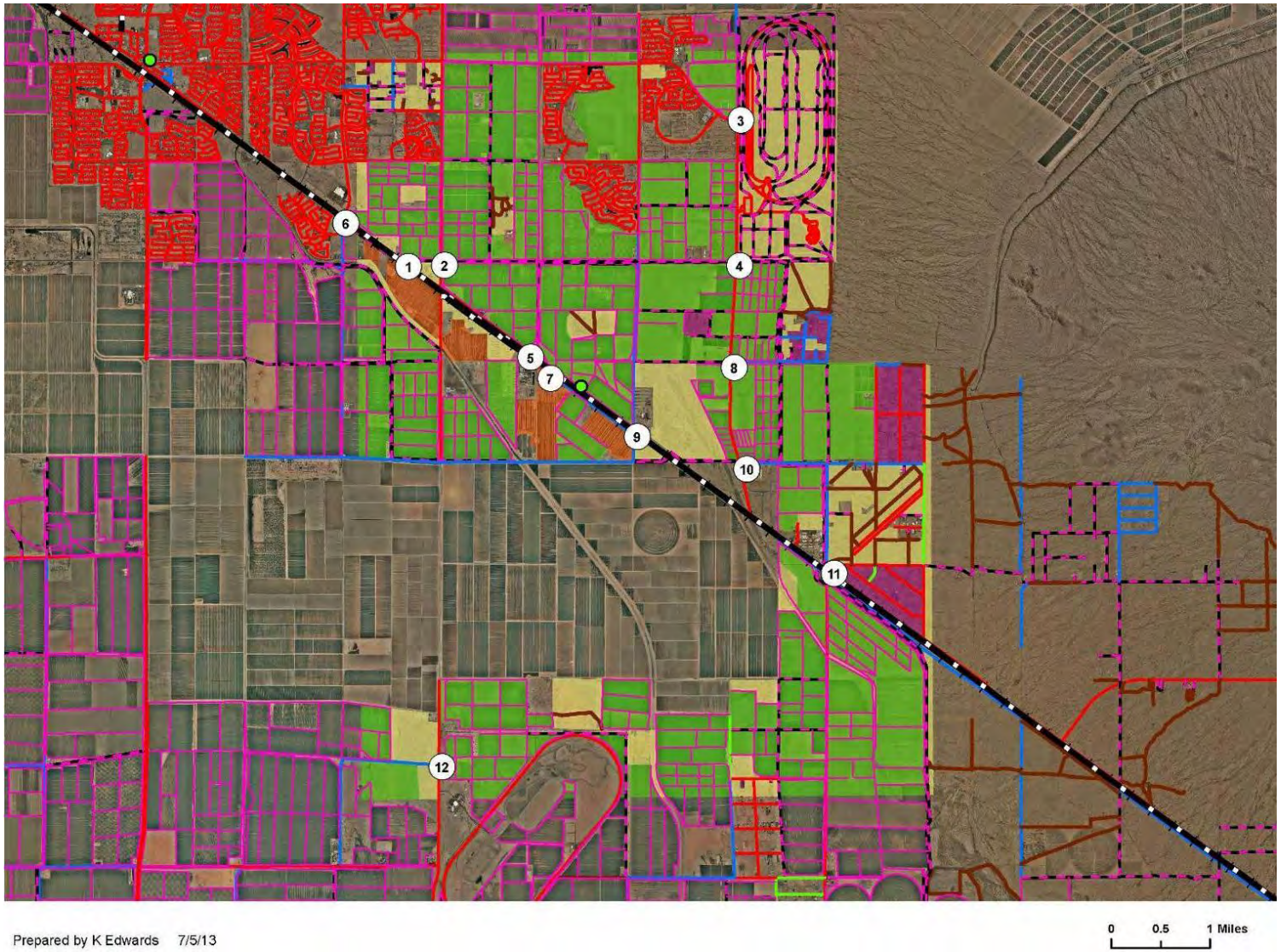
[62] System for Continuous Aerosol Monitoring of Particle Emissions from Roadways (SCAMPER)
[63] "PM-10 Source Attribution and Deposition Study," Report No. 2008-03-01 prepared by Sierra Research for Maricopa Association of Governments, March 2008
[64] "Revised PM10 State Implementation Plan for the Salt River Area, Technical Support Document," ADEQ Air Quality Division, September 2005

Figure 3-7
Cowtown Trackout Hot Spots



Prepared by K Edwards 7/5/13

Figure 3-8
Stanfield Low Wind Hot Spots

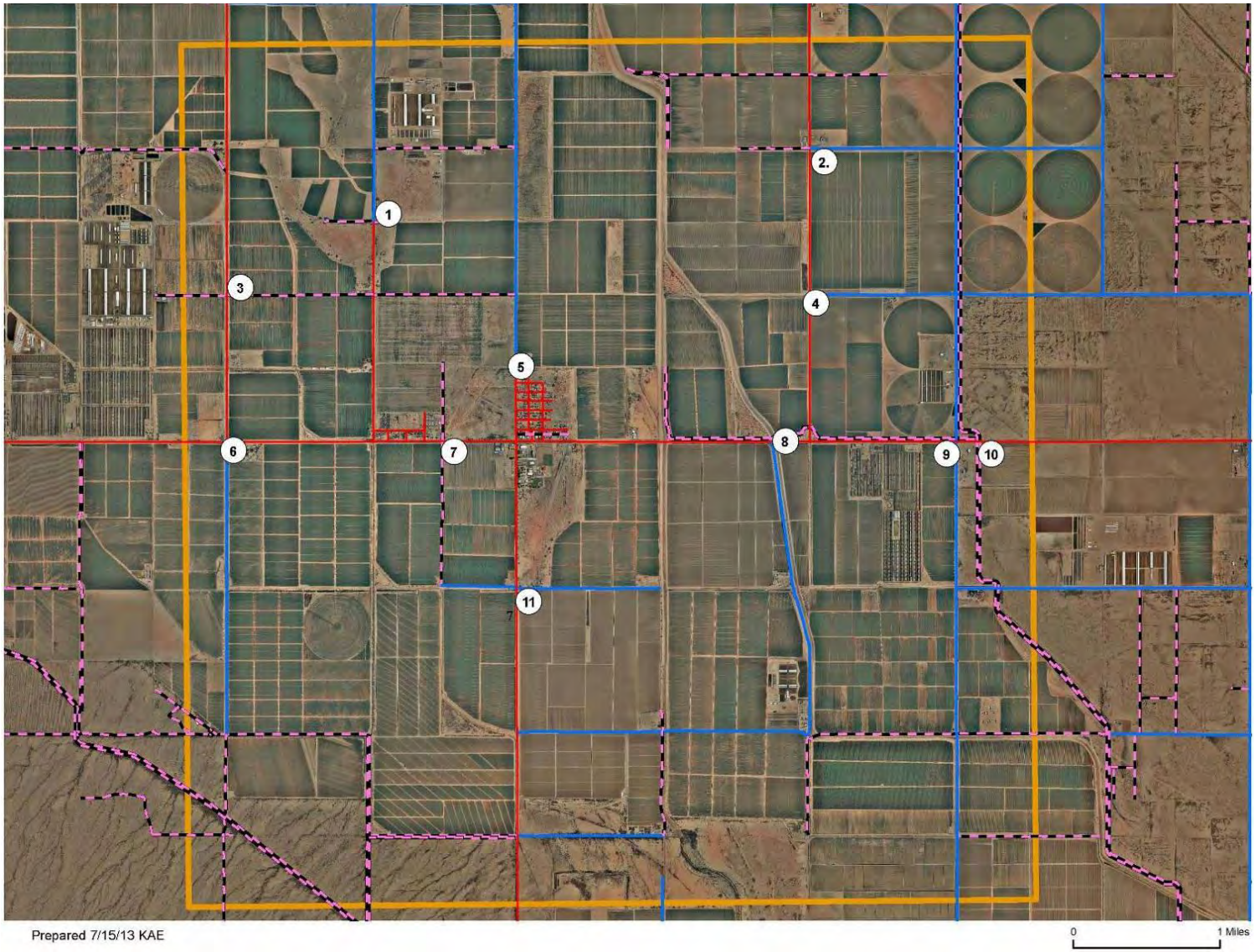
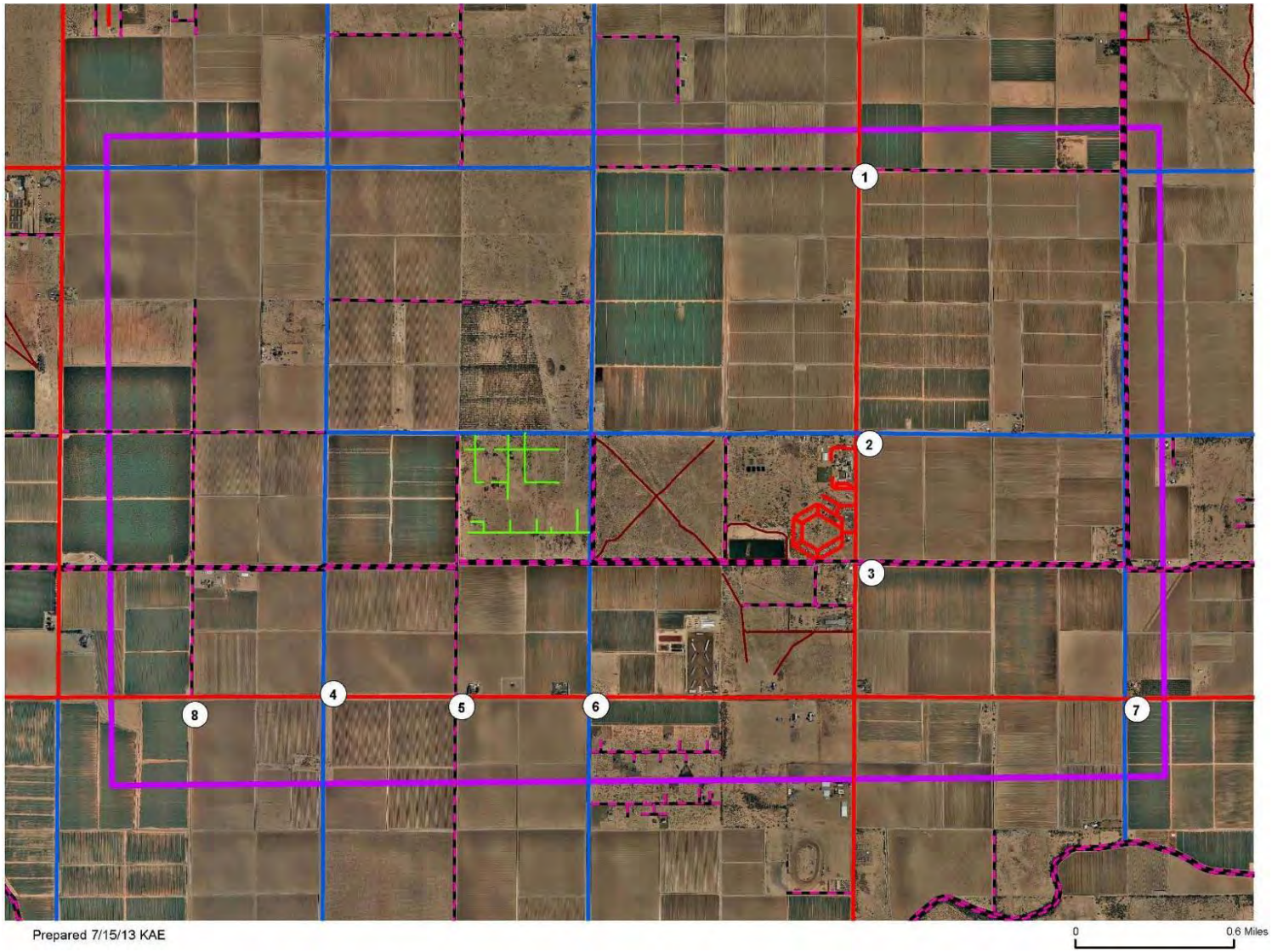


Figure 3-9
PCH Low Wind Hot Spots



The largest potential for impact is at the Cowtown monitor along the adjacent Maricopa-Casa Grande Hwy. Several hotspots are within a mile, with the closest being 0.1 miles. To evaluate the potential for emission impacts from these sites, silt loadings were increased from 0.23 g/m^2 to 1.0 g/m^2 between the end points marked by PCAQCD. The goal was to use a conservative increase to assess the potential impact. Similar silt loadings were used to quantify the impact of trackout at the other locations identified by PCAQCD staff in Figures 3-7, 3-8 and 3-9.

As discussed in Section 3.1.3, the default 0.23 g/m^2 silt loading produces an emission rate of 0.69 g/mi. Increasing the silt loading to 1.0 g/m^2 increases the emission rate to 2.63 g/mi. The impact of this increase depends on the level of travel (i.e., VMT) across roads with trackout, which is a function of road mileage with elevated silt loadings and average daily traffic (ADT). Since the extent of roadway with increased silt loadings is unknown, it was assumed that the increase would extend between endpoints of applicable road segments (i.e., to the next intersection). In the case of the Maricopa-Casa Grande Highway, the entire segment included within the Cowtown monitoring domain was assumed to have trackout, due to the number of hot spots identified by PCAQCD staff.

A review of the local roads surrounding each of the low wind monitoring sites found that no ADT levels were available from ADOT travel demand modeling.[65] For Cowtown, this was not a problem since ADOT estimates were available for the Maricopa-Casa Grande Highway and other relatively higher volume roads (e.g., John Wayne Highway, etc.). Most of the remaining roads are unpaved and, as discussed in Section 3.1.4, PCAQCD provided guidance on ADT for each of those roads.

For the Stanfield and Pinal County Housing modeling domains, a decision was made to combine household trip generation rates from the Institute of Transportation Engineers (ITE)[66] with information on the number of homes located on each of the adjacent roads obtained from Google Earth images.[67] A review of the Google Earth images, shown in Figures 3-10 and 3-11, also determined that each of the surrounding neighborhoods contained unpaved roads and alleys not included in the ADEQ/PCAQCD GIS files. Travel estimates on the paved and unpaved roads were derived by counting the number of homes on each street and multiplying that value by 10 trips per household, per the ITE trip generation guidance, and then using average values for all roads within each neighborhood (i.e., 70 trips/day). Discussions with PCAQCD staff responsible for maintaining each of the monitors provided further guidance on the level of travel to assume for the unpaved roads within each neighborhood. For the Stanfield site, it was assumed the unpaved alleys had 2 trips per day; for the Pinal County Housing site, it was

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[65] Because it is impractical to model travel on all roads, travel demand models breakup modeling domains into traffic analysis zones or TAZs and assess demand for travel on local roads (i.e., low ADT roads) within that zone through a "centroid connector" that aggregates travel for local roads. This approach ensures the model accounts for all travel activity, but it does not provide estimates of travel for individual local roads, which because of their proximity to individual monitors can be very important.

[66] "Informational Report, Trip Generation," by ITE Technical Council Committee 6A6. *http://www.ite.org/membersonly/itejournal/pdf/JJA76A42.pdf*

[67] MAG used this approach to quantify travel for homes located on unpaved roads. *https://www.azmag.gov/Documents/pdf/cms.resource/PM10_2007_Appendices_vol-3.pdf*

Figure 3-10
Local Roads Surrounding Stanfield Monitoring Site

Figure 3-11
Local Roads Surrounding Pinal County Housing Monitoring Site

also assumed that unpaved roads had 2 trips per day. The silt levels used for unpaved roads were based on guidance provided in Section 3.1.4. The emissions produced for each road were distributed diurnally based on the profiles employed for paved roads (Section 3.1.3) and unpaved roads (Section 3.1.4).

The overall increase in paved road emissions within each modeling domain is relatively large (ranging from 50.8-203.6%); the increase in unpaved road emissions is relatively small (ranging from 0.17-0.24% for unpaved roads). Those impacts, however, will increase because of their proximity to the monitors; they will be quantified in subsequent air quality modeling analysis.

3.1.7 Railroad Emission Methodology

PM_{10} emission rates for railroad operations within the Cowtown low wind attainment demonstration modeling domain were derived from EPA emissions studies and industry financial reports. This Cowtown domain is the only one evaluated in this plan that hosts an active rail line and locomotive emissions. A Union Pacific Railroad (UPRR) main line runs parallel and to the south of the West Maricopa-Casa Grande Highway (Arizona Route 238), adjacent to the feedlots on Cowtown Road and within 300 feet of the Cowtown monitoring station. The frequency of trains passing the monitor on an annual average day in 2008 has been difficult to quantify accurately as this information cannot be readily obtained from the carrier. Information provided by ADOT on a proposed project to construct a grade-separated crossing of this main line by Arizona Route 347 within the Maricopa city limits reports train frequencies in 2012 to be 40 to 60 per day.[68]

PM_{10} Emission Factor – EPA most recently summarized emissions factors for locomotives in a 2009 study.[69] The PM_{10} emission factor averaged over the line haul locomotive fleet in the United States is reported as 5.1 grams emitted per gallon of Diesel fuel consumed. This factor can be converted to activity units of engine brake-horsepower hours by dividing it by 20.8 bhp-hr/gallon of fuel consumed, producing a PM_{10} emission factor of 0.245 g/bhp-hr. No information could be found on the average speed of trains traversing the main line section between Maricopa and Casa Grande during October 2008. UPRR reported to the American Association of Railroads, however, that the average speed traveled by trains in its system in October 2008 was 24.0 mph.[70] A typical line haul locomotive is rated at 4400 bhp and operates at a fleetwide load factor of 27.5% on level ground at 24.0 mph.[71] Applying these factors to the emission factor above produces a PM_{10} emission rate of 296.5 g/hr-locomotive. Line haul trains typically operate with three locomotives, resulting in train emissions of 889.4 g/hr-train. At an

[68] State Route 347 at Union Pacific Railroad, Agency and Public Scoping Summary, ADOT, November 2012, http://www.azdot.gov/highways/Projects/SR347_Union_Pacific_RR/PDF/Agency-Public-Scoping-Summary-Report.pdf, accessed on July 15, 2013.
[69] Emission Factors for Locomotives, EPA-420-F-09-025, U.S. Environmental Protection, April 2009
[70] Performance Measures 2008, Union Pacific Railroad, AAR, http://www.up.com/investors/attachments/reports/dwell/2008.pdf, accessed on July 15, 2013
[71] "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder," EPA-420-R-08-001, U.S. Environmental Protection Agency, March 2008.

average speed of 24.0 mph, the PM_{10} emissions from each train passing the Cowtown monitor is 37.06 g/mi.

PM_{10} Emission Rate – The line haul trains are assumed to have passed the Cowtown monitor in 2008 at a maximum rate of 60 per day, based on the ADOT Maricopa grade-crossing project information. At this frequency, the PM_{10} emissions from each mile of track would be 2,233.4 g/mi-day, or 4.90 lb/mi-day. This emission rate was used in the Cowtown low wind design day attainment demonstration modeling analysis to represent PM_{10} emissions from locomotives passing near the monitor.

3.1.8 Construction

The location of construction activity and related fugitive dust emissions shifts from year to year. The best source of information for tracking activity within a specific domain and time period is dust control permits. PCAQCD staff[72] reviewed permits issued in late 2007 (4th quarter) and selected those that were most likely to continue into 2008; these were then combined with permits issued in 2008 to create a shape file of polygons identifying the location of each of the issued permits. A total of 2,874 sites were identified in the PM_{10} nonattainment area. The following information was provided for each site:

- Permit type;
- Site location coordinates; and
- Acreage.

Three types of permits were found in the file provided:

- 5 – Construction;
- 7 – Commercial Construction; and
- 8 – Site Development.

Discussions with PCAQCD staff confirmed that type 5 represented residential construction and type 7 represented commercial construction (as listed). Type 8 was assumed to represent commercial construction and accounted for 2% of the issued permits. Type 5 residential projects were assumed to represent a single home if the acreage was ≤ 5 acres; larger plots of land were assumed to represent multi-home subdivisions.

Since the duration of construction activity varies by project type, information on the starting date for each project is needed to assess whether it was active on specific design days. To address this limitation, random starting dates from 10/1/2007 through

[72] Email from Kate Edwards, Pinal County to Bob Dulla, Sierra Research, 2008 Construction Dust Permits, November 28, 2012.

12/31/2008 were assumed for each single home (i.e., type 5 with ≤ 5 acres) and for commercial development. The duration of single-family home house construction were estimated to be six months, according to EPA's Emission Inventory Improvement Program (EIIP) guidance.[73] The duration of nonresidential construction were estimated to be 11 months according to the WRAP Fugitive Dust Handbook.[74] The estimates of project duration were used to count backwards from the design date to determine if a permitted site could be active on the design day. Thus, for example, any commercial project started more than 11 months prior to the day to be modeled was excluded from the inventory of sources that impacted that date. No construction activity was assumed to occur on weekends. For residential projects larger than 5 acres, with more than one home under development, it was assumed that construction would occur at that site throughout the entire year.

The methodology used by Maricopa County to estimate the 2008 PEI[75] was used to estimate emissions for each project determined to be active on the design day. Emissions for each project were calculated by multiplying the number of acres times an emission factor that varies by project type (in units of tons/acre-month as shown in Table 3-37). The tons/month were converted to lbs/day by dividing its emission by the number of days per month (22 days per month) of construction duration assuming number of weeks per month for a construction schedule that is assumed to run 5 days per week. The daily emissions in lbs/day were converted to hourly emissions (lbs/hour) by dividing the emissions by the number of hours of operation per day (10 hours/day, from 7 am to 5 pm, were assumed as number of hours of operation per day for each source).

Table 3-37
Average Construction Project Duration and Emission Factor by Project Type

Project Type	Average Duration (Months)	Emission Factor (Tons PM_{10}/Acre-Month)
Residential Single Family	6	0.032
Commercial	11	0.19

Thus, for a 5-acre residential project, monthly emissions are calculated to be 0.16 tons of PM_{10} (0.032 x 5) or 320 lbs of PM_{10} (2000 x 0.16). The 320 lbs are spread across 22 days and amount to 14.5 lbs/day. Uniform hourly values of 1.45 lbs/hour are assumed to be emitted between 7 am and 5 pm on a design day on which construction occurs for this permit.

[73] See http://www.epa.gov/ttnchie1/eiip/techreport/volume09/residn3.pdf
[74] See http://www.wrapair.org/forums/dejf/fdh/content/Ch3-Construction_and_Demolition_Rev06.pdf
[75] 2008 PM10 Periodic Emissions Inventory for the Maricopa County, Arizona, Nonattainment Area, Maricopa County Air Quality Department

Table 3-38 summarizes the number of construction permits located within each modeling domain on both low wind days and high wind days with low wind hours. As can be seen, the Maricopa domain was estimated to have the highest level of construction activity.

Table 3-38
Active Construction Permits for Pinal County
PM_{10} Modeling Domains in 2008

Modeling Domain		# of Permits
Pinal County Housing	Low Wind Day	1
	Low-Wind Hours on High-Wind Design Days	0
Cowtown	Low Wind Day	111
	Low-Wind Hours on High-Wind Design Days	183
Stanfield	Low Wind Day	1
	Low-Wind Hours on High-Wind Design Days	3
Maricopa	Low-Wind Hours on High-Wind Design Days	525

In 2008, PCAQCD staff conducted a total of 416 dust permit inspections—374 were found to be in compliance, suggesting a compliance rate of 90%. Permitted sites are required to comply with construction dust rules[76] that address site preparation, bulk material handling, and carryout activity and emissions. While no local estimate of control efficiency is available, a review of the WRAP handbook[77] shows that applying water at various intervals results in a 61% PM_{10} control efficiency. When combined with the compliance rate of 90%, this produces an estimate of overall control effectiveness of 54%.

3.1.9 Permitted Source Emission Methodology

PM_{10} emissions rates for permitted industrial facilities were derived from the Pinal County Air Quality Control District (PCAQCD) permit files. PCAQCD permits provide estimates of PM_{10} emissions for stationary sources only—PM_{10} emissions from area sources such as unpaved road travel, livestock movement, and windblown dust were estimated separately and these separate methodologies are discussed elsewhere.

[76] Article 3, Construction Site Fugitive Dust, *http://pinalcountyaz.gov/Departments/AirQuality/Documents/Dust/Article%203%20Construction%20Dust.pdf*

[77] Table 3-7. Control Efficiencies for Control Measures for Construction/Demolition, Chapter 3 Construction and Demolition, *http://www.wrapair.org/forums/dejf/fdh/content/Ch3-Construction_and_Demolition_Rev06.pdf*

Cowtown Monitoring Station – For the Cowtown attainment demonstration modeling, several industrial facilities with permitted sources were found to be operating in the Cowtown low wind modeling domain in 2008. Hourly emission data for stationary source processes and stacks were extracted from the current permits provided by PCAQCD for the following facilities:

- Arizona Grain, Inc./Eagle Milling Company, Inc. – Maricopa;
- Pinal Feeding Company – Maricopa;
- Pinal Energy, LLC – Maricopa;
- Reliant Processing, Ltd. – Maricopa; and
- The Scotts Company – Maricopa.

Initial review of these data and the process descriptions indicated that PM_{10} emissions from the Pinal Energy and Reliant Processing facilities were less than significant in comparison to those of the other permitted facilities and the area sources included in the low wind design day modeling analysis. As a result, no further analysis of the PM_{10} emissions from these two facilities was conducted.

Review of the Arizona Grain/Eagle Milling permit indicated that two stationary sources at this facility emitted the majority of PM_{10}: the railcar unloading shed, and the airsweep systems that exhausted suspended PM_{10} from the railcar and truck unloading sheds. PM_{10} emissions from minor sources at this facility that are not included in the modeling analysis are subsumed by the use of over-estimated emissions rates from the railcar unloading shed and the airsweep systems. These sources were assumed on a worst-case basis to operate continuously on the low wind design day because unloading a dedicated supply train requires more than 24 hours to complete.

The Pinal Feeding permit listed a number of material transfer points and emissions sources within the facility area dedicated to grain processing and storage. To expedite modeling of these emissions, the permitted emissions rates of all of these stationary sources were combined and assumed to be vented from a volume source that enclosed all of the source release points. Emissions were assumed to occur for up to 4 hours per day between 6:00 am and 4:00 pm based on information provided by representatives of the company. In a sensitivity modeling run, emissions were switched on during the hours ending at 11:00 am, 12:00 pm, 2:00 pm, and 3:00 pm, when measured winds blew from this facility to the monitor on the low wind design day of October 29, 2008.

The Scotts Company operates a bark and soil processing facility approximately 1.3 miles west of the monitoring station. The permit requires operation of a water spray system to control emissions from conveyors, crushers, vibrating screens, stockpiles, and shakers. Based on the allowed processing rates in the permit and emissions factors for these types of equipment that process low density and friable materials like bark and soil, the maximum PM_{10} emission rate for the facility—assuming that only one of the three processing lines operates at one time—was calculated to be significantly higher than that estimated in the permit. The modeling of emissions from this facility used the calculated worst-case PM_{10} emission rate (144 lb/hr). In the absence of operating hour information

in the permit, the processing line responsible for producing this high emission rate was assumed to operate for only two hours per day based on the maximum processing capacity of this line and the annual production rate of this product as specified in the permit. In a sensitivity modeling run, worst-case impacts at the Cowtown monitor were assessed when this processing line was operating and the wind direction during the hour ending at 12:00 pm was pointed directly toward the monitor from the facility. The reported PM_{10} impact was very low, probably because of the separation distance between this facility and the monitor. On the basis of this information, the higher emission rate was used in the attainment demonstration modeling and the processing line was assumed to operate during the two hours on the low wind design day that winds blew generally from the facility to the monitor.

Stanfield Monitoring Station – Three facilities are located within the low wind modeling domain of the Stanfield monitoring station:

- Potters Field;
- Carranza Farm Airstrip; and
- Pinal Gin.

Since permits for these facilities were not available, data from the 2008 National Emission Inventory[78] (NEI) were reviewed. Potters Field and Carranza Farm Airstrip are coded as "Airports" in the NEI, with annual PM_{10} emissions of less than 0.02 tons per year each. Pinal Gin is coded as a cotton gin in the NEI, with annual PM_{10} emissions of less than 0.02 tons per year. In the absence of information on any industrial facility operating in 2008 with PM_{10} emissions greater than 10 tons per year, no stationary source process or stack emissions were included as point sources in the low wind design day attainment modeling analysis for this site.

Pinal County Housing Monitoring Station – One facility that is located within the low wind modeling domain for Pinal County Housing (PCH): the Eleven Mile Corner Farmers Gin. This facility was permitted by PCAQCD for annual PM_{10} emissions of 33 tons per year in 2008. The facility operates two cotton cleaning lines—a long staple gin and a short staple gin—that are assumed to operate 24 hours per day during the cotton harvesting season. PM_{10} emissions from each line are ducted to a bank of cyclones where fibers and larger particles in the exhaust stream are captured and the PM_{10} fraction is emitted to the air. The PCAQCD permit for the two gins allows hourly PM_{10} emissions of 33 lb/hr, and this emission rate was used in the PCH low wind design day attainment demonstration modeling analysis. Combined PM_{10} emissions from the two banks of cyclones were modeled as a single volume source that encompassed the gin building and the banks of cyclones on each side.

[78] 2008 National Emissions Inventory Data, U.S. Environmental Protection Agency, *http://www.epa.gov/ttn/chief/net/2008inventory.html*, accessed on July 13, 2013

3.1.10 Dairy Emission Methodology

Although dairies are scattered throughout the PM_{10} nonattainment area, only two—Rio Bravo Dairy near Stanfield and Sidewinder Dairy near Pinal County Housing—are located within low wind modeling domains. PM_{10} emissions factors for dairy operations were derived from the Agricultural Best Management Practices for Livestock Operations guide published by the Governor's Agricultural BMP Committee.[79] Because of the substantial separation distances between the dairies and the PM_{10} monitoring stations, PM_{10} emissions factors for the following four different area source operations at dairies were combined into a single factor for use in computing average daily emissions from each facility:

- Unpaved access connections and equipment areas;
- Unpaved roads or feed lanes;
- Animal feeding, waste hauling and transporting, and
- Arenas, corrals and pens.

The combined factor of 5.21 lb./head-year was converted to 6.48 gm/head-day and multiplied by the reported livestock population at each facility in 2008 to produce a facility-wide daily emission rate. In the absence of specific activity data for dairies, emissions from unpaved road travel, feed lane travel, feed transfer, and animal corrals were assumed to be uniform between 6:00 am and 9:00 pm. For modeling purposes, PM_{10} emissions were assumed to be released from each facility at a height of 2.3 meters uniformly across a single area source covering all corrals and active unpaved roads.

3.1.11 Tribal Sources

Both the AK-Chin and Gila River Indian communities (GRIC) fall within portions of three modeling domains: the Low Wind Design Day at Cowtown, low wind hours of High Wind Design Day at Cowtown, and low wind hours of High Wind Design Day at Maricopa.

Contacts were established with the air quality staff at each community to request information on activities for key sources located within the design day modeling domains. Formal requests were submitted for the following:

- Unpaved Roads: Name, ADT, and speed for road links or categories of roads located within each of the modeling domains;

- Agriculture: GIS information on the size and location of each parcel, crops under cultivation in 2008, identification of fallow land, and insight into changes in crop distribution in subsequent years; and

[79] Agricultural Best Management Practices for Livestock Operations, As Adopted by the Governor's Agricultural Best Management Practices Committee on July 27, 2010.

- Point Sources: the coordinates, stack height and stack temperature, and emissions (and changes over time) for each source.

GRIC provided a copy of a 2007 emission inventory for the entire community[80] and traffic count data collected for 188 community roads in 2004.[81] Google Earth images[82] for Ak-Chin lands and unpaved roads and a map documenting the level of PM_{10} control on individual roads[83] were also received. While the GRIC emissions inventory provided source-specific emission estimates, it did not provide the detail needed to characterize activity and emissions on their lands within the design day modeling domains. A review of the traffic count data found that only three paved and three unpaved roads links fell within the design day modeling domains. For the unpaved roads, the counts were contrasted with estimates for similar road categories provided by PCAQCD. For paved roads, the counts were contrasted with travel model estimates provided by ADOT and discrepancies were noted. Given the limited sample size, a decision was made to use the ADOT and PCAQCD estimates, to provide consistency in the paved and unpaved road emission calculations. The Google Earth images and related road map for the Ak-Chin lands contained no information on vehicle activity or emissions. Therefore, other methods were needed to estimate emissions on their lands within the design day modeling domains.

Presented below is a description of the methods used to quantify emissions within each of the tribal domains.

- Unpaved Roads – Based on Google Earth, the coordinates of the end points of AK-Chin and GRIC unpaved roads within the Cowtown and Maricopa modeling domains were identified and input to ARCGIS Shape files. These shape files were sent back to the tribes for confirmation. A similar approach was used to identify end points for Ag roads (a total of 59 miles within the Cowtown modeling domains were identified). There is no information, however, on the ADT levels, the width of roads, the vehicle speeds on the roads, and traffic diurnal variation for these roads. To estimate the emissions for non-AG roads, the average ADT levels, the average width, the average vehicle speeds and the average diurnal variations of non-Ag unpaved County roads that fall into the rest of corresponding domains were used to represent these roads. For unpaved AG roads, the values for County unpaved Ag roads within the corresponding domains were used. Estimates of travel activity on paved roads within the tribal domains were provided by ADOT. Emissions on these roads were calculated using the paved road methodology.

[80] 2007 Emissions Inventory Update for the Gila River Indian Community, submitted to EPA, Region 10, January 2009
[81] Memorandum from Sandra Shade to Patricia Mariella, re Traffic Counts, April 7, 2004
[82] Email from Bryan Paris to Steve Calderon and Bob Dulla, *Ak Chin EI data for Pinal County SIP*, 5/10/13
[83] Email from Bryan Paris to Bob Dulla and Steve Calderon, *Maps*, 5/15/2013

- Agriculture – As discussed in Chapter 3, most of the low wind modeling domains fell within 6 km radius of the CRPC data provided for each monitor. The land use information provided by ADEQ/PCAQCD identified land parcels within the tribal domains and provided general information on uses (e.g., agriculture, etc.), but did not provide information on crop type. Since CRPC data provided no information on crop type within the tribal domains, an average was computed for the crops included within the CRCP domains and the fractional share of each crop was applied to each land parcel in the tribal domain. Emissions on those parcels were calculated using the appropriate low wind methodology described in this section for agriculture.

- Nonroad – NONROAD estimates of Pinal County emissions were allocated to the tribal lands following methods described in the EPA NONROAD methodology in Section 3.1.5.

- Point Sources – A review of point source data determined that no GRIC sources were located within either Maricopa or Cowtown modeling domains. Ak-Chin lands were determined not to have sources within the Cowtown domains.

3.2 High Wind Fugitive Dust Methodology

Background – Two different methods for quantifying high wind emission factors were proposed in the Inventory Preparation Plan (IPP).

- The ADEQ method back-calculates emission factors for upwind areas by regression analysis of wind speed, PM_{10} concentration, and the pattern of land use along the back-trajectory path. The method uses a least-squares approach to compute emission rates by wind speed range and land use type within a "footprint," or bounded area, responsible for a high fraction of PM_{10} impacts at the monitoring station. This method is summarized in a report entitled "A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM_{10} Emissions."[84]

- The MAG method, which was employed in quantifying high wind emissions rates for the Maricopa County 2008 Periodic Emission Inventory (PEI) for PM_{10} and MAG's 2012 Five Percent Plan for PM_{10} for the Maricopa County Area, computes emissions as a function of land use, disturbance level, and wind speed; agricultural emissions are calculated using a U.S. Department of Agriculture (USDA) equation for soil erodibility. A copy of this methodology is presented in Appendix 6.

Analysis – AERMOD, an EPA-approved dispersion model of general utility, was used to perform quality control assessments of the ability of each method to replicate emissions

[84] Ryan Templeton, Arizona Department of Environmental Quality, 7/02/2012

rates of area sources responsible for PM_{10} concentrations recorded during high wind hours. Initial efforts focused on the 14 high wind hours at the PCAQCD's Pinal County Housing (PCH) monitoring station on January 1, 2008. Land use information provided by ADEQ and PCAQCD was used to support the calculation of parcel-specific emission estimates for key land use categories (e.g., agriculture, developed rural, developed urban, cleared area, desert shrubland, unpaved roads, etc.).

The ADEQ method calculated emissions factors for each of the land use categories located within the domain determined by the footprint model to be impacting the monitor. In the PCH proof-of-concept test, the modeling domain specified by the footprint model was considerably smaller than the domains proposed in the IPP, which were designed to encompass the one-hour back trajectories of high wind hours on each high wind design day. For each land use category, the footprint model computed PM_{10} emission factors within each of several user-specified wind speed ranges.

The MAG method used portable wind tunnel test data collected on soil surfaces dedicated to specific disturbance activities to compute wind speed-dependent PM_{10} emissions factors for most local land uses. Analysis of the test data, collected by Nickling and Gillies in 1986 in central Arizona,[85] suggested that land use was not a factor in constructing an emission factor equation for windblown PM_{10}, with one exception—PM_{10} emissions rates of agricultural soils did not follow the same trend with respect to wind speed that was common to the emissions rates of soils disturbed by non-agricultural activities. As a result, separate methodologies were used by MAG to estimate windblown PM_{10} emissions rates for agricultural versus non-agricultural lands in the Maricopa County area. The data collected by Nickling and Gillies on all non-agricultural lands were combined and used to generate an emission factor equation using a derivative of wind speed as the dependent variable. For computational ease, the equation was used to compute emissions factors for specific wind speeds designed to represent wind speed ranges spanning 5 mph intervals. These factors were then employed in each hour that the average of wind speeds measured by a set of regional monitors exceeded the threshold velocity for generating windblown PM_{10}.

MAG used a soil erodibility formula developed by the USDA to compute windblown PM_{10} emissions factors on agricultural lands.[86] This formula calculates emissions as a function of soil erodibility, climate, surface roughness, uncovered field width and vegetative cover, but does not use wind speed as a variable; it thus cannot replicate the relationship between PM_{10} concentration and wind speed that is strongly evident in Pinal County monitoring data on high wind days.

The MAG method also configured separate high wind modeling domains around the 1-hour back-trajectories of each high wind hour in the design day. The modeling of PM_{10} impacts from area sources along these back-trajectories revealed that emissions from area

[85] "Evaluation of Aerosol Production Potential of Type Surfaces in Arizona," W.G Nickling and J.A. Gillies, EPA Contract No. 68-02-380, 1986

[86] "Development of Emission Factors for Fugitive Dust Sources," EPA 450/3-74-037, U.S. EPA, Research Triangle Park, NC, June; updated in September 1988 in "Control of Open Fugitive Dust Sources," EPA-450/3-88-008.

sources within a few miles of the monitor dominated the concentrations measured at the monitoring station. This understanding led to the IPP design of high wind modeling domains at the Pinal County attainment demonstration sites that were initially restricted to rectangular domains one mile long along the back-trajectory and two miles wide centered over the trajectory. The coordinates and land use designations of parcels within each domain were provided by ADEQ and PCAQCD. Parcel-specific information on crops under cultivation within a 6 km radius of each monitoring station was obtained from the Arizona Cotton Research and Protection Council (CRPC). The IPP proposed that emissions would be computed using the MAG non-agricultural emission factors and the USDA equation specific to the crops under cultivation within the restricted domain.

The ADEQ-derived emission factors were applied to the same domain and land use data employed in the development of the MAG-based high wind emissions inventory, with the thought that contrasting AERMOD-estimated hourly concentrations using the same meteorology and modeling domain with the different emission factors would be revealing.

A review of the initial results found several differences between the two methods, as outlined below.

- The ADEQ method did a better job of tracking changing hourly values, whereas the MAG method produced a more uniform result that was insensitive to speed or time of day.

- Both methods were found wanting in terms of their representation of agricultural emissions. The ADEQ method aggregated all agricultural land uses into a single factor, so there was no crop distinction. On the other hand, the USDA equation was found to produce windblown emission estimates that were orders of magnitude lower than the non-agricultural windblown emission estimates and therefore had little or no impact on the resulting hourly concentrations.

- The MAG method was found to be largely insensitive to wind speed because of the 5 mph speed bins, applied to the non-agricultural lands. A review of the wind speeds used shows that all of the high winds (at 10 meters) were addressed by two speed bins: 15-20 mph and 20-25 mph.

- The upwind area, defined by the ADEQ methodology, as impacting the PCH monitor was limited to a trajectory of roughly 400 yards, which was barely sufficient to reach nearby agricultural lands. This suggests little or no impact from sources outside of that very limited domain.

- The USDA equation has no term for wind speed. This means that modifications to other variables to more accurately represent Pinal County will show no diurnal variation, just more of a contribution to the total emission inventory.

After considering the advantages and disadvantages of both methods, the analysis evolved to consider several revisions/improvements in the MAG methodology to estimate high wind fugitive dust emissions in Pinal County, as described below.

- The MAG methodology for non-agricultural lands (disturbed and undisturbed) was revised to evaluate the effect of emission factors in 1 mph increments (using an interpolation scheme), the development of these emission factors is described in Appendix 5.

- Given that little difference was observed between agricultural lands and non-agricultural lands in the Nickling and Gillies report, MAG's method was revised to apply to agricultural lands with one modification—the vegetative cover factor was added to adjust emissions to account for crop-specific coverage effects (e.g., the factor for alfalfa is 0, whereas the factor for cotton is 0.7).

- The initial analysis of MAG's method applied uniform disturbance fractions to land use parcels in the upwind domain. Many of MAG's values, however, are not applicable to Pinal County because they were based on the results of field inspections. This led to a joint effort between PCAQCD and ADEQ to collect local observations and conduct a literature review of land disturbance levels used in other PM_{10} SIPS of similar climatology (e.g., Clark County, Imperial County, etc.). The literature review determined that in most cases, Pinal County has differentiated land use types to a greater resolution than the other SIPs analyzed. Thus, some judgment was applied, based on the available information, to prepare the summary of the resulting disturbance and stable land estimates presented in Table 3-39 for non-agricultural lands.

- ADEQ staff developed emission factor (EF) adjustment curves through an analysis of monitor-specific concentrations recorded during high wind hours (exceeding 12 mph) with steady wind direction. The EF adjustment curves account for Pinal County windblown emissions during sustained high winds and are assumed to account for saltation initialization periods, diminished particle supply, etc. Calculation of the EF adjustment curves is detailed in Appendix 7.

- A review of the current Guide to Agricultural PM_{10} Best Management Practices (BMPs) and the related 2001 Technical Support Document found that BMP emission reduction estimates for wind erosion control measures were based on the USDA equation. The TSD, however, recognized that wind tunnel test data were used to estimate windblown emission factors in the micro-inventory study conducted at West Chandler and Gilbert, and that it was not appropriate to compare the results of the two different methods because each was appropriate for its specific spatial resolution and intended purpose.

- The modeling domains impacting the high wind design day monitors are substantially larger than those defined by the ADEQ methodology; they are also larger than the initial 1 mile x 2 mile domain noted above. To address this limitation, the domains were extended farther along the high wind back

trajectories. A description of the method derived to select the upwind domains is presented in Section 2.1.

Table 3-39
Disturbance Level for Non-Agricultural Land Used in Pinal High Wind Annual Emission Inventory

Land Use ID	Description	Disturbance	Stable
A	Developed Urban Lands[87]	2.5%	0.0%
B	Developed Rural Lands (low density residential)	5.0%	95.0%
C	Paved Roads[88]	0.0%	0.0%
D	Unpaved Roads (Private Dirt, Ag Road, and Trail)	100.0%	0.0%
D	Unpaved Roads (Public Dirt)	75.00%	25.00%
E	Cleared Areas	15.00%	85.00%
F	Residential Construction*	46.0%	54.0%
G	CAFOs and Dairies	50.0%	50.0%
H	Desert Shrubland	5.0%	95.0%
J	Commercial Construction*	46.0%	54.0%
K	Other	10.00%	90.00%
L	Site Development	46.0%	54.0%

* See discussion below on how these values were estimated.

To address the issues outlined above, separate methods were developed to calculate windblown emissions for agricultural lands, non-agricultural lands, and construction sites. A discussion of each follows.

Agricultural Windblown Emissions – Given the extent of agricultural land located within each modeling domain and the difficulty of developing observational estimates of disturbance levels by crop type, ADEQ determined that estimates of disturbance should be interpreted from an existing data set. The crop calendar was selected to provide insight on crop-specific disturbance levels. Presented below is a summary of the approach used to extract that insight.

A review of the information contained in the shapefiles provided by ADEQ/PCAQCD and by CRPC identified several different categories of agricultural land use within each modeling domain, including the following:

[87] In contrast to other communities, this land use category did not include urban fringe areas, but only lands within the urban core. Given the extensive surface coverage observed on urban core lands in Pinal County, the disturbance levels are limited and assumed to be 2.5%. The stable portion is assumed to have no emissions.

[88] Maintenance practices within the County ensure that paved roads have 0% disturbance and that there is no distinction between disturbed and stable.

- CRPC crop lands – crop types CRPC identified for parcels under cultivation in 2008;

- Fallow lands – parcels CRPC identified as being fallow in 2008;

- Other Agricultural Lands – parcels not addressed by CRPC, but identified by ADEQ/PCAQCD as agricultural land.

The "Other" agricultural lands category includes (1) parcels identified by AZDEQ/PCAQCD, through aerial photography and land ownership records, as agricultural but for which CRPC did not provide crop data for (i.e., lands within the overlap of the two shapefiles), and (2) parcels ADEQ/PCAQCD identified as agricultural, through land ownership records, located outside of the 6 km radial boundary supplied by CRPC.

The distribution of crop lands, including fallow land and Other ag lands, was calculated for each monitor/modeling domain from the CRPC and ADEQ/PCAQCD shapefiles. A summary of those values is presented in Table 3-40. The results show many crops were not identified by CRPC within the modeling domains as being actively cultivated in 2008; these are listed as N/A. The crop categories actively under cultivation within the domains include cotton, alfalfa, corn, and, to a lesser extent, grain and orchards. Fallow land is shown to represent a small fraction of land for all domains (less than 10%), while the significance of Other Agricultural Land varies by monitor.

An understanding of the significance of agricultural lands within each modeling domain can be gained from a review of the agricultural land share presented at the bottom of Table 3-40. It shows agriculture has a dominant share of the modeling domains at PCH and Stanfield, a significant share of the Cowtown domain, and a more modest share of the Maricopa domain.

As discussed earlier, emissions are calculated separately for disturbed and stable land. The approach used to determine if CRPC crop lands were disturbed or stable was to review the crop calendar provided by PCAQCD (presented in Appendix 3) and ask farmers for insight on design day activities. The ten-day period in which the design day occurred (highlighted in Appendix 3) was reviewed to determine if any activity (i.e., harvesting, planting, etc.) occurred for each crop. The results, summarized in Table 3-41, show that design days for PCH, Stanfield, and Maricopa all occurred in periods when cotton was being harvested (scored with a "D" for disturbed), while the design day for Cowtown occurred in the spring, which had a mixture of activities depending on the crop type. Crops being planted were also scored "D," while those between harvest and planting were scored with an "S" for stable, as no activity was assumed. As previously noted, insight gained from discussions with farmers about design day activities was used to modify crop calendar listings. For example, corn is shown to be actively harvested in October in the crop calendar, but farmers indicated that corn harvesting occurs earlier in the June/July/August time frame, so the disturbance assumption is listed as "S" instead of "D".

Table 3-40 Distribution of Crop Categories for Agricultural Lands Located in High Wind Modeling Domains (%)				
Crop	PCH	Stanfield	Cowtown	Maricopa
Cotton	30.6	31.7	10.7	1.4
Alfalfa	39.5	30.6	38.1	17.6
Corn	N/A	14.4	N/A	12.8
Grain	19.0	N/A	N/A	N/A
Melons	N/A	N/A	0.3	N/A
Orchard	N/A	N/A	8.0	N/A
Wheat	N/A	N/A	N/A	N/A
Barley	N/A	N/A	N/A	N/A
Sorghum	N/A	N/A	N/A	N/A
Other Vegetables	N/A	N/A	N/A	N/A
Citrus	N/A	N/A	N/A	N/A
Fallow	6.2	0.0	9.0	0.0
Other Agriculture	4.7	23.3	34.0	68.1
Ag land share (%) of the domain	78.8	73.1	46.1	27.0

Note: NA denotes crops not identified within the modeling domains as being actively cultivated in 2008.

Table 3-41 Disturbance Assumptions for Agricultural Lands Identified in Cotton Research and Protection Council Shapefile for High Wind Modeling Domains					
Crop	VC	PCH	Stanfield	Cowtown	Maricopa
Cotton	0.7	D	D	D	D
Alfalfa	0.0	-	-	-	-
Corn	0.44	-	S	-	S
Grain	0.0	-	-	-	-
Melons	0.77	-	-	S	-
Orchard	0.77	-	-	S	-
Wheat	0.0	-	-	-	-
Barley	0.0	-	-	-	-
Sorghum	0.0	-	-	-	-
Other Vegetables	0.77	-	-	-	-
Citrus	0.77	-	-	-	-
Design Date		01/01/08	11/21/08	04/27/08	10/27/08
Previous Rainfall Date*		12/11/07	09/10/08	02/16/08	09/10/08

D = 100% disturbed
S = 100% stable
* Rainfall data based on measurements at the Arizona Meteorological Network (AZMET) Maricopa station, as published at *http://ag.arizona.edu/azmet/az-data.htm*.

The next step was to identify the most recent date preceding the design day on which measurable rainfall (0.01") occurred to determine if soil moisture levels were sufficient to prevent particle entrainment. Three of the sites (Stanfield, Cowtown, and Maricopa) had a period of more than a month between rainfall and the design day. The shortest period was at PCH, which had 20 days between rainfall and design day—sufficient time for the soil to dry and not invalidate decisions about the land disturbance.

In addition to rainfall, a number of other factors can influence windblown dust emissions on agricultural lands, including crop canopy, post-harvest crop residue, etc. Since the influence of these factors is only partially addressed in the original Nickling and Gillies wind tunnel measurements and is also not readily available for Pinal County, the vegetative coverage (VC) factor employed in the USDA soil erodibility formula[89] was used to account for the collective effect of these factors on windblown dust production. The crop-specific values are displayed in Table 3-41. As can be seen, the dense vegetative cover produced by alfalfa eliminates windblown dust throughout the year, whereas cotton coverage reduces windblown emissions by 30%. To simplify the table, no information was extracted from the crop calendar for crops with a VC value of "0"or for crops not being actively cultivated as shown in Table 3-40. The disturbance values for those crops is represented by "-".

The equation used to calculate windblown dust emissions for disturbed agricultural land is shown as Equation 1 below.

$$Esj = F_{EFAdjusment} A \bullet EF_{Disturbed,bin} \bullet V' \qquad (1)$$

where:

Esj = suspended PM_{10} in gram/sec for hour j

$F_{EFAdjustment}$ = the Emission Adjustment factor for diminished particle supply

A = the area of each crop's land parcel, in m^2

$EF_{Disturbed,bin}$ = the windblown dust emission factor developed for disturbed soil for that wind speed bin, gram/m^2-sec for hour j (detailed in Appendix 7)

V' = vegetative cover for crop specific, presented above in Table 3-41

Equation 1 was used to quantify windblown dust emissions for disturbed land at PCH, Stanfield, and Maricopa during the harvesting season. For Cowtown, the vegetative coverage factor was not included in the disturbance calculation, because the crop coverage would be limited during the planting season.

[89] MAG used the soil erodibility formula to quantify high wind emissions from active agricultural lands in the Five Percent Plan.

The equation used to calculate windblown dust emissions from stable agricultural lands is presented below as Equation 2. (The same equation is used to calculate emissions for stable non-agricultural lands.) It assumes 100% stable land ($P_{Stable}=1$).

$$Esj = F_{EFAdjusment} A \bullet EF_{stable,bin} \bullet P_{stable} \quad (2)$$

where:

Esj = suspended PM_{10} in gram/sec for hour j

$F_{EFAdjustment}$ = the Emission Adjustment factor

A = the area of each parcel, in m^2

$EF_{Stable,bin}$ = the windblown dust emission factor developed for stable soil for that wind speed bin, gram/m^2-sec for hour j (detailed in Appendix 7)

P_{Stable} = the percentage of stable soil for agricultural land

For fallow lands and for Other Agricultural Lands, guidance from PCAQCD and ADEQ[90] staff was used to estimate the distribution of stable and disturbed land (90%/10%). Equation 2 was used to quantify windblown dust emissions for the stable portion of fallow and Other Agricultural Lands. Equation 1 without the crop coverage factor was used to quantify emissions from the disturbed portion of both land use categories.

Non-Agricultural Windblown Emissions – Information provided by PCAQCD staff on disturbance for non-agricultural lands, presented in Table 3-39, was used to quantify emissions for disturbed and stable lands. Equation 3 was used for computing windblown dust emissions for the disturbed portion of non-agricultural land:

$$Esj = F_{EFAdjusment} A \bullet EF_{Disturbed,bin} \bullet P_{Disturbed} \quad (3)$$

where:

Esj = suspended PM_{10} in gram/sec for hour j

$F_{EFAdjustment}$ = the Emission Adjustment factor for diminished particle supply

A = the area of each parcel, in m^2

$EF_{Disturbed,\ bin}$ = the windblown dust emission factor developed for disturbed soil for that wind speed bin, gram/m^2-sec for hour j (detailed in Appendix 7)

[90] Email from Ryan Templeton, ADEQ to Bob Dulla, Sierra Research, 10/30/13.

$P_{disturbed}$ = the disturbed level, in percentage for each category of non-agricultural land, specified in Table 3-38

Equation 4, which is essentially the same as Equation 2, was used to quantify emissions for stable non-agricultural lands:

$$Esj = F_{EFAdjusment} A \bullet EF_{stable,bin} \bullet P_{stable} \tag{4}$$

where:

Esj = suspended PM_{10} in gram/sec for hour j

$F_{EFAdjustment}$ = the Emission Adjustment factor

A = the area of each parcel, in m^2

$EF_{Stable,bin}$ = the windblown dust emission factor developed for stable soil for that wind speed bin, gram/m^2-sec for hour j (detailed in Appendix 7)

P_{Stable} = the percentage of stable soil for agricultural land for each different non-agriculture land, detailed in Table 3-39.

Construction – A review of the literature and discussions with industry representatives failed to provide insight into soil disturbance levels on construction sites. Lacking this information, the stagnant construction dust construction calculation assumes 100% of the permitted acreage is disturbed. The uncontrolled emission estimate computed for this acreage is then reduced to account for the combined effect of fugitive dust rule compliance and control measure efficiency. As discussed in Section 3.1.8, construction dust permit inspections found a 90% compliance rate with the rule requirements. Discussions with industry representatives determined that watering is the most common control measure employed in Pinal County and the 61% control efficiency for watering at 3.2-hour intervals at construction sites listed in the WRAP Fugitive Dust Handbook is representative of Pinal County applications. Collectively, these metrics indicate a 54% fugitive dust control effectiveness. Since this benefit should apply to both low and high wind hours, it is used to estimate the fraction of land that is stabilized on construction sites. The remaining 46% of permitted lands are assumed to be disturbed.

Low Wind Hours on High Wind Days – The emission estimates for the low wind hours during high wind days are calculated using the source-specific emission estimates outlined earlier in the low wind section of this chapter. A description of the methods used to select the low wind hour domains on high wind days is presented in Section 2.2.

Activity-Based Emissions – Activity-based emissions are quantified for stagnation conditions and are generally not addressed in inventory development during high wind hours, because of differences in magnitude. A review of the diurnal profiles presented in Section 4, however, found that activity-based estimates in low wind hours exceeded the fugitive-based estimates for many of the high wind hours. Similarly, low wind hour concentrations were found to exceed high wind hour concentrations for one or more hours at all of the violating high wind monitors. Recognizing that activity-based emissions in high wind hours can be significant led to a decision to include them in the inventory. The approach used was to quantify activity-based emissions within the low wind domains for each hour of the high wind days. Because the areal extent of these domains encompassed the high wind domains, activity (or mechanically) driven emissions for sources located within the high wind domains could be extracted for the high wind hours in the modeling analysis.

Table 3-42 summarizes activity-based emissions during low and high wind hours within the low wind domains for each of the high wind design days. It shows that in most cases the high wind hour activity emissions are substantially greater than the low wind hour values. That is because the high wind hours typically occur during the middle of the day when anthropogenic activity is highest. A detailed listing of diurnal estimates for windblown emissions, activity-based emissions, and total emissions by source category is presented in Appendix 10.

Table 3-42
Summary of Activity-Based PM_{10} Emitted Within Low Wind Domains During Low and High Wind Hours on High Wind Days
(Average lbs/day)

Model Domain	Units	Construction	Agriculture	CAFOs	Unpaved Roads				Total[a]
					Ag	Public	Private	Trail	
PCH	Low Wind	-	10.0	-	22.8	24.7	6.0	0.3	78.6
	High Wind	-	33.1	-	68.5	81.8	26.7	1.1	212.3
	Total	-	44.1	-	91.3	106.5	32.7	1.4	290.9
CWT	Low Wind	-	12.3	210.6	41.2	69.9	19.8	0.4	404.2
	High Wind	-	21.2	98.5	82.2	95.8	29.7	0.7	393.5
	Total	-	33.5	309.1	123.4	165.7	49.5	1.1	797.7
MAR	Low Wind	10.7	1.3	47.6	19.9	8.4	10.5	0.1	111.7
	High Wind	96.2	3.9	26.7	59.7	17.3	19.1	0.4	235.0
	Total	106.9	5.2	74.3	79.6	25.7	29.6	0.5	346.7
STF	Low Wind	0.1	6.2	70.6	78.8	62.5	15.1	0.2	234.2
	High Wind	0.4	18.5	41.5	236.3	87.6	21.4	0.8	406.6
	Total	0.5	24.7	112.1	315.1	150.1	36.5	1.0	640.8

a. Total includes values for all source categories not just those displayed in this table.

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4. EMISSION SUMMARY

The methods and activity levels described in Section 3 were applied to the modeling domains and land uses detailed in Section 2 to estimate emissions for each parcel under stagnation/low wind and high wind conditions. A summary of the hourly emission estimates in units of lbs/hour for each source category is presented in Tables 4-1 through 4-3 for Cowtown, Stanfield, and Pinal County Housing stagnation design days and Tables 4-4 through 4-7 for the high wind Pinal County Housing, Cowtown, Maricopa, and Stanfield monitors.

To provide perspective on hourly changes by source, information on hourly wind speed (WSPD) in miles/hour, wind direction (WD) in degrees, and PM_{10} observations (µg/m3) is also provided. To gain insight into source apportionment, average daily emission estimates are presented along with their percentage contribution to the overall level of PM_{10} emitted. Air quality modeling—which combines information on emissions, location, and meteorology—will provide more detail on each source's contribution to concentrations recorded on the selected design days.

To aid review of the high wind day estimates, the high wind hours (WSPD $\geq$ 12 mph) are shaded to distinguish them from low wind hours. Estimates in the high wind tables show that loose particles entrained during high wind hours are substantially greater than those produced by mechanical activities and combustion during low wind hours.

Neighborhood roads, including paved with trackout and unpaved, are presented separately for the Stanfield and Pinal County Housing domains to provide insight into the magnitude of their emissions. Trackout for all other paved roads is included with the paved road estimates to simplify the summaries. Non-road emissions are not displayed because they account for very small portions of the stagnation emissions: 0.6% for Cowtown, 0.01% for Stanfield, and 0.0004% for Pinal County Housing.

Table 4-1
Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at Cowtown on 10/29/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Observation ($\mu g/m^3$)	RailRoad	Permitted Point Sources	Paved Road	Construction	CAFOs	Agriculture		Unpaved Road					Total
									County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribe road	
1	2.2	153.0	402.3	1.2	10.0	2.0	0.0	37.1	0.0	0.0	0.0	12.6	3.5	0.0	2.2	68.6
2	2.9	178.0	343.0	1.2	10.0	1.9	0.0	37.1	0.0	0.0	0.0	12.5	17.5	0.0	4.7	84.8
3	3.4	133.0	417.8	1.2	10.0	1.8	0.0	74.2	0.0	0.0	0.0	12.5	8.7	0.0	2.7	111.2
4	3.8	153.0	125.4	1.2	10.0	2.2	0.0	148.4	0.0	0.0	0.0	10.7	0.0	0.0	1.4	173.9
5	2.0	152.0	248.4	1.2	10.0	4.3	0.0	370.9	0.0	0.0	0.0	20.9	10.5	0.0	5.0	422.7
6	0.9	198.0	156.5	1.2	10.0	14.0	0.0	370.9	0.0	0.0	0.0	52.3	36.7	0.0	13.3	498.5
7	2.9	198.0	294.2	1.2	10.0	24.0	0.0	370.9	19.3	0.8	318.6	115.3	73.4	2.3	154.5	1090.4
8	2.9	182.0	171.8	1.2	10.0	21.2	194.4	370.9	19.3	0.8	318.6	165.2	45.5	2.3	156.7	1306.1
9	2.5	184.0	136.3	1.2	10.0	17.8	194.4	370.9	19.3	0.8	318.6	143.0	61.2	2.3	157.8	1297.3
10	0.9	252.0	219.5	1.2	10.0	13.6	194.4	370.9	19.3	0.8	318.6	164.6	115.4	2.3	167.6	1378.8
11	1.6	327.0	165.8	1.2	207.4	14.7	194.4	296.7	19.3	0.8	318.6	144.1	76.9	2.3	160.4	1436.8
12	2.5	348.0	103.2	1.2	207.4	15.4	194.4	296.7	19.3	0.8	318.6	173.7	118.9	2.3	170.1	1518.8
13	2.7	13.0	76.3	1.2	10.0	14.4	194.4	222.5	19.3	0.8	318.6	152.3	85.7	2.3	163.9	1185.5
14	4.0	326.0	61.7	1.2	63.4	15.1	194.4	222.5	19.3	0.8	318.6	173.8	136.4	2.3	173.3	1321.1
15	3.1	328.0	38.5	1.2	63.4	19.1	194.4	222.5	19.3	0.8	318.6	192.3	108.4	2.3	170.4	1312.7
16	2.5	336.0	41.5	1.2	10.0	32.3	194.4	296.7	19.3	0.8	318.6	204.7	115.4	2.3	172.4	1368.1
17	1.8	4.0	103.2	1.2	10.0	30.3	194.4	370.9	19.3	0.8	318.6	182.0	83.9	2.3	165.4	1379.2
18	3.4	327.0	60.6	1.2	10.0	16.5	0.0	519.2	19.3	0.8	318.6	164.2	69.9	2.3	160.0	1282.0
19	1.1	347.0	67.2	1.2	10.0	8.9	0.0	667.6	0.0	0.0	0.0	91.5	73.4	0.0	24.1	876.7
20	1.8	286.0	300.9	1.2	10.0	7.1	0.0	667.6	0.0	0.0	0.0	51.6	56.0	0.0	15.8	809.3
21	2.7	131.0	383.6	1.2	10.0	6.1	0.0	519.2	0.0	0.0	0.0	53.7	63.0	0.0	17.2	670.4
22	1.6	158.0	194.8	1.2	10.0	4.4	0.0	370.9	0.0	0.0	0.0	45.8	17.5	0.0	8.7	458.5
23	3.4	149.0	228.4	1.2	10.0	3.3	0.0	111.3	0.0	0.0	0.0	31.7	15.7	0.0	6.3	179.5
24	4.0	149.0	189.2	1.2	10.0	2.5	0.0	111.3	0.0	0.0	0.0	21.0	5.2	0.0	3.5	154.7
Average			188.7	1.2	30.9	12.2	81.0	309.1	9.7	0.4	159.3	99.7	58.3	1.2	86.6	849.4
Percentage Contribution				0.1%	3.6%	1.4%	9.5%	36.4%	1.1%	0.0%	18.8%	11.7%	6.9%	0.1%	10.2%	100.0%

Table 4-2
Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at Stanfield on 10/29/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Observation ($\mu g/m^3$)	Paved Road	Neighbor-hood Paved Road	Neighbor-hood UnPaved Road	Construction	CAFOs	Agri-culture	Unpaved Road				Total
										AG Road	Public Dirt	Private Dirt	Trail	
1	2.1	251.9	46.0	0.3	0.0	0.0	0.0	21.4	0.0	0.0	19.2	10.5	0.0	51.4
2	2.3	159.9	79.0	0.2	0.0	0.0	0.0	21.4	0.0	0.0	11.8	5.2	0.0	38.7
3	3.5	139.5	76.8	0.2	0.0	0.0	0.0	42.8	0.0	0.0	12.4	0.0	0.0	55.4
4	2.8	155.2	63.0	0.3	0.0	0.0	0.0	85.5	0.0	0.0	24.9	6.3	0.0	117.0
5	2.8	99.4	144.0	0.5	0.0	0.0	0.0	213.8	0.0	0.0	50.3	22.0	0.0	286.7
6	1.9	108.0	183.5	1.8	0.0	0.1	0.0	213.8	0.0	0.0	126.1	44.1	2.5	388.4
7	1.8	179.6	187.7	3.1	0.1	0.2	0.0	213.8	63.5	646.7	174.8	27.3	2.5	1132.1
8	1.8	171.9	307.2	2.7	0.1	0.1	1.3	213.8	63.5	646.7	164.0	36.7	2.5	1131.5
9	1.5	183.8	226.0	2.3	0.1	0.2	1.3	213.8	63.5	646.7	172.1	69.3	2.5	1171.8
10	3.6	82.4	133.2	1.8	0.0	0.3	1.3	213.8	63.5	646.7	158.9	46.2	2.5	1135.1
11	3.2	121.4	126.2	1.9	0.0	0.2	1.3	171.1	63.5	646.7	183.4	71.4	2.5	1142.0
12	2.9	129.8	116.1	2.0	0.1	0.3	1.3	171.1	63.5	646.7	164.5	51.4	2.5	1103.4
13	3.0	165.8	101.7	1.9	0.0	0.2	1.3	128.3	63.5	646.7	185.4	81.9	2.5	1111.8
14	2.0	112.1	69.7	2.0	0.0	0.4	1.3	128.3	63.5	646.7	205.8	65.1	2.5	1115.6
15	2.2	67.2	65.5	2.5	0.1	0.3	1.3	128.3	63.5	646.7	223.8	69.3	2.5	1138.2
16	2.4	94.3	43.8	4.0	0.1	0.3	1.3	171.1	63.5	646.7	221.2	50.4	2.5	1161.1
17	2.8	59.4	43.8	3.8	0.1	0.2	1.3	213.8	63.5	646.7	192.8	42.0	2.5	1166.7
18	2.6	5.3	509.1	2.1	0.1	0.2	0.0	299.4	63.5	646.7	111.5	44.1	0.0	1167.5
19	2.5	297.8	341.7	1.1	0.0	0.2	0.0	384.9	0.0	0.0	68.6	33.6	0.0	488.5
20	1.8	296.4	628.5	0.9	0.0	0.2	0.0	384.9	0.0	0.0	74.1	37.8	0.0	497.9
21	2.9	260.5	124.8	0.8	0.0	0.2	0.0	299.4	0.0	0.0	58.7	10.5	0.0	369.6
22	2.2	253.8	72.7	0.6	0.0	0.0	0.0	213.8	0.0	0.0	38.0	9.4	0.0	261.9
23	2.9	169.3	93.1	0.4	0.0	0.0	0.0	64.1	0.0	0.0	25.3	3.1	0.0	93.1
24	3.5	163.9	106.6	0.3	0.0	0.0	0.0	64.1	0.0	0.0	25.9	3.2	0.0	93.6
Average			162.1	1.6	0.0	0.2	0.5	178.2	31.8	323.4	112.2	35.0	1.3	684.1
Percentage Contribution				0.2%	0.0%	0.0%	0.1%	26.0%	4.6%	47.3%	16.4%	5.1%	0.2%	100.0%

Table 4-3
Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at PCH on 10/29/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Observation ($\mu g/m^3$)	Paved Road	Neighbor-hood Paved Road	Neighbor-hood UnPaved Road	Permitted Point Sources	Construction	Dairies	Agriculture	Unpaved Road				Total
											AG Road	Public Dirt	Private Dirt	Trail	
1	2.1	100.2	91.4	0.2	0.0	0.0	33.0	0.0	0.2	0.0	0.0	9.7	1.6	0.0	44.8
2	1.3	122.1	86.1	0.2	0.0	0.0	33.0	0.0	0.2	0.0	0.0	10.7	8.1	0.0	52.2
3	1.1	73.5	72.5	0.2	0.0	0.0	33.0	0.0	0.4	0.0	0.0	8.8	4.0	0.0	46.5
4	1.1	144.0	67.8	0.2	0.0	0.0	33.0	0.0	0.8	0.0	0.0	9.4	0.0	0.0	43.4
5	1.1	246.0	76.6	0.5	0.0	0.0	33.0	0.0	2.0	0.0	0.0	21.9	4.9	0.0	62.2
6	1.1	142.8	60.1	1.5	0.0	0.0	33.0	0.0	2.0	0.0	0.0	44.3	17.0	0.0	97.9
7	1.1	189.5	145.8	2.4	0.0	0.0	33.0	0.0	2.0	35.7	152.4	93.8	34.0	0.7	353.9
8	1.1	276.0	287.0	2.2	0.0	0.0	33.0	0.2	2.0	35.7	152.4	137.3	21.0	0.7	384.4
9	1.6	133.5	179.2	1.8	0.0	0.0	33.0	0.2	2.0	35.7	152.4	130.7	28.3	0.7	384.7
10	1.1	300.9	455.2	1.5	0.0	0.0	33.0	0.2	2.0	35.7	152.4	141.9	53.4	0.7	420.7
11	1.4	18.9	234.8	1.6	0.0	0.0	33.0	0.2	1.6	35.7	152.4	131.7	35.6	0.7	392.5
12	1.6	259.9	85.6	1.7	0.0	0.0	33.0	0.2	1.6	35.7	152.4	150.7	55.0	0.7	430.9
13	1.4	308.7	71.4	1.6	0.0	0.0	33.0	0.2	1.2	35.7	152.4	132.3	39.7	0.7	396.6
14	2.6	263.9	62.7	1.7	0.0	0.0	33.0	0.2	1.2	35.7	152.4	145.8	63.1	0.7	433.7
15	2.2	292.9	65.6	2.1	0.0	0.0	33.0	0.2	1.2	35.7	152.4	159.1	50.2	0.7	434.5
16	1.5	244.0	54.5	3.3	0.0	0.0	33.0	0.2	1.6	35.7	152.4	163.9	53.4	0.7	444.2
17	1.5	294.0	40.8	3.1	0.0	0.0	33.0	0.2	2.0	35.7	152.4	159.6	38.9	0.7	425.5
18	1.1	300.1	368.4	1.7	0.0	0.0	33.0	0.0	2.8	35.7	152.4	136.6	32.4	0.7	395.2
19	1.1	53.0	588.4	1.0	0.0	0.0	33.0	0.0	3.6	0.0	0.0	76.2	34.0	0.0	147.7
20	1.1	57.4	453.5	0.8	0.0	0.0	33.0	0.0	3.6	0.0	0.0	43.9	25.9	0.0	107.2
21	1.1	91.7	281.6	0.7	0.0	0.0	33.0	0.0	2.8	0.0	0.0	46.7	29.1	0.0	112.3
22	1.1	82.1	199.3	0.5	0.0	0.0	33.0	0.0	2.0	0.0	0.0	36.8	8.1	0.0	80.4
23	1.1	128.4	128.6	0.4	0.0	0.0	33.0	0.0	0.6	0.0	0.0	24.4	7.3	0.0	65.6
24	1.1	187.8	114.4	0.3	0.0	0.0	33.0	0.0	0.6	0.0	0.0	18.8	2.4	0.0	55.1
Average			188.7	1.3	0.0	0.0	33.0	0.1	1.6	17.9	76.2	84.8	27.0	0.3	242.2
Percentage Contribution				0.5%	0.0%	0.0%	13.6%	0.0%	0.7%	7.4%	31.5%	35.0%	11.1%	0.1%	100.0%

Figure 4-1
Summary of Stagnation Design Day Source Distribution by Modeling Domain

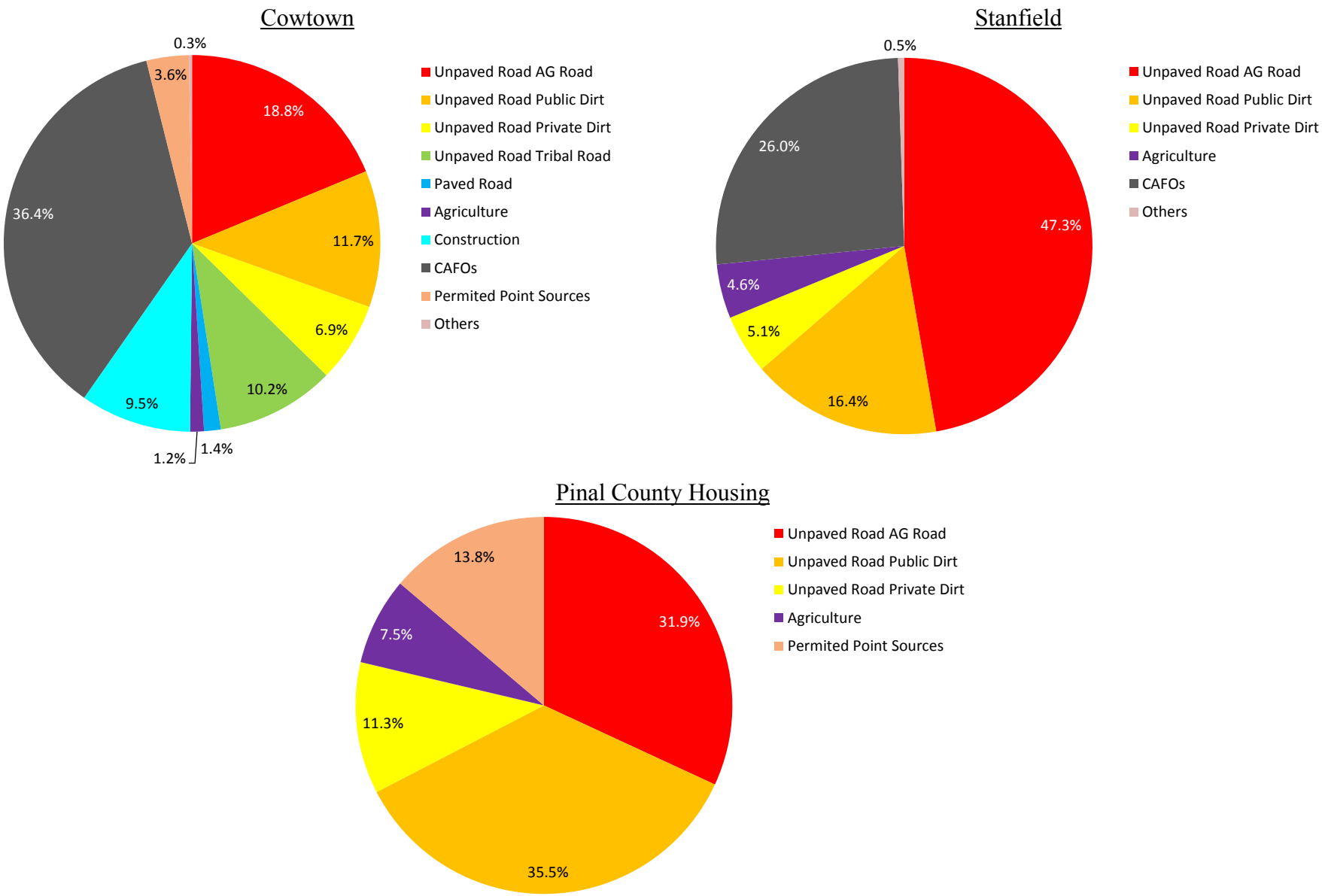


Table 4-4
Emissions Inventory (lbs/hour) for the High wind Day at PCH on 1/1/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Observation ($\mu g/m^3$)	Paved Road	Permitted Point Sources	Dairies	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agriculture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	1.6	303.8	28.2	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	12.8	2.0	0.0	48.5
2	1.5	318.0	21.0	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	10.4	9.8	0.0	53.8
3	2.0	335.4	22.2	0.4	33.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	12.3	4.9	0.0	51.1
4	2.5	333.7	24.5	0.5	33.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	45.8
5	5.9	352.2	16.4	1.0	33.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	26.8	5.9	0.0	68.7
6	3.2	299.6	19.1	3.4	33.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	60.8	20.6	0.0	119.8
7	3.9	339.3	16.2	5.5	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	119.4	41.3	2.8	474.8
8	5.7	5.0	22.7	4.9	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	177.7	25.5	2.8	516.8
9	4.8	53.9	34.7	4.1	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	162.1	34.4	2.8	509.2
10	16.3	41.2	871.2	0.0	0.0	2.0	119.0	297.2	42.6	11.0	2521.4	352.2	230.0	107.5	15.6	3698.5
11	21.4	46.3	919.3	0.0	0.0	1.6	355.2	823.7	118.2	37.3	8165.9	755.1	315.6	187.1	45.9	10805.6
12	25.1	49.6	1136.1	0.0	0.0	1.6	641.0	1486.2	213.3	67.3	14663.9	1215.6	463.7	326.4	80.5	19159.6
13	23.6	48.5	790.7	0.0	0.0	1.2	275.3	638.4	91.6	28.9	6348.8	626.3	284.8	159.6	36.2	8491.2
14	22.9	48.3	946.1	0.0	0.0	1.2	135.1	313.3	45.0	14.2	3160.4	400.3	245.5	131.3	19.2	4465.5
15	19.2	47.6	320.0	0.0	0.0	1.2	65.5	163.5	23.5	6.1	1427.0	275.9	229.5	84.4	9.9	2286.4
16	22.3	53.6	397.9	0.0	0.0	1.6	87.6	203.2	29.2	9.2	2081.0	323.8	245.1	100.3	13.5	3094.4
17	19.9	53.6	281.9	0.0	0.0	2.0	80.0	199.8	28.7	7.4	1724.6	296.7	219.5	75.8	11.4	2645.9
18	15.0	50.6	65.8	0.0	0.0	2.8	20.5	53.3	7.7	1.8	480.7	209.6	172.7	46.1	4.9	1000.0
19	15.5	54.6	50.9	0.0	0.0	3.6	14.6	38.1	5.5	1.3	280.3	19.3	95.4	46.1	1.5	505.7
20	19.4	58.1	61.5	0.0	0.0	3.6	18.2	45.4	6.5	1.7	371.9	25.9	55.8	37.9	1.9	568.8
21	19.3	56.7	70.6	0.0	0.0	2.8	21.8	54.5	7.8	2.0	446.3	31.1	58.8	43.2	2.3	670.6
22	19.2	57.4	67.6	0.0	0.0	2.0	21.8	54.5	7.8	2.0	446.3	31.1	49.5	17.6	2.3	635.0
23	17.2	55.7	32.7	0.0	0.0	0.6	6.6	16.6	2.4	0.6	135.5	9.4	31.4	11.2	0.7	215.0
24	14.9	54.6	139.3	0.0	0.0	0.6	13.0	33.9	4.9	1.1	249.3	17.2	27.0	7.3	1.3	355.6
Average			264.9	0.9	12.4	1.6	78.1	184.2	26.4	8.0	1782.0	214.1	138.3	63.6	10.7	2520.3
Percentage Contribution				0.0%	0.5%	0.1%	3.1%	7.3%	1.0%	0.3%	70.7%	8.5%	5.5%	2.5%	0.4%	100.0%

Shaded Area = High Wind Hours

Table 4-5
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Cowtown on 04/27/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Obser-vation ($\mu g/m^3$)	Rail Road	Permitted Point Sources	Paved Road	Construc-tion	Cleared Area	Desert Shrubland		Devel-oped Rural Lands	Devel-oped Urban Lands	Un-known	CAFOs	Agriculture		Unpaved Road					Total
									County	Tribal					County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	6.1	332.4	68.3	1.2	10.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	3.5	1.5	0.0	19.6	3.0	0.0	2.3	79.0
2	0.7	320.5	73.0	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	3.5	1.5	0.0	22.2	14.8	0.0	4.8	96.0
3	5.9	314.7	88.1	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.2	3.5	1.5	0.0	18.1	7.4	0.0	2.8	119.5
4	3.9	84.4	59.7	1.2	10.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.4	3.5	1.5	0.0	18.3	0.0	0.0	1.5	185.3
5	2.2	25.7	92.3	1.2	10.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	39.7	8.9	0.0	5.1	442.8
6	2.4	156.6	492.9	1.2	10.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	84.1	31.2	0.0	13.7	522.5
7	1.6	229.1	326.4	1.2	10.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	185.9	62.3	2.2	138.1	1143.4
8	2.1	11.6	222.0	1.2	10.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	268.9	38.6	2.2	140.4	1203.6
9	10.9	33.2	372.4	1.2	10.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	249.1	51.9	2.2	141.5	1196.9
10	20.0	52.9	886.8	0.0	0.0	0.0	621.2	59.8	1156.3	451.0	101.0	3.5	0.2	370.9	2022.3	52.1	415.5	301.2	385.2	6.3	151.6	6098.2
11	17.6	44.4	107.7	0.0	0.0	0.0	164.7	15.8	306.5	119.5	26.8	0.9	0.1	296.7	582.7	52.1	291.4	256.7	141.5	3.3	144.2	2402.9
12	15.7	43.0	122.3	0.0	0.0	0.0	75.2	7.2	140.0	54.6	12.2	0.4	0.0	296.7	300.6	52.1	267.1	291.8	135.7	2.7	154.2	1790.8
13	17.7	37.0	72.0	0.0	0.0	0.0	153.7	14.8	286.0	111.5	25.0	0.9	0.1	222.5	548.0	52.1	288.5	261.6	143.8	3.3	147.8	2259.5
14	14.7	44.0	38.4	0.0	0.0	0.0	51.6	5.2	105.1	41.0	9.2	0.3	0.0	222.5	230.8	52.1	260.3	285.7	139.0	2.6	157.5	1562.9
15	16.1	49.6	36.4	0.0	0.0	0.0	76.2	7.3	141.8	55.3	12.4	0.4	0.0	222.5	303.7	52.1	267.4	315.6	127.3	2.7	154.4	1739.1
16	15.1	50.7	23.1	0.0	0.0	0.0	60.9	6.2	124.1	48.4	10.8	0.3	0.0	296.7	261.1	52.1	262.8	330.5	125.4	2.6	156.5	1738.5
17	12.1	59.4	69.7	0.0	0.0	0.0	11.6	1.2	23.7	9.2	2.1	0.1	0.0	370.9	101.2	52.1	249.8	314.0	76.5	2.3	149.3	1363.9
18	9.2	68.9	101.2	1.2	10.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	519.2	63.5	52.1	246.7	272.8	59.4	2.2	143.7	1378.2
19	5.2	40.9	230.1	1.2	10.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	667.6	3.5	1.5	0.0	152.8	62.3	0.0	24.8	927.8
20	4.0	8.0	72.9	1.2	10.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	667.6	3.5	1.5	0.0	88.7	47.5	0.0	16.3	839.6
21	2.9	37.2	79.7	1.2	10.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	519.2	3.5	1.5	0.0	94.2	53.4	0.0	17.8	703.6
22	3.0	35.3	42.6	1.2	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	76.2	14.8	0.0	9.0	489.2
23	3.8	111.6	232.5	1.2	10.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.3	3.5	1.5	0.0	50.7	13.4	0.0	6.5	199.5
24	4.7	9.3	127.5	1.2	10.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.3	3.5	1.5	0.0	36.6	4.5	0.0	3.6	173.3
Average			168.3	0.8	6.7	2.5	50.6	4.9	95.1	37.1	8.3	0.3	0.0	309.1	193.6	26.8	137.1	168.1	72.8	1.5	78.6	1194.0
Percentage Contribution				0.1%	0.6%	0.2%	4.2%	0.4%	8.0%	3.1%	0.7%	0.0%	0.0%	25.9%	16.2%	2.2%	11.5%	14.1%	6.1%	0.1%	6.6%	100.0%

Shaded Area = High Wind Hours

Table 4-6
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Maricopa on 10/27/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Observa-tion ($\mu g/m^3$)	Rail Road	Paved Road	Construc-tion	CAFOs	Cleared Area	Desert Shrub-land	Devel-oped Rural Lands	Devel-oped Urban Lands	Un-known	Agriculture		Unpaved Road					Total
													County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	3.8	160.0	239.9	1.0	3.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.8	0.0	1.0	18.9
2	2.0	106.0	143.5	1.0	2.8	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	8.9	0.0	2.2	25.2
3	1.3	6.0	70.3	1.0	2.8	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.4	0.0	1.3	30.6
4	1.3	348.0	73.8	1.0	3.4	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.7	43.4
5	2.5	290.0	98.7	1.0	6.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	5.3	0.0	2.3	111.1
6	2.0	241.0	91.8	1.0	21.3	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	18.7	0.0	6.3	153.3
7	1.3	215.0	129.8	1.0	32.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	28.9	37.4	1.0	18.2	384.9
8	5.6	82.0	160.4	1.0	28.8	256.5	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	43.9	23.1	1.0	19.2	639.5
9	13.0	84.0	326.2	0.0	0.0	631.0	89.2	108.5	52.4	59.9	30.2	8.8	247.3	7.2	175.9	41.6	36.4	1.6	19.7	1509.8
10	16.1	85.0	852.9	0.0	0.0	2657.9	89.2	663.4	305.9	349.2	200.6	53.0	1428.2	7.2	270.5	63.4	94.0	5.0	24.3	6211.9
11	18.3	81.0	496.5	0.0	0.0	2401.5	71.3	592.5	273.3	311.9	179.2	47.3	1276.8	7.2	258.6	55.7	70.7	4.6	20.9	5571.4
12	16.3	82.0	293.2	0.0	0.0	1193.1	71.3	425.3	119.3	136.2	78.3	20.7	563.3	7.2	202.6	56.8	74.2	2.6	25.5	2976.4
13	17.0	79.0	176.0	0.0	0.0	1055.9	53.5	220.8	101.8	116.3	66.8	17.6	482.4	7.2	196.2	47.9	55.3	2.3	22.6	2446.6
14	16.8	74.0	141.9	0.0	0.0	878.3	53.5	171.8	79.2	90.4	51.9	13.7	377.5	7.2	188.0	52.1	78.5	2.0	27.0	2071.0
15	15.4	72.0	84.8	0.0	0.0	514.8	53.5	71.5	36.2	41.3	20.8	6.1	173.8	7.2	170.7	52.6	58.8	1.4	25.6	1234.4
16	13.6	71.0	76.6	0.0	0.0	350.1	71.3	27.1	13.1	15.0	7.6	2.2	69.6	7.2	163.3	50.3	60.0	1.2	26.6	864.7
17	13.0	72.0	68.6	0.0	0.0	318.9	89.2	18.1	8.7	10.0	5.0	1.5	49.9	7.2	161.9	42.3	43.6	1.1	23.3	780.6
18	8.7	62.0	60.4	1.0	23.1	0.0	124.8	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	36.7	35.6	1.0	20.7	419.7
19	7.2	61.0	56.2	1.0	13.5	0.0	160.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.6	37.4	0.0	11.3	243.3
20	7.4	68.0	45.1	1.0	10.7	0.0	160.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	28.5	0.0	7.5	217.7
21	9.6	70.0	36.1	1.0	9.2	0.0	124.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	32.0	0.0	8.1	184.6
22	9.8	80.0	30.8	1.0	6.8	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	8.9	0.0	4.1	117.5
23	9.2	82.0	33.2	1.0	5.0	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	8.0	0.0	3.0	49.6
24	8.9	78.0	38.7	1.0	3.8	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.7	0.0	1.7	40.9
Average			159.4	0.6	7.2	427.4	74.3	95.8	41.2	47.1	26.7	7.1	195.8	3.6	94.4	27.6	34.3	1.0	13.5	1097.8
Percentage Contribution				0.1%	0.7%	38.9%	6.8%	8.7%	3.8%	4.3%	2.4%	0.6%	17.8%	0.3%	8.6%	2.5%	3.1%	0.1%	1.2%	100.0%

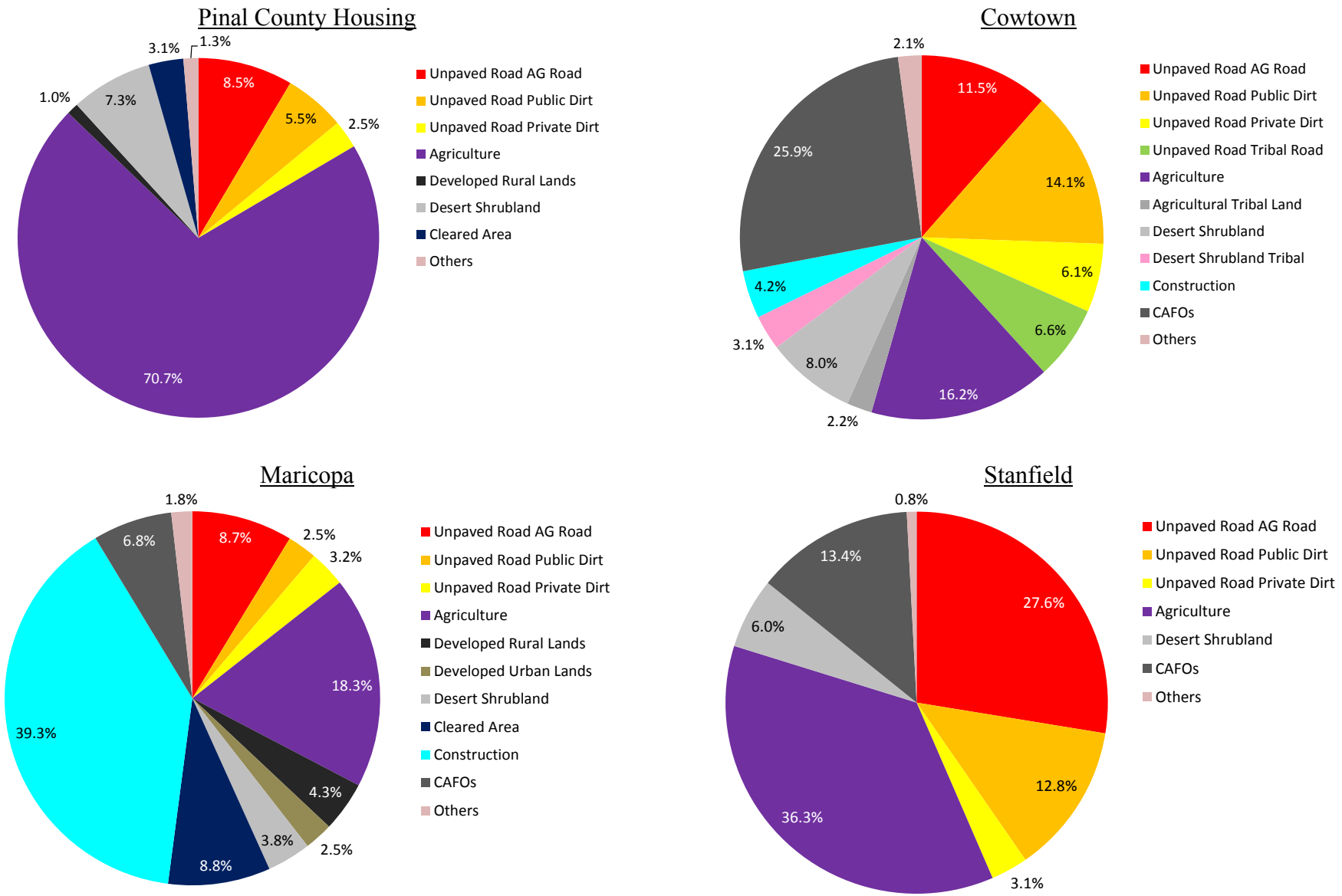
Shaded Area = High Wind Hours

Table 4-7
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at STF on 11/21/2008

Hour	WSPD (mph)	WD (degree)	PM_{10} Observation ($\mu g/m^3$)	Paved Road	Construc -tion	CAFOs	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	4.1	119.2	112.4	0.2	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	18.0	2.2	0.0	33.9
2	3.5	161.6	59.4	0.2	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	22.4	10.9	0.0	47.0
3	3.9	117.3	157.4	0.2	0.0	26.9	0.0	0.0	0.0	0.0	0.0	0.0	16.7	5.5	0.0	49.3
4	4.3	125.4	158.4	0.3	0.0	53.8	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	70.8
5	3.7	274.2	102.3	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	33.6	6.6	0.0	175.2
6	4.0	240.9	234.2	1.7	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	72.2	23.0	0.0	231.5
7	15.9	85.5	357.4	0.0	0.0	215.9	2.1	112.8	9.5	0.1	697.8	668.3	181.7	49.3	2.5	1939.9
8	18.3	81.9	326.6	0.0	1.3	267.8	3.4	185.0	15.5	0.2	1112.4	692.6	261.2	33.9	2.9	2576.2
9	20.4	82.2	584.6	0.0	1.3	720.1	14.8	812.6	68.2	0.8	4719.2	904.2	304.6	62.4	5.7	7613.9
10	19.9	81.1	429.2	0.0	1.3	351.8	5.5	301.5	25.3	0.3	1782.0	731.9	269.3	81.1	3.4	3553.4
11	20.0	80.2	334.3	0.0	1.3	255.4	3.7	205.0	17.2	0.2	1227.5	699.3	238.5	54.2	3.0	2705.4
12	18.2	80.4	186.1	0.0	1.3	175.8	1.7	94.5	7.9	0.1	592.7	662.1	262.9	77.2	2.5	1878.7
13	14.7	79.2	93.9	0.0	1.3	104.3	0.6	36.0	3.0	0.0	239.1	641.0	228.7	54.5	2.2	1310.8
14	13.4	78.5	65.1	0.0	1.3	90.7	0.3	15.2	1.3	0.0	129.7	634.8	254.4	85.7	2.1	1215.5
15	12.3	75.3	64.8	0.0	1.3	84.8	0.1	6.2	0.5	0.0	90.3	632.1	282.0	68.0	2.1	1167.4
16	9.9	77.2	65.2	3.9	1.3	107.6	0.0	0.0	0.0	0.0	49.4	630.2	302.0	72.2	2.0	1168.7
17	7.1	74.7	87.1	3.7	1.3	134.5	0.0	0.0	0.0	0.0	49.4	630.2	289.0	52.5	2.0	1162.7
18	4.7	73.8	104.6	2.0	0.0	188.4	0.0	0.0	0.0	0.0	49.4	630.2	254.2	43.8	2.0	1170.0
19	6.3	75.1	88.3	1.1	0.0	242.2	0.0	0.0	0.0	0.0	0.0	0.0	143.5	45.9	0.0	432.7
20	5.6	86.2	56.1	0.9	0.0	242.2	0.0	0.0	0.0	0.0	0.0	0.0	85.0	35.0	0.0	363.0
21	2.6	158.4	98.3	0.7	0.0	188.4	0.0	0.0	0.0	0.0	0.0	0.0	90.5	39.4	0.0	319.0
22	2.2	230.2	249.6	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	74.5	10.9	0.0	220.5
23	2.9	270.1	171.6	0.4	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	49.1	9.8	0.0	99.8
24	2.4	291.4	99.5	0.3	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	33.4	3.3	0.0	77.4
Average			178.6	0.7	0.5	165.1	1.3	73.7	6.2	0.1	447.5	339.9	157.7	38.6	1.4	1232.6
Percentage Contribution				0.1%	0.0%	13.4%	0.1%	6.0%	0.5%	0.0%	36.3%	27.6%	12.8%	3.1%	0.1%	100.0%

Shaded Area = High Wind Hours

Figure 4-2
Summary of High Wind Design Day Source Distribution by Modeling Domain



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5. ANNUAL EMISSIONS INVENTORY

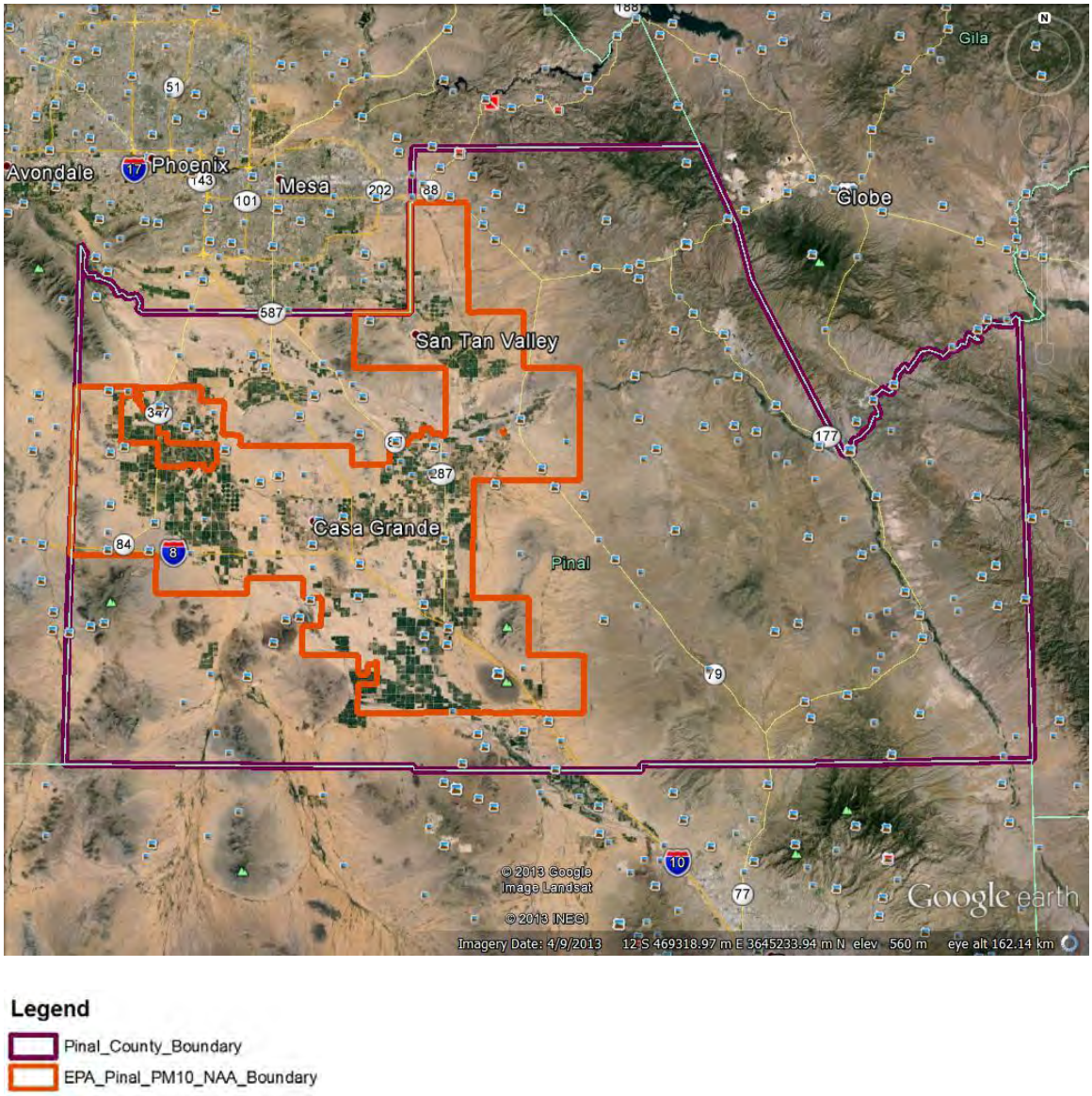
EPA designated the western portion of Pinal County, excluding tribal lands, as nonattainment for the 24-hour PM_{10} national ambient air quality standard (NAAQS) in 2012. Title I of the 1990 Clean Air Act Amendments requires the development of a baseline emission inventory and periodic revisions for areas that fail to meet the NAAQS. The earlier sections of this report addressed the requirement to develop baseline emission inventory estimates for the design days and related modeling domains selected to demonstrate attainment; this section addresses the requirement to develop an annual baseline emissions inventory for the entire PM_{10} nonattainment area. As noted in the Inventory Preparation Plan, also prepared earlier to guide compilation of these baseline inventories, an annual emissions inventory helps identify which sources and source categories predominate in the generation of PM_{10} emissions across the nonattainment area. This ranking of source significance provides the basis for analysis of long-term emission trends impacted by changes in source activity rates and implementation of regulatory control strategies.

A map of Pinal County and the PM_{10} nonattainment area is displayed in Figure 5-1. The County, as reported on its website,[91] covers an area of about 5,400 square miles and is comprised of two distinct geographic regions: an eastern portion characterized by mountains reaching 6,000 feet in elevation, and a western area consisting primarily of low desert valleys hosting irrigated agricultural land. As can be seen in Figure 5-1, the nonattainment area is an irregular shape that covers the western portion of the County with an area of 1325.2 square miles. It should also be noted that while Indian lands are located within the boundaries of the nonattainment area, and within the Maricopa and Cowtown monitoring station modeling domains, these lands are not designated nonattainment for the 24-hour PM_{10} NAAQS and, therefore, are not included in this annual emissions inventory.

The spatial distribution of estimated PM_{10} emissions within the nonattainment area was facilitated by GIS shapefiles provided by ADEQ and PCAQCD that provide information on land use, population, etc. For several source categories (e.g., nonroad vehicles and equipment), emissions in the nonattainment area were estimated from available county-wide values adjusted by the ratio of nonattainment area population to the county total. For other source categories (e.g., construction, confined animal feeding operations (CAFO), and railroads), estimates are based on activity rates of sources within the nonattainment area and emissions factors representative of these sources.

[91] *http://pinalcountyaz.gov/Departments/BudgetOffice/Documents/BB0607/countyoverview.pdf*

Figure 5-1
Comparison of Pinal County and Western Pinal County PM_{10} Nonattainment Boundaries



Legend

Pinal_County_Boundary

EPA_Pinal_PM10_NAA_Boundary

Following the approach described in Section 3, separate estimates of emissions were prepared for low and high wind conditions. Where appropriate, local precipitation event data were factored into the annual fugitive dust emissions calculations according to EPA guidance (e.g., such as reported for paved and unpaved road emissions in AP-42[92]). Since the Maricopa Association of Governments (MAG) is responsible for the development of transportation conformity budgets for the Western Pinal County PM_{10}

[92] Compilation of Air Pollutant Emissions Factors, AP-42, U.S. Environmental Protection Agency, *http://www.epa.gov/ttn/chief/ap42/index.html*, accessed on July 29, 2013.

nonattainment area, emissions data and assumptions derived from these budgets, as discussed in in Section 3, were used to prepare annual emission estimates for on-road sources in this section. Summaries of the methods and data sources used to estimate emissions for PM_{10} source categories that are significant in the nonattainment area are presented below.

5.1 Low Wind Emissions Inventory

Descriptions of the adjustments made to the Section 3.1 low wind methodologies to estimate annual emissions are presented in the subsections below. No estimates are provided for emissions on tribal lands because these areas are not included in the nonattainment designation; also, no estimates of trackout emissions from local paved roads are provided because insufficient information is available to characterize the locations and activity levels of such source areas within the nonattainment area. The remainder of the source discussions are presented in the order in which they occur in Section 3.1.

5.1.1 Agriculture Emissions

To compute annual emissions within the entire nonattainment area, the methods presented in Section 3.1.1 were adjusted to:

- Develop estimates of total areas within the nonattainment area devoted to cultivation of locally-prominent crops;
- Develop an estimate of the total acreage considered to be fallow; and
- Eliminate adjustments for diurnal variations, which are not germane to annual emission estimates.

While the Arizona Cotton Research and Protection Council (CRPC) provided detailed information on crops under cultivation within 6 kilometers of each high wind monitor, no similar information is available for portions of the nonattainment area outside these zones. A review of available data sources found that the 2007 Agricultural Census[93] contained county-specific information on farm operations in Arizona, including total acres harvested by crop. Recognizing that farmers respond to market conditions and that decisions on crops to plant/harvest change year to year, the county agricultural agent was contacted for information on crops under cultivation in 2008.[94] He provided information from the 2008 Arizona Agricultural Statistics Bulletin on acres in production in Pinal

[93] *http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Arizona/cp04021.pdf*

[94] Phone conversation with Rick Gibson, University of Arizona Cooperative Extension and Bob Dulla, August 23, 2013

County for a limited number of crops. A comparison of these values with those reported in the 2007 Agricultural Census found total cultivated acreages to be roughly equivalent (~ 12,000 acre difference = 6% of the county total) and the crop distributions to be similar. However, the Census provided more valuable detail on the crops under cultivation. For this reason, the 2007 Census values for Pinal County were used to characterize the crop distribution in the PM_{10} nonattainment area in 2008. Table 5-1 provides a summary of the acreage and percentage distribution by crop type found in the 2007 Census data.

Table 5-1
Acres of Crops Under Cultivation in 2007 Agricultural Census for Pinal County

Crop	Acres	Percent
Field Crops		
Barley for Grain	11,718	6.1%
Corn for Grain	1,101	0.6%
Cotton	73,718	38.3%
Sorghum for Grain	10,255	5.3%
Wheat for Grain	19,316	10.0%
Field Seeds, Hay, Forage, Silage		
Field and Grass Seed	2,836	1.5%
Forage - All Hay, Haylage, Sileage & Greenchop	63,811	33.2%
Vegetables – Total	9,611	5.0%
Total	192,366	100.0%

Since annual tilling emissions are based on the number of passes per year and harvesting emissions are based on lbs/acre-year, crop calendar information was not used to prepare the annual emission estimates. Total annual PM_{10} emissions and annual-average day emissions are presented in Table 5-2 for tillage operations and in Table 5-3 for harvest operations by crop type. The acreage values presented in the tables are derived from the GIS shapefiles provided by ADEQ and PCAQCD. The total number of agricultural acres in the nonattainment area was reduced by 7% to account for the average share of fallow land found within each of the modeling domains.

Table 5-2 2008 Crop Acreage, Annual PM_{10} Tillage Emissions, and Typical Daily Tillage Emissions in Pinal PM_{10} Nonattainment Area					
Crop	Acres	Tillage Passes (per year)	PM_{10} Annual Emissions (tons/year)	Tillage Operation (Days/year)	Typical Daily Emissions (lbs/day)
Alfalfa	74,007	5.1	606	91	13,329
Corn	1,277	7.3	15	152	197
Grain	47,943	3.1	239	243	1,966
Cotton	85,496	8.8	1,209	364	6,643
Hay	3,289	5.1	27	91	592
Vegetable	11,147	14.0	251	182	2,756
Total	223,159	N/A	2,347	N/A	25,482

Table 5-3 2008 Crop Acreage, Annual PM_{10} Harvesting Emissions, and Typical Daily Harvesting Emissions in Pinal PM_{10} Nonattainment Area					
Crop	Acres	PM_{10} Emission Factor (lbs/acre-yr)	PM_{10} Annual Emissions (tons/year)	Harvest (Days/year)	Typical Daily Emissions (lbs/day)
Alfalfa	74,007	0.00	0.0	294	0.0
Corn	1,277	1.70	1.1	91	23.9
Grain	47,943	5.80	139.0	60	4,634.5
Cotton	85,496	3.40	145.3	143	2,032.8
Hay	3,289	1.70	2.8	294	19.0
Vegetable	11,147	0.17	0.9	116	16.3
Total	223,159	N/A	289.2	N/A	6,726.5

5.1.2 Concentrated Animal Feeding Operations (CAFO)

Annual PM_{10} emissions generated by CAFOs within the nonattainment area in 2008 were computed using the average daily PM_{10} emission factor described in Section 3.1.2 and 2008 animal population averages for affected facilities provided by representatives of the Arizona Cattle Feeders Association. The daily PM_{10} emission factor for CAFOs, in units of pounds of PM_{10} per animal head-day, was computed from the medians of hourly emissions factors per the recommendation of Bonifacio et al.[95] in their assessment of PM_{10} emissions from two CAFOs in Kansas. Because the hourly emissions factors were calculated from a subset of the 2008 hourly PM_{10} and meteorological data collected at the

[95] "Particulate matter emission rates from beef cattle feedlots in Kansas – Reverse dispersion modeling," Bonifacio, H.F., R.G. Maghirang, B.W. Auvermann, E.B. Razote, J.P. Murphy, and J.P. Harner III; JAW&MA 62(3)350-361, 2012.

Cowtown monitoring station, these factors represent annual average values and not design-day-specific values. Thus, the daily emission factor computed in Section 3.1.2 represents an annual-average-day value that is appropriate for use in compiling an annual inventory for the nonattainment area.

Annual-average-day animal population values for each of the nine CAFOs located in the nonattainment area were provided by the Arizona Cattle Feeders Association.[96] These population values were multiplied by the average daily PM_{10} emission factor to derive daily PM_{10} emission rates for each CAFO, and these rates were further multiplied by 366 to determine annual PM_{10} emissions. The annual emissions rates for all of the CAFOs in the nonattainment area were summed to determine total annual PM_{10} emissions in 2008 for this source category. A summary of the facilities, the head counts, and related emissions is presented in Table 5-4.

Table 5-4
Summary of the 2008 Annual Emissions and Typical Daily Emissions for CAFOs in Western Pinal County PM_{10} Nonattainment Area

Facility	# Head	Emission Factors (lbs/head/day)	Annual Emissions (tons/yr)	Typical Daily Emissions (lbs/day)
Pinal East Pens	18,900	0.066	228	1,244
Pinal West (W of Fuqua)[a]	15,645	0.066	188	1,029
Pinal West (E of Fuqua)[a]	33,497	0.066	403	2,204
Owen Kelly Feed Yard	5,900	0.066	71	388
Maricopa Cattle Company	21,200	0.066	255	1,395
Maricopa Cattle Company	17,600	0.066	212	1,158
Red River Feed Yard	48,200	0.066	580	3,171
Benedict Feed Yard	16,800	0.066	202	1,105
Paradise Cattle	3,000	0.066	36	197
Total	180,742	N/A	2,176	11,892

a. Fuqua Road is at the mile mark between White & Parker Road and Hartman Road.

5.1.3 Fugitive Dust Emissions from Paved Roads

Fugitive PM_{10} emissions from paved roads were calculated using the guidance in section 13.2.1 of AP-42.[92] The new AP-42 equation published by EPA in January 2011 has been applied to estimate PM_{10} emissions from paved roads in the nonattainment area.

[96] Conference call with Bas Aja/Arizona Cattle Feeders Association and staff of the Arizona Department of Environmental Quality and Pinal County Air Quality Control District, May 13, 2013; and email correspondence from Bas Aja dated June 11, 2013.

In the AP-42 equation, paved road emissions are a function of silt loading values and the average weight of vehicles traveling on paved road surfaces. Paved roads have been classified as freeways, high-traffic arterials, and low-traffic arterials to reflect different silt loading assumptions. An arterial carrying a traffic volume of less than 10,000 vehicles per average weekday is classified as low-traffic; all other roads that are not freeways are classified as high-traffic arterials. The silt loading levels used in this inventory, in grams per square meter, are 0.02 for freeways, 0.067 for high-traffic arterials, and 0.23 for low-traffic arterials. The silt loadings and average vehicle weights were derived from the MAG 2012 Five Percent Plan for PM-10 in the Maricopa County nonattainment area. The fugitive dust emission factors for paved roads were calculated using the following AP-42 equation:

$$E = k \times sL^{0.91} \times W^{1.02} \times (1 - P/4N)$$

where:

E = annual average particulate emission factor (g/mile);

k = particle size multiplier for particle size range (1.0 g/mile for PM_{10} and 0.25 g/mile for $PM_{2.5}$);

sL = road surface silt loading (0.02 g/m^2 for freeways, 0.067 g/m^2 for high-traffic arterials, and 0.23 g/m^2 for low-traffic arterials);

W = average weight of the vehicles traveling on the roads (3.53 tons on freeways and 2.65 tons on arterials);

P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (31 days in 2008); and

N = annual number of days (366 days in 2008).

The annual average PM_{10} and $PM_{2.5}$ emission factors for paved roads derived from the AP-42 equation are presented in Table 5-5.

Table 5-5
2008 Paved Road Emission Factors

Silt Loading Category	PM_{10} Emission Factor (g/mile)
Freeways	0.10
High Traffic Arterials	0.23
Low Traffic Arterials	0.69

The 2008 vehicle miles of travel (VMT) by silt loading category was used to estimate paved road fugitive PM_{10} emissions. Daily VMT by silt loading category is shown in Table 5-6. The 2008 VMT for the West Pinal PM_{10} nonattainment was obtained from ADOT. This VMT was multiplied by 0.92 to convert from average weekday to annual average daily traffic. The distribution by silt loading category within the West Pinal PM_{10} nonattainment area was derived from a MAG 2011 traffic assignment.

Table 5-6
2008 VMT by Silt Loading Category for Paved Roads

Silt Loading Category	PM_{10} Nonattainment Area Annual Average Daily VMT
Freeways	1,399,459
High Traffic Arterials	757,558
Low Traffic Arterials	3,625,871
Totals:	5,782,889

Applying the emission factors in Table 5-5 to the VMT values in Table 5-6 produces the 2008 particulate emissions from paved roads for the West Pinal PM_{10} nonattainment area, as shown in Table 5-7.

Table 5-7
2008 Paved Road Emissions for the West Pinal PM_{10} Nonattainment Area

Silt Loading Category	Typical Daily Emissions (lbs/day)	Annual Emissions (tons/yr)
Freeways	309	56
High Traffic Arterials	384	70
Low Traffic Arterials	5,516	1,009
Totals:	6,208	1,136

5.1.4 Fugitive Dust Emissions from Unpaved Roads

Fugitive PM_{10} emissions from unpaved roads were calculated using the guidance in Section 13.2.2 of AP-42. AP-42 emission factors were applied to unpaved road VMT values to estimate fugitive PM_{10} emissions. The unpaved road particulate emission factors were derived from the following AP-42 equation for publicly accessible unpaved roads.

$$E = \left[\frac{k \left(\frac{s}{12}\right)^{1} \left(\frac{S}{30}\right)^{0.5}}{\left(\frac{M}{0.5}\right)^{0.2}} - C \right] \left(1 - \frac{P}{N}\right)$$

where:

E = annual average particulate emission factor adjusted for natural mitigation (lb/mile);

k = particle size multiplier for particle size range (1.8 lb/mile for PM_{10} and 0.18 lb/mile for $PM_{2.5}$);

s = surface material silt content;

S = mean vehicle speed;

M = surface material moisture content;

C = emission factor for 1980s vehicle fleet exhaust, brake wear, and tire wear (0.00047 lb/mile for PM_{10});

P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (31 days in 2008); and

N = annual number of days (366 days in 2008).

Four categories of unpaved roads have been identified in Pinal County: agricultural, public, private, and trails. The surface material silt and moisture contents for each category are shown in Table 5-8. The silt and moisture contents were obtained from a Pinal County field study conducted in June 2013.

Subcategories were developed for agricultural, public, and private unpaved roads to account for variations in average vehicle speeds and annual average daily traffic (ADT). Speeds for each subcategory are identified in Table 5-8; ADT, mileage, and VMT are listed in Table 5-9 The ADT and speed values for public and private roads and trails were obtained from the PCAQCD Traffic Analysis Report cited in Section 3.1.4. The ADT and speed values for agricultural roads were calculated from information provided by Pinal County farmers for non-harvest and harvest activities, also cited in the same section. ADT is multiplied by total mileage to calculate daily VMT. The PM_{10} emission factors were multiplied by the VMT in Table 5-9 to produce unpaved road emissions for the PM_{10} nonattainment area, which are summarized by category in Table 5-10.

Table 5-8 Pinal County Inputs to AP-42 Equation for Unpaved Roads			
Subcategory	Silt Content	Moisture Content	Speed
Agricultural			
Operations	14.9%	0.8%	28.2 mph
Inspection			28.2 mph
Harvest			22.8 mph
Public			
Class A	7.1%	0.3%	20 mph
Class B			25 mph
Class C			30 mph
Class D			35 mph
Class E			40 mph
Private			
Non-Irrigation	14.4%	0.3%	25 mph
Principal Canal			25 mph
Secondary Canal			15 mph
Trails			
	14.4%	0.3%	15 mph

Table 5-9 2008 Unpaved Road Emission Factors and Daily VMT				
Subcategory	PM_{10} Emission Factor (g/mi)	Daily VMT	Average Daily Traffic	Miles
Agricultural				
Operations	487.47	10,454	11.33	923
Inspection	770.87	32,071	11.33	2,831
Harvest	597.07	8,412	19.95	422
Public				
Class A	399.66	2,556	28.5	90
Class B	446.85	21,408	89.5	239
Class C	489.52	11,347	126.5	90
Class D	528.76	22,186	185.5	120
Class E	565.28	26,222	438.5	60
Private				
Non-Irrigation	906.5	22,330	25	893
Principal Canal	906.5	2,223	15	148
Secondary Canal	702.12	2,231	3	744
Trails				
	702.13	2,488	2	1,244

Table 5-10 2008 Unpaved Road Emissions for the West Pinal PM_{10} Nonattainment Area		
Unpaved Road Category	Typical Daily Emissions (lbs/day)	Annual Emissions (tons/yr)
Agricultural	90,477	16,557
Public	94,130	17,226
Private	52,522	9,612
Trails	3,851	705
Total	240,980	44,100

5.1.5 Nonroad Emissions

The same general nonroad exhaust emission calculation methodology used for preparing the modeling domain inventories (described in Section 3) was also used to calculate annual nonroad emissions for the nonattainment area. Pinal County-specific emissions[97] were determined using EPA's NONROAD model,[98] which included Pinal County-specific input values where available. As described below, in the absence of sector-specific information for the entire nonattainment area county-wide nonroad emissions were allocated to the nonattainment area using human population ratios.[99]

NONROAD Calculation Methodology – EPA's NONROAD emissions model calculates emissions from each source according to the methodology described below. Note that this calculation yields emission results in grams per year, which the model then converts to tons.

$$Emissions = EF \times DF \times P \times LF \times Hours \times Units$$

where:

EF = emission factor in g/hp-hr
DF = deterioration factor (dimensionless)
P = power in horsepower
LF = load factor (dimensionless)
Hours = annual operating hours for each unit
Units = total population of engines operating in a given year

[97] Input files are included in Appendix 8.
[98] U.S. EPA NONROAD Model, Version 2008a, released July 2009.
[99] The ratio (i.e., 280,006/ 375,770 = 74.5%) was determined using 2010 Pinal County population from U.S. Census data, (http://quickfacts.census.gov/qfd/states/04/04021.html), and 2010 PM_{10} nonattainment area census block data provided by ADEQ.

Pinal County Inputs – Total emissions estimates for Pinal County were determined for calendar year 2008 by determining totals for each of the 12 months, using average ambient temperatures specific to each.[100] Calendar year 2008 summertime and wintertime fuel parameters for both Diesel and gasoline, shown below in Table 5-11, were obtained from the 2008 North American fuel surveys published by the Alliance of Automobile Manufacturers (AAM), and were verified by staff at the PCAQCD. Gasoline and Diesel parameters are based on values reported in the Phoenix area; it is assumed that the fuel mix used in Phoenix during calendar year 2008 is delivered to the Pinal County nonattainment area as well because the fuel requirements are the same in both areas.[101]

Table 5-11
NONROAD Modeling Fuel Parameters Pinal County – CY 2008

Fuel Parameter	NONROAD Default	Pinal County (2008)	
		Winter	Summer[a]
Fuel RVP for gas	8.0	8.8	6.6
Oxygen Weight (%)	2.44	3.5	0.0
Gas Sulfur (%)	0.0339	0.0015	0.0039
Diesel Sulfur (%)	0.0351	0.0006	0.0006
CNG/LPG Sulfur (%)	0.003	0.003	0.003
Stage II Control (%)	0	0[b]	0[b]
EtOH Blend Market (%)	75.1	100	0
EtOH Volume (%)	9.3	10	0

a. A "Summer" fuel blend is required in virtually all parts of the nonattainment area during June-September/
b. Note that while Stage II controls are required at the highest volume stations in Pinal County's "Area A," we assumed zero Stage II coverage both to be conservative and to simplify the analysis.

Nonroad Emission Allocation Methodology – As noted above, the sector-specific information used to allocate county-wide nonroad emissions to the low wind modeling domains was not available for the nonattainment area. Therefore, for all equipment categories listed in Table 5-12 below, county-wide emissions were allocated to the nonattainment area using resident population data. As was the case with the nonroad analysis presented in Section 3, the "Pleasure Craft" and "Railway Maintenance" equipment categories were excluded due to the absence of recreational areas and rail yards in the nonattainment area that would accommodate their use.

[100] See http://www.weatherforyou.com/
[101] This was confirmed by Scott Dibiase at the PCAQCD.

Table 5-12 2008 NONROAD Emissions – Western Pinal County PM_{10} Nonattainment Area			
Equipment Category	Equipment Population	PM_{10} (tons/year)	PM_{10} (tons/day)
Agricultural	2,348	11.0	0.030
Airport Ground Support	0	0.0	0.000
Commercial	2,087	1.7	0.005
Construction and Mining	6,054	73.6	0.201
Industrial	390	2.8	0.008
Lawn and Garden	77,716	7.2	0.020
Logging	-	0.0	0.000
Recreational	20,909	10.7	0.029
Underground Mining	-	0.0	0.000
TOTAL	109,505	107	0.29

5.1.6 Railroad Emissions

The daily PM_{10} emission factor and emission rates for estimating railroad operations are described in Section 3.1.7. The same emission factors are used in calculating the annual railroad emissions by assuming 2 trains travelling through the nonattainment area each hour, 366 days per year. Table 5-13 summarizes the length of track and the annual and typical daily emissions in the nonattainment area.

Table 5-13 Summary of the 2008 Annual Emissions and Typical Daily Emissions for Railroads in Pinal County PM_{10} Nonattainment Area				
Track Length in PM_{10} Nonattainment Area (miles)	Emission Factors (g/mile/hour/train)	# of Trains (per hour)	Annual Emissions (tons/yr)	Typical Daily Emissions (lbs/day)
120	37	2	86	470

5.1.7 Construction Emissions

As discussed in Section 3.1.8, PCAQCD staff[102] reviewed building permits issued in late 2007 (4th quarter) and selected those that were most likely to continue into 2008. These

[102] Email from Kate Edwards, Pinal County to Bob Dulla, Sierra Research, 2008 Construction Dust Permits, November 28, 2012.

were combined with permits issued in 2008 to create a shape file of polygons identifying the location of each of the issued permits. A total of 2,668 construction sites were identified in the PM_{10} nonattainment area in 2008. The following information was provided by PCAQCD for each site:

- Permit type;
- Site location coordinates; and
- Acreage.

Three types of permits were found in the data provided:

- 5 – Construction;
- 7 – Commercial Construction; and
- 8 – Site Development.

Discussions with PCAQCD staff confirmed that Type 5 permits represented residential construction and Type 7 represented commercial construction (as listed); Type 8 was assumed to represent commercial construction and accounted for 2% of the issued permits. Type 5 residential projects were assumed to represent single homes if the acreage was ≤ 5 acres; larger plots of land were assumed to represent multi-home subdivisions.

The methodology used by Maricopa County to estimate the 2008 PEI[103] was used to estimate emissions for each project determined to be active on the design day. Annual emissions for each construction project were calculated by multiplying the number of acres by an emission factor that varies by project type (in units of tons/acre-month as shown in Table 5-14) by the average duration for a project type. The typical daily emissions were calculated by dividing the emissions by the number of days per month (22 days per month), and by the average duration of a project type.

In 2008, PCAQCD staff conducted a total of 416 dust permit inspections—374 were found to be in compliance, suggesting a compliance rate of 90%. Permitted sites are required to comply with construction dust rules[104] that address site preparation, bulk material handling, and carryout activity and emissions. While no local estimate of control efficiency is available, a review of the WRAP handbook[105] shows that applying water at various intervals results in a 61% PM_{10} control efficiency. When combined with the compliance rate of 90%, this would produce an estimate of overall control

[103] 2008 PM10 Periodic Emissions Inventory for the Maricopa County, Arizona, Nonattainment Area, Maricopa County Air Quality Department

[104] Article 3, Construction Site Fugitive Dust, *http://pinalcountyaz.gov/Departments/AirQuality/Documents/Dust/Article%203%20Construction%20Dust.pdf*

[105] Table 3-7. Control Efficiencies for Control Measures for Construction/Demolition, Chapter 3 Construction and Demolition, *http://www.wrapair.org/forums/dejf/fdh/content/Ch3-Construction_and_Demolition_Rev06.pdf*

effectiveness of 54%. The number of precipitation days in 2008 was also used to adjust the annual emissions by multiplying a factor of (1-P/N), where *P* = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (31 days[106] in 2008), and *N* = annual number of days (366 days in 2008).

Table 5-14 summarizes the number of construction sites located within the nonattainment area, the emission factors, the control efficiency, the annual emissions, and the annual-average-day construction PM_{10} emissions in the nonattainment area.

Table 5-14
Summary of 2008 Construction Project, Annual Emissions, and Annual-Average-Day Construction PM_{10} Emissions by Project Type

Project Type	Project Duration (Months)	Total Area (Acres)	Emission Factor (Tons PM_{10}/ Acre-Month)	Annual Emissions (Tons PM_{10}/ Year)	Number of Working Days[a] (Days/year)	Typical Daily Emissions (lbs/day)
Residential Single Family	6	4,728	0.032	382	264	2,896
Commercial	11	2,429	0.19	2,137	264	16,193
Site Development	11	3,454	0.19	3,039	264	23,026
Total	N/A	10,611	N/A	5,559	N/A	42,114

a. The total number of working days per year was assumed to be 22 days/month times 12 months/year (i.e., 264 days/year).

5.1.8 Emissions from Permitted Sources

PM_{10} annual emissions (tons/yr) for each permitted industrial facility in the nonattainment area were provided by the Pinal County Air Quality Control District (PCAQCD) from permit files. PCAQCD permits include estimates of PM_{10} emissions for stationary sources only. PM_{10} emissions from area sources such as unpaved road travel, livestock movement, and windblown dust were estimated separately and these separate methodologies are discussed in Section 3. Table 5-15 summarizes the annual emissions and annual-average-day emissions for these facilities assuming they are operating 366 days/yr.

[106] 2008 precipitation data was obtained from the AZMET station located in the City of Maricopa.

Table 5-15 Summary of the 2008 Annual Emissions and Annual-Average-Day PM_{10} Emissions for Permitted Sources in the Western Pinal County Nonattainment Area		
Total Permittted Facilities	Annual Emissions (tons/yr)	Typical Daily Emissions (lbs/day)
220	516	2,822

5.1.9 Dairy Emissions

Annual PM_{10} emissions for dairy operations in the nonattainment area in 2008 were derived from an emission factor published by the Arizona Governor's Agricultural BMP Committee[107] and estimates of average annual animal populations at affected dairies provided by United Dairymen of Arizona[108]. The published emission factor was reported to represent annual-average-day conditions and, thus, no adjustment was needed to use this factor in the computation of annual PM_{10} emissions from individual dairies. This factor, 5.21 lb./head-year, was multiplied by the average annual animal population at each dairy to calculate annual PM_{10} emissions at each affected facility, and the annual emissions of all affected facilities were summed to compute annual PM_{10} emissions from this source category on an annual basis for 2008. Table 5-16 summarizes the number of cows and their annual emissions.

Table 5-16 Summary of the 2008 Annual Emissions and Annual-Average-Day PM_{10} Emissions for Dairies in the Western Pinal County Nonattainment Area			
Total # Head in PM_{10} Nonattainment Area	Emission Factor (lbs/head/year)	Annual Emissions (tons/yr)	Typical Daily Emissions (lbs/day)
72,852	5.21	190	1,037

5.2 High Wind Emission Inventory

The methodology described in Section 3.2 was designed to quantify emissions for lands located within the high wind modeling domains during hours when hourly average wind speeds exceeded 12 mph. To quantify emissions over the entire nonattainment domain,

[107] Agricultural Best Management Practices for Livestock Operations, As Adopted by the Governor's Agricultural Best Management Practices Committee on July 27, 2010.
[108] Mike Billotte, United Dairymen of Arizona, email to Lisa Tomczak ADEQ, June 11, 2013.

an alternative method needed to be developed to estimate the hourly wind speeds impacting each land parcel over calendar year 2008. The preferred method selected for this purpose assigned each parcel to an area surrounding one of the six PM_{10} monitoring sites at which, or near to which, hourly meteorological data is recorded[109] (i.e., Casa Grande, Combs School, Cowtown, Maricopa, Pinal County Housing, and Stanfield). The method used to assign a parcel to its nearest monitoring station involved computing the distance from the centroid of that parcel to each of the six monitors. Meteorological data collected at the monitor closest to the parcel was selected to represent meteorological conditions at the parcel in 2008.

The next step was to screen the hourly wind speeds throughout the year and select those hours in which the hourly-average speed exceeded 12 mph[110]. Unlike the high wind days, which were selected for having elevated winds during several consecutive hours, days with high wind episodes as short as one hour were found in the monitoring station records. The numbers of high wind hours, low wind hours, and total windspeed monitoring hours at each of the six stations in 2008 are presented in Table 5-17. This tabulation shows that the ratio of total high wind hours to total low hours varies from monitor to monitor and ranges from a low of 4.9% at Pinal County Housing to a high of 9.2% at Casa Grande.

Table 5-17
Summary of Low and High Wind Hours in 2008 for the Western Pinal County PM_{10} Monitors

Monitors	Number of High Wind Hours	Number of Low Wind Hours	Total Number of Hours[a]
Cowtown	539	6,720	7,259
PCH	349	6,810	7,159
Stanfield	411	6,913	7,324
Casa Grande	738	7,302	8,040
Maricopa	493	7,531	8,024
Combs School	480	7,560	8,040

a. Missing data vary by monitor and influence the totals.

As described in Section 3.2, hourly high wind emission factors during multi-hour high wind episodes were adjusted to account for the effects of delayed initialization of saltation and diminished particle supply. To be consistent, the same saltation initiation delay factors from Section 3.2 were applied to emission factors for single hour high wind

[109] For some monitors with missing data, values from other monitors were substituted (e.g., for Maricopa AZMET wind data was substituted for missing Cowtown data on 2/19/08-4/25/08 & 5/15/08-9/5/18).
[110] ADEQ adjusted the wind measurements at each monitor to a standard height of 10 meters using methods described in Section 3. In the process of preparing these values, days with moisture levels exceeding 0.01 inches of rainfall were excluded from hourly counts.

events.[111] Other adjustments outlined in Section 3.2 were also applied to the emission factors used to compute fugitive PM_{10} emitted from each land parcel in the nonattainment area during a high wind hour.

Agriculture – For agricultural windblown emissions, information was needed on the distribution of disturbance levels by crop type across the year. PCAQCD staff provided a spreadsheet for the 2008 crop calendar for Pinal County that breaks each month into three ten-day periods (0-10, 10-20 and 20-30). The calendar color codes each ten-day period for the following activities:

- Planting,
- Begin/end harvest,
- Most active harvest, and
- No activity.

Using the information in the calendar, each ten-day period was assumed to be 100% disturbed if it was coded for one of the first three activities noted above. Ten-day periods with no activity were coded 0% activity. The number of ten-day periods with 100% activity was summed for each crop, multiplied by 10 and the total was divided by 360 for each crop; the same calculation was prepared for the ten-day periods with 0% activity. A summary of the results for the crops identified in the 2007 Agricultural Census, which provided % crop acreage distribution for land under cultivation within Pinal County, is presented below in Table 5-18.[112] Also presented in Table 5-18 is the crop distribution obtained from the 2007 Agricultural Census for Pinal County. It shows that cotton and forage account for 66% of the land under cultivation.

Estimates of the total agricultural acreage within the nonattainment area were obtained from the shapefiles supplied by ADEQ/PCAQD. The acreage under active cultivation was calculated after subtracting the share[113] of fallow land (7%) from the total. The crop distribution from the 2007 Agricultural Census, presented in Table 5-18 was used to determine the acreage for each of the crop categories. Emissions were then calculated for each crop type following Equation 1 (disturbed) and Equation 2 (stable) presented in Section 3-2. The crop-specific emission estimates were weighted in proportion to the disturbance/stable values presented in Table 5-18 to quantify annual windblown emissions for active crop lands within the nonattainment area. Emissions for fallow lands were calculated using Equations 1 and 2 (from Section 3-2). The emission estimates were weighted according to the 90%/10% undisturbed/disturbed estimate provided by PCAQCD staff. Total emissions were calculated by summing estimates from active agricultural crop lands and fallow lands.

[111] Application of this curve to subsequent low wind hours was considered, but not applied because of concern about overstating the effect during low wind hours.
[112] 7 percent of Fallow lands were considered in the calculation based on the Crop information we received from CRPC.
[113] The average calculated for the shapefiles provided CRPC.

Table 5-18 Annual Crop Distribution for Pinal County and Disturbance Levels Derived from 2007 Agricultural Census and 2008 Pinal County Crop Calendar			
Crop Type	Crop Distribution	Disturbed	Undisturbed/Stable
Barley for Grain	5.7%	41.7%	58.3%
Corn for Grain	0.5%	47.2%	52.8%
Cotton	35.6%	58.3%	41.7%
Sorghum for Grain	5.0%	47.2%	52.8%
Wheat for Grain	9.3%	41.7%	58.3%
Field and Grass Seed	1.4%	30.6%	69.4%
Forage[a] – All Hay, Haylage, Silage & Greenchop	30.8%	83.3%	16.7%
Vegetables – Total	4.6%	63.9%	36.1%

a. Includes alfalfa

Construction – The randomized process used to quantify high wind emissions presented in Section 3.2 for a specific day becomes quite complex for calculating annual emissions. Therefore simplifying, but conservative assumptions were employed. Each permit was assumed to have a period where the land was (1) cleared and (2) the land was under active construction. All residential permits were assumed to have a 6-month period of construction activity in 2008. All commercial and site development permits were assumed to have 11 months of construction activity in 2008. The residential construction estimate was modified to account for the average increase calculated for cleared emissions in Section 3.2. Commercial construction emissions were modified to include 1-month of cleared emissions to complete the year.

A summary of the total annual emissions estimated for each land use category during high wind hours in 2008 is presented in Table 5-19 (descriptions of each category are provided in Appendix 11). It shows desert shrubland is estimated to account for more than half of the windblown dust emissions. Agriculture is estimated to account for almost 32% of the windblown dust emissions. These values reflect the dominance of these lands within the nonattainment area.

5.3 Summary of Annual Emissions

A summary of source specific contributions to the annual emissions inventory is presented below in Table 5-20. It shows that even though windblown hours occur less than 10% of the year, the emissions produced during that time is sufficient to account for almost 65% of the annual inventory. Emissions from unpaved roads are the next largest source accounting for 28% of the annual inventory. Collectively these two sources account for over 93% of annual emissions.

Table 5-19 Summary of the 2008 Annual High Wind Emissions in Western Pinal County			
Land Use ADEQ ID	Land Use Category	Emissions (Tons/year)	Percentage
A	Developed Urban Lands	253	0.2%
B	Developed Rural Lands (low density residential)	2,482	2.4%
D	Unpaved Roads	5,855	5.7%
E	Cleared Areas	475	0.5%
F	Residential Construction	1162	1.1%
G	CAFOs and Dairies	1,009	1.0%
H	Desert Shrubland	52,531	50.8%
I	Agricultural Croplands	32,357	31.3%
J	Commercial Construction	585	0.6%
K	Other[a]	5,826	5.6%
L	Site Development	789	0.8%
Total Emissions		103,324	100%

a. "Other" land includes land covered with water, mountain peaks, or other unidentifiable lands from aerial photography.

Table 5-20 Summary of the 2008 Annual PM_{10} Emissions in the Western Pinal County Nonattainment Area			
Source Category		PM_{10} Emissions (tons/year)	% of Total
Agriculture	Harvesting	302	0.2%
	Tilling	2,452	1.5%
CAFOs		2,176	1.4%
Paved Road		1,136	0.7%
Unpaved Road		44,100	27.6%
Non-Road		107	0.1%
Railroad		86	0.1%
Construction		5,559	3.5%
Dairy		190	0.1%
Permitted Sources		516	0.3%
Sub-Total: Low Wind Emissions		56,624	35.4%
Windblown Emissions		103,324	64.6%
Total Emissions		159,948	100.0%

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Pinal County PM10 Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains

Appendices

prepared for:

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December 2013

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Pinal County PM10 Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains

Appendices

Appendix 1 – Analysis of Unpaved Roads in the Pinal County PM10 Nonattainment Area

Appendix 2 – PM_{10} Dust Silt Contents and Moisture Contents Measurement in Pinal Nonattainment Area

Appendix 3 – Pinal County Crops Calendar

Appendix 4 – Traffic Counts (ADT levels) for the Unpaved Roads in Each of the Modeling Domains

Appendix 5 – Methodology for Estimating Windblown Emission Factors within 1 MPH Wind Speed Bins

Appendix 6 – Evaluation of a Wind Erosion PM_{10} Emission Equation for Agricultural Lands in the Western Pinal County PM_{10} Nonattainment Area

Appendix 7 – Ambient Monitoring Data Based Emission Factor Adjustments

Appendix 8 – NONROAD Input Files

Appendix 9 – Agricultural Unpaved Road Activity and Speed Notes

Appendix 10 – Listing of Diurnal Profiles for Windblown, Activity-Based, and Total Emissions on High Wind Days

Appendix 11 – Pinal County Land Use Descriptions

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Appendix 1

Analysis of Unpaved Roads in the Pinal County
PM_{10} Nonattainment Area
Revised by Kate Edwards 3/07/2013

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Analysis of Unpaved Roads in the Pinal County PM10 Nonattainment Area

Revised by Kate Edwards
3/07/2013

Introduction

Preparation of a Pinal County PM10 State Implementation Plan (SIP) requires a detailed inventory of all PM10 emission sources. Unpaved roads in Pinal County need to be evaluated as part of the emissions inventory. PM10 emissions from unpaved roads reflect roadway lengths, traffic volumes, traffic speed, surface moisture and surface silt loading.

Since management responsibility largely follows surface ownership and maintenance, this analysis attempts to define a roadway classification system. The analysis also posits suggested corresponding values for traffic volume ("average daily travel" or "ADT"), traffic speed and surface silt content. Where traffic volumes vary markedly as a result of recurring seasonal activity, the analysis also posits suggested seasonal ADT levels.

GIS aerials photographs were reviewed and in-field "ground truthing" employed to assess roadway use and ownership. Based on that effort, roads were broken down into four categories: Agricultural apron roads (Ag roads), Publicly maintained roads (county/city maintained roads), Private roads, and Trails. Two sets of field tests were conducted to collect silt data for various roadway categories. The samples were sent to JBR Environmental Consultants (JBR, 2012) for laboratory analysis of moisture content and silt content. Figure 1 is a summary chart from the report. Map locations are shown in Figure 2.

Silt can be categorized in two ways: Silt Content or Silt Loading. Silt content is expressed as a weight fraction, namely as a percent of the weight of silt (soil passing a 200 mesh sieve) in a soil sample. Silt loading is expressed as mass per area, such as $200g/m^2$. In a sense, silt content is a shovel sample and silt loading is broomed samples. Silt that is available to become airborne is a function of the mechanical wear and tear and maintenance of a road base. Identical road bases can show markedly different soil loadings due to the amount and type of traffic (mechanical wear). Additional road data for Pinal County is available in a 2006 report prepared for Arizona Department of Transportation (ADOT) and Pinal County by DKS Associates (DKS, 2006). Figure 3, which is Page 3-8 of the report, is a summary of the Silt and Moisture Contents of the roads under study. The accompanying General Soil Map from the USDA Soil Conservation Service (Figure 4) shows the road locations in relation to the major soil basins. Five unpaved roads were characterized for silt content, moisture content, ADT and average vehicle speed in the study. It should be noted that silt content and silt loading is variable based on traffic loading and meteorological conditions (i.e. wind, precipitation) and is simply an estimate of conditions on the day that sampling occurred.

For the most part, surface moisture content is low (<8%).

A contractor was hired to conduct traffic counts at selected representative locations on publicly maintained roadways. That data was compared to historic records of unpaved roadway traffic count data. The most recent traffic volume data was grouped according to volume and a series of five traffic loading categories defined.

This first analysis was compiled for modeling purposes. Suggested values contained herein are intended for use in short term (24 hr) use in modeling and daily average calculations. On an annual basis these short term ADT values for ag roads, may overstate actual activity. Further revisions/adjustments will be made pending additional review.

Agricultural Roads

In terms of miles of unpaved roads, ag roads are the most common in the county. Since ag roads are on private property for the most part, public access is restricted, thus limiting the amount of data that can be collected. Specific access was granted for a joint Pinal County Air Quality Control District (PCAQCD) / Arizona Department of Environmental Quality (ADEQ) study of soils on state land, which included some agricultural property. Two of the samples were from ag roads. One showed a silt content of 16.2%, the other a silt content of 35.1%, for an average silt content of 25.6%. In the 2008 Maricopa Co. PM10 Emissions Inventory, a value of 11.9% was used for unpaved agricultural roads.

Empirical observation suggests that vehicle traffic on ag roads falls into three categories: operations, inspections and harvest. Operations include generally low-speed roadway transport of planting and tilling equipment and travel by operators setting and removing irrigation equipment. Inspection involves supervisory visits to growing operations, and often occurs at higher speeds. Harvest operations entail both slow moving equipment and personal vehicles, as well as haul trucks traveling back and forth to the nearest paved arterial. Haul traffic typically involves higher speeds.

As for daily traffic counts, the Maricopa County 2008 PM10 Emissions Inventory report uses 49.5 VMT / 1000 acres based on a study done in 2001. (Agricultural operations typically occur on fractions of 640 acre mile-square sections of land; that VMT value equates to about 32 VMT per section). The report, Technical Support Document for Quantification of Agricultural Best Management Practices, was prepared by URS and the Eastern Research Group for ADEQ. If a 1000 acre parcel is layed out with 20 acre panels, two trips around each panel per day results in approximately 45 VMT. Thus the 49.5 VMT / 1000 acres factor equates to about 2 ADT and appears to be very plausible for normal, everyday business. Again, based on empirical observation, that traffic can be further divided into 1.5 ADT for planting, tilling, and irrigation traffic, and 0.5 ADT for inspection operations. However, unpaved ag road traffic increases significantly during the harvest operations. VMT for harvest seasons needs to reflect the significant traffic increase during those harvest operations. For example, such an adjustment would logically be required for the design day of October 29, 2008.

Suggested inventory values:

- Silt content – 25.6% (Average from JBR and 2012 testing)
- Moisture content – 1.5% (Average from JBR and 2012 testing)
- Traffic volume (non-harvest operations) – 1.5 ADT @ 10 mph
- Traffic volume (inspection operations) – 0.5 ADT @ 25 mph
- Traffic volume (harvest operations) – 50 ADT @ 15 mph

Public Maintained Roads

Due the rural nature of the county, many roads remained unpaved until the housing boom began in 2003. As subdivisions blossomed across the county in areas formerly used as farm fields, more roads were paved to provide access. However, a good many roads remain unpaved in the county and within municipal boundaries. The 1922 Declaration of Road for Pinal County gave the county right of way on section lines for most sections, townships and ranges that are in the PM10 NAA. Over time some of these roads were annexed into cities and towns. Though a road may be in a county right-of-way, in some cases, the Right of Way (ROW) still does not fall within the county maintenance system. PCAQCD has done simple, daily average road counts throughout the county, usually based on a complaint. In January, 2013, as part of the preparation for the emission inventory, an outside company was consulted (Traffic Research, 2013) to do more sophisticated counts that include 15 minute incremental traffic counts on 20 unpaved roads chosen by PCAQCD. A summary is shown below in Table 1. Locations are shown in Figure 5.

Table 1 – Proposed Classifications for Public Unpaved Roads

Road Name	ADT	Classification	Classification Criteria
Eleven Mile Corner Rd S of Phillips Rd	17	A	Dead end within 0.5 miles in any direction
Papago Rd E of Hidden Valley Rd	18	A	Dead end within 0.5 miles in any direction
Hidden Valley Rd N of Dune Shadow Rd	25	A	Dead end within 0.5 miles in any direction
Clemans Rd S of Martin Rd	54	A	Dead end within 0.5 miles in any direction
Hartman Rd N of Maricopa-CG Hwy	72	B	Rural access road
White & Parker S of Hwy 84	81	B	Rural access road
Green Reservoir Rd E of Tweedy Rd	94	B	Rural access road
Alsdorf Rd W of Toltec Hwy	96	B	Rural access road
Curry Rd S of Hwy 287	97	B	Rural access road
Cornman Rd E of Eleven Mile Corner Rd	97	B	Rural access road
Montgomery Rd N of Clayton Rd	106	C	Rural arterial road
Bartlett Rd W of Skousen Rd	118	C	Rural arterial road
Hash Knife Rd W of Schnepf Rd	134	C	Rural arterial road
Peters Rd E of Stanfield Rd	148	C	Rural arterial road
Storey Rd W of Sunshine Rd	170	D	Rural major arterial
Amarillo Valley Rd S of Barnes Rd	177	D	Rural major arterial
Peters Rd W of Bianco Rd	188	D	Rural major arterial
Thornton Rd S Hanna Rd	208	D	Rural major arterial
Cooper Rd N of Arizona Farms Rd	358	E	Urban arterial - to be paved in near future
Earley Rd E of Peart Rd	519	E	Urban arterial - to be paved in near future

The Classification and Classification Criteria listed above is a suggested way to label roads for emission inventory purposes only. For lack of definitive characterization, all section line roads are assumed to be county maintained roads if not located within another municipal boundary. This may overstate the public road lengths and understate the private road lengths but the data will be revised or adjusted if more detailed information is forthcoming

Suggested inventory values:

- Silt content – 7.5 % (Average silt content from DKS, 2006 and JBR, 2012)
- Moisture content – < 1% (Average silt content from DKS, 2006 and JBR, 2012)
- Traffic volume (Class A roadways) – 28.5 ADT @ 20 mph
- Traffic volume (Class B roadways) – 89.5 ADT @ 25 mph
- Traffic volume (Class C roadways) – 126.5 ADT @ 30 mph
- Traffic volume (Class D roadways) – 185.5 ADT @ 35 mph
- Traffic volume (Class E roadways) – 438.5 ADT @ 40 mph

The ADT values represent the numerical average of the class. The proposed speeds represent an estimated average speed for the class of road. The speed for the Class E roadways was taken from the ADOT/Pinal County report (DKS, 2006). See Figure 6. Roads with high traffic volumes typically have better maintenance, hence higher average speeds.

Private Dirt Roads

Private dirt roads can generally be attributed to two categories: canal roads and other non-public, regularly traveled unpaved roads. Non-canal roads may provide access to residences or places of business but are wholly owned by the property owners. An easement may have been given to the public and/or utilities for ingress/egress purposes. These roads may run from a hundred feet to several miles. Since they are not publicly owned roads, there is not much available data regarding ADT/VMT or silt content. They are simply established, and sometimes graded, out of the natural soil in place. Canal roads are constructed by the canal companies on both sides of their canals in order to do their business. Private dirt roads are often composed of native soil or material dredged from canals. Often times signs prohibit trespass but some trespass undoubtedly occurs. The Institute of Transportation Engineers (ITE) has developed a Trip Generation Report that contains ADT rates and ranges for residential, commercial, industrial and other categories. The residential standard of 10 ADT per dwelling unit is utilized in many SIPs and Emissions Inventories. Since there is no data for the private roads in the county, using the ITE residential trip value is the best option. As for canal roads, Doug Mason of the San Carlos Irrigation District suggested in 2011 that a reasonable number for ADT would be four, but acknowledged some areas get much more traffic from trespassers. Since canal roads run on each side of the canal, this is reflected in the ADT below. So for a principle canal road, there would be a total of 30 ADT in any given stretch.

Suggested inventory values:

- Silt content – *Based on NRCS major soil basin map characteristics*
- Moisture content - < 1%
- Traffic volume (non-irrigation roads) – 10 ADT/residence @ 25 mph (further investigation pending)
- Traffic volume (principal canal roads) – 15 ADT @ 25 mph
- Traffic volume (secondary canal roads) – 3 ADT @ 15 mph

Trails

In Pinal County there are many trails that crisscross the landscape. Most are shortcuts from place to place, developed by OHVs, animals and vehicles. Other roads that have been classified as trails are pipeline ROWs that are not maintained but traversed periodically. When digitizing the Roads layer, not all shortcut trails were counted. If there were several trails within a quarter of a mile of each other, only one was digitized. In addition, long, unpaved driveways were also digitized as trails, since they have regular traffic (probably in excess of 2 ADT) over typically unstabilized ground. ADTs for trails will only be an approximation as most are on private ground, with localized traffic that is sporadic in nature. However, to account for the emissions, some numbers must be assigned.

Suggested inventory values:

- Silt content - *Based on NRCS major soil basin map characteristics*
- Moisture content - < 1%
- Traffic volume – 2 ADT @ 15 mph

Conclusion

These values reflect PCAQCD's best estimates, based on the data and analysis discussed above.

References

JBR, 2012. A report prepared by JBR Environmental Consultants, Inc. for Sierra Research dated December 5, 2012 Re: Moisture and Silt Analysis of Soil Samples Results.

DKS, 2006. Final Report, Identification of Emissions Sources for Pinal County. Prepared by DKS Associates for Pinal County.

Traffic Research, 2013. A tabulation or road counts prepared by Traffic Research & Analysis, Inc. for Sierra Research dated January 22, 2013.

Figure 1 – Laboratory Results from JBR Environmental Consultants, Inc.

JBR ENVIRONMENTAL CONSULTANTS, INC.
LABORATORY RESULTS

creating solutions for today's environment

PROJECT: Sierra Research Corporation

Sample ID	Sample Source	Moisture Content (%)	Silt Content (%)	Silt Content (grams)
ST-01	Desert Soil	3.07	17.9	239.5
ST-02	Maintained Dirt Road	0.41	7.9	85.9
ST-03	AG Road	0.84	16.2	162.0
ST-04	AG Field	1.93	10.6	108.6
EL-01	Vacant Land	2.05	22.7	305.7
EL-02	AG Field	2.45	23.9	405.3
EL-03	AG Road	2.26	35.1	494.0
EL-04	Maintained Dirt Road	0.68	15.7	194.0
PI-01	Desert Soil	1.70	18.9	262.2
Sample Site #1 (1)	Unpaved Road Fluff	N/A	16.1	65.2
Sample Site #1 (2)	Unpaved Road Fluff	N/A	18.0	57.3
Sample Site #2 (1)	AG Field	N/A	17.9	65.6
Sample Site #2 (2)	Fallow AG Field	N/A	17.9	62.9
Sample Site #3 (1)	Cloded Fallow AG Field	N/A	11.5	24.2
Sample Site #3 (2)	Cloded Fallow AG Field	N/A	15.1	30.4
Sample Site #4 (1)	Very Silty Road (Story)	N/A	28.5	91.5
Sample Site #4 (2)	Very Silty Road (Story)	N/A	24.4	86.2
PCH	Unknown	N/A	34.1	154.9
Florence	Unknown	N/A	23.0	100.5
Cowtown	Unknown	N/A	29.2	115.4
Average		**1.71**	**20.2**	

Figure 2 – Soil Sampling Locations in Pinal County

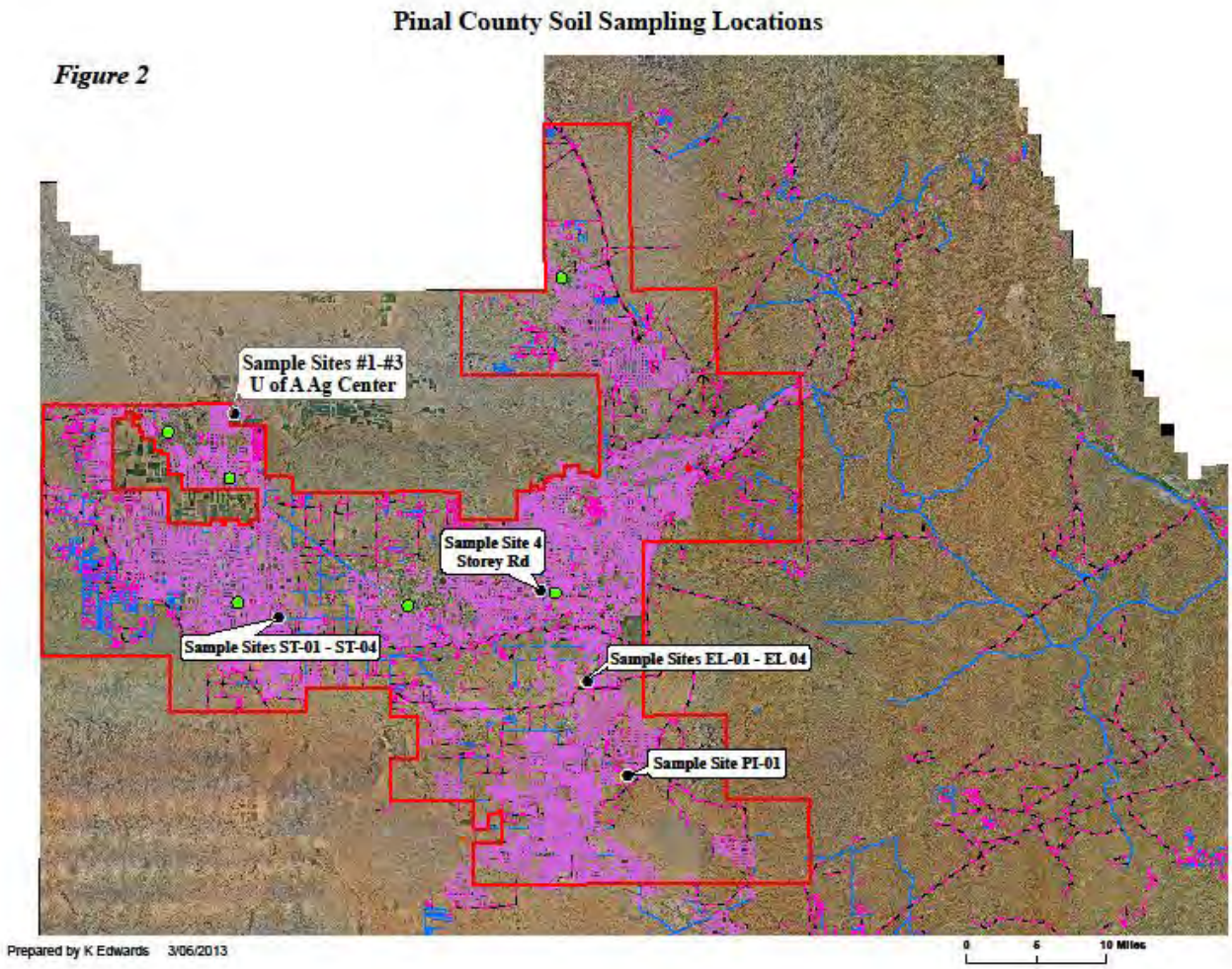
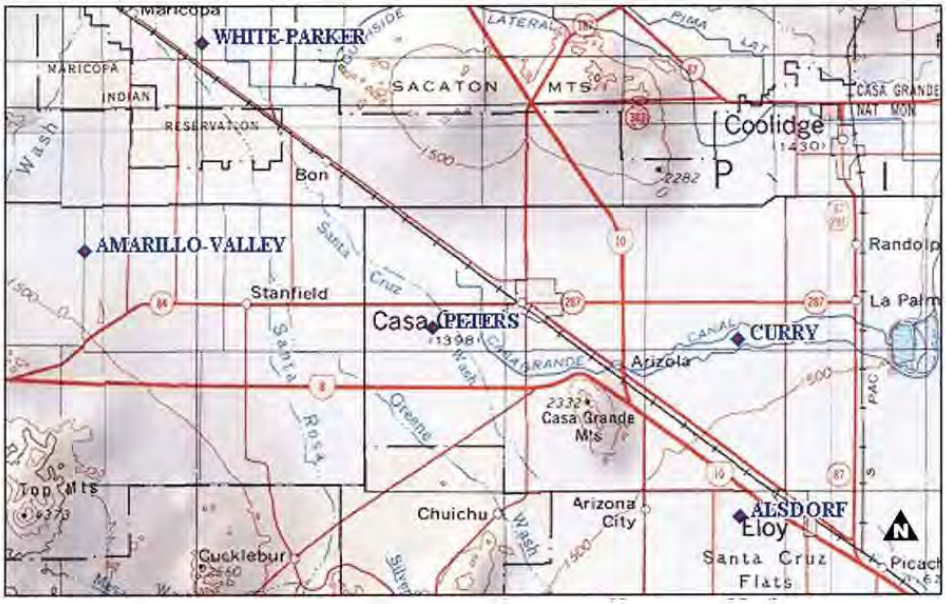


Figure 3 – Unpaved Road Surface Soil Silt and Moisture Content

Figure 2: Locations of Unpaved Road Traffic Count and Soil Sampling Sites



PSI performed sieve and moisture content analyses on the shipped samples. For the first two samples collected (Alsdorf Road and Curry Road), these analyses were conducted within about one week of receipt by the laboratory. Because of personnel changes at the laboratory, however, the second set of samples collected (Amarillo Valley Road, Peters Road, and White & Parker Road) was not analyzed until about three weeks after receipt by PSI. Although the delay in analysis of the second set of samples could have allowed moisture in the soil to evaporate, the moisture contents of soil samples at the time of collection were undoubtedly very low, and the reported measurements indicate that moisture contents of the second set of samples were equivalent to or greater than those of the first set. For these reasons, we conclude that the delay in performing moisture content analyses of the second set of soil samples did not significantly affect the analytical results. The silt and moisture contents reported for each sample are listed in Table 3.

Table 3: Unpaved Road Surface Soil Silt and Moisture Content

Unpaved Road	Silt Content	Moisture Content
Alsdorf Road	2.60%	0.097%
Amarillo Valley Road	7.40%	0.106%
Curry Road	4.20%	0.154%
Peters Road	7.10%	0.306%
White & Parker Road	5.90%	0.477%

Figure 4 – West Pinal County General Soil Map

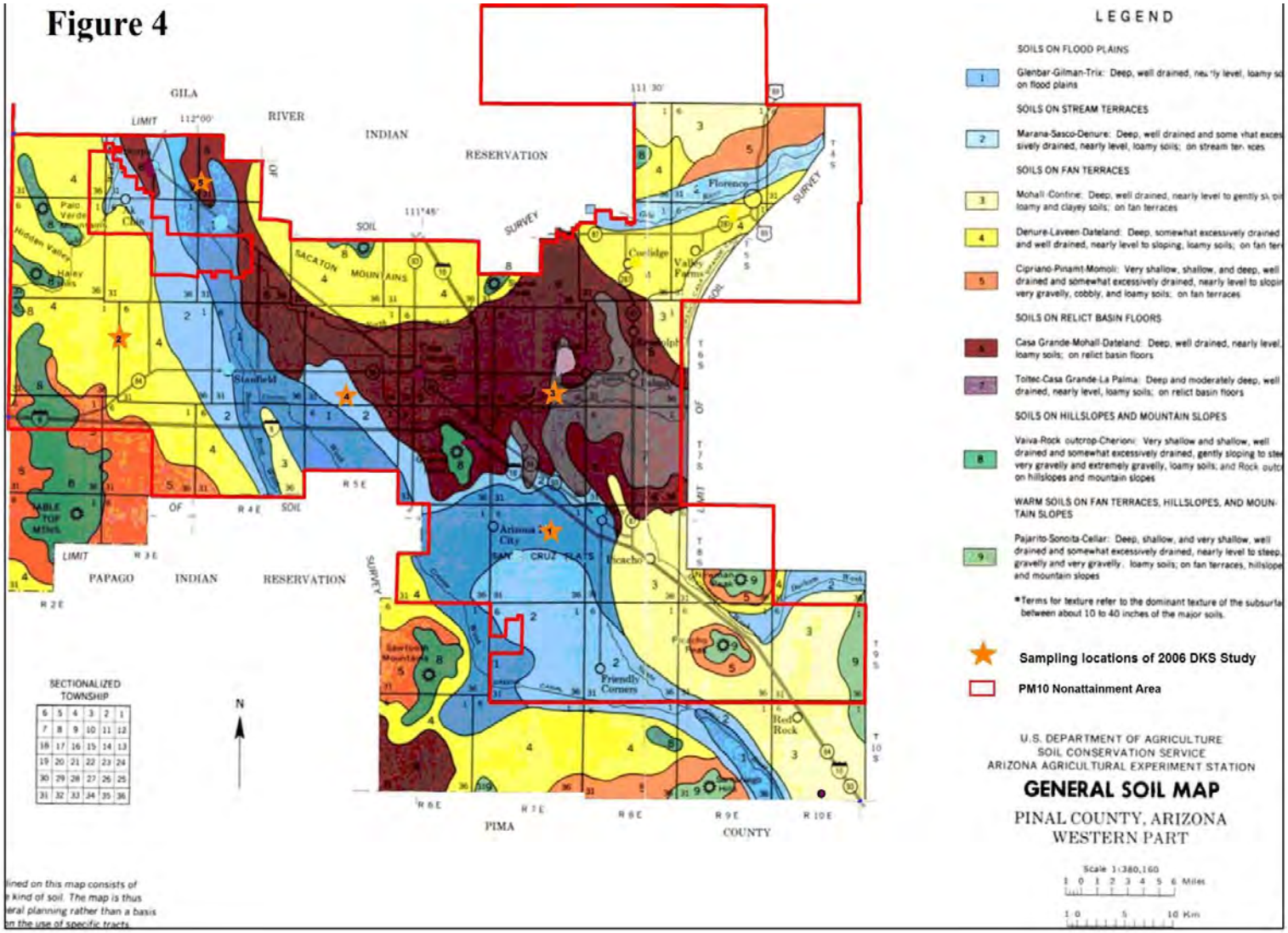
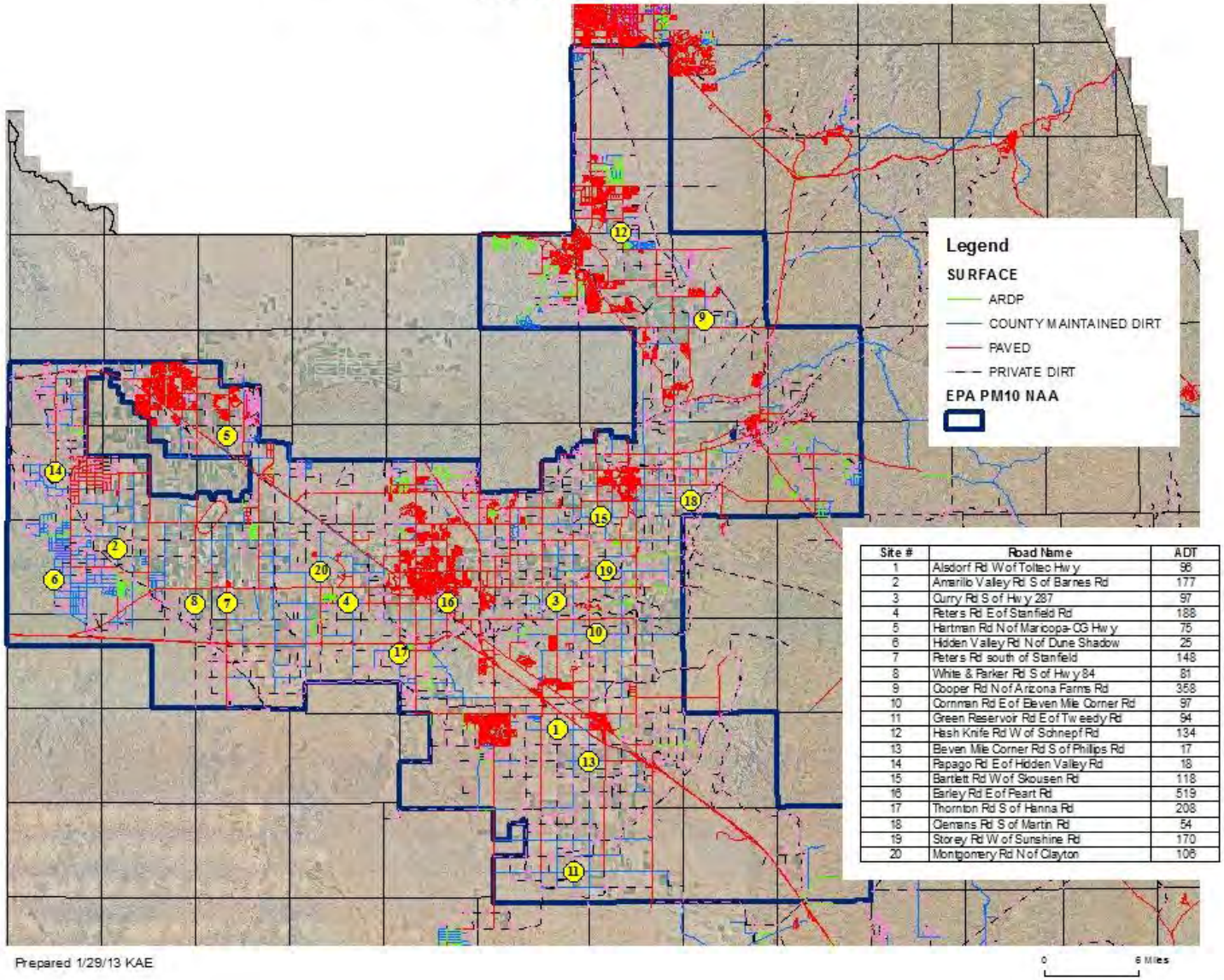


Figure 5 – Summary of Road Count Locations and ADTs

Pinal County Nonattainment Area Unpaved Road Counts
1/12/2013 - 1/18/2013



Site #	Road Name	ADT
1	Alsdorf Rd W of Toltec Hwy	96
2	Amarillo Valley Rd S of Barnes Rd	177
3	Curry Rd S of Hwy 287	97
4	Peters Rd E of Stanfield Rd	188
5	Hartman Rd N of Maricopa-CG Hwy	75
6	Hidden Valley Rd N of Dune Shadow	25
7	Peters Rd south of Stanfield	148
8	White & Parker Rd S of Hwy 84	81
9	Cooper Rd N of Arizona Farms Rd	358
10	Cornman Rd E of Eleven Mile Corner Rd	97
11	Green Reservoir Rd E of Tweedy Rd	94
12	Hash Knife Rd W of Schnepf Rd	134
13	Eleven Mile Corner Rd S of Phillips Rd	17
14	Papago Rd E of Hidden Valley Rd	18
15	Bartlett Rd W of Skousen Rd	118
16	Earley Rd E of Peart Rd	519
17	Thornton Rd S of Hanna Rd	208
18	Clemans Rd S of Martin Rd	54
19	Storey Rd W of Sunshine Rd	170
20	Montgomery Rd N of Clayton	106

Figure 6 – Average Vehicle Speeds and Average Daily Traffic Counts

As the EPA emission factor equation for unpaved road travel also includes average vehicle speed as a variable, data on vehicle speeds were collected through the use of traffic counters. Traffic Research and Analysis, Inc. (TRA) of Phoenix, Arizona installed dual tube counters on each of the five unpaved road segments in late May 2005. Each of the counters was left in place for seven days except for the counter on Amarillo Valley Road. Due to a communication gap, the Pinal County Public Works Department graded the portion of this road where the counter was located, causing the counter to cease operation after four days. After being repaired, the counter completed a seven-day traffic count in the following week. The average vehicle speeds and average daily traffic counts for each unpaved road segment are presented in Table 4.

Table 4: Average Vehicle Speeds and Average Daily Traffic Counts

Unpaved Road	Average Vehicle Speed (mph)	Average Daily Traffic Count
Alsdorf Road	42.8	153
Amarillo Valley Road	40.7	174
Curry Road	40.5	646
Peters Road	34.1	252
White & Parker Road	40.5	118

Two other factors that are constants in the EPA equation, for the purpose of this spreadsheet tool, were derived from EPA estimates and local meteorological data. The factor "C" in the EPA equation represents PM_{10} emissions from vehicle travel that are not generated by travel over unpaved roads. These emissions include particulate matter emissions from the vehicle exhaust pipe, brake wear particles, and tire wear particles. Data reported in the EPA MOBILE6.2 mobile source emission factor model lists the total of these emissions for the average light duty vehicle to be 0.00016 pounds of PM_{10} per vehicle mile traveled. This factor is subtracted from the total emissions reported by roadside testing to isolate the contribution made by travel over unpaved soil surfaces. The factor "P" in the EPA equation represents the number of days per year when rainfall reduces unpaved road travel emissions to zero. Other research referenced in AP-42 indicates that this situation occurs on any day in which 0.01 inches or more of precipitation occurs. From long-term rainfall data collected at Stanfield and Casa Grande, as tabulated on a website maintained for the National Oceanographic and Atmospheric Administration by the Desert Research Institute,[6] the annual average number of precipitation days in the agricultural district is 30 days per year. The precipitation day adjustment factor is used to adjust annual average emission factors only. The maximum 24-hour PM_{10} impacts are assumed to occur on a day with no measurable rainfall.

[6] Average Number of Days With Measurable Precipitation, Arizona, Western Regional Climate Center, NOAA and DRI, http://www.wrcc.dri.edu/htmlfiles/az/az.01.html, accessed on August 22, 2005

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Appendix 2

PM_{10} Dust Silt Contents and Moisture Contents Measurement in Pinal Nonattainment Area

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Pinal County Field Sampling and Analysis for the Silt Characterization of Unpaved Road Dust and Agricultural Soil

June 18th, 2013

FINAL REPORT

Arizona Department of

Environmental Quality

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Purpose:

The primary purpose of this field investigation was to determine the silt content of soil samples taken from unpaved roads and secondarily, determine silt content from soil samples taken from agricultural fields. Silt content is an important variable in many emission factor equations. This investigation was a joint effort between Pinal County Air Quality Control District (PCAQCD), the Arizona Department of Environmental Quality Air Quality Division (ADEQ AQD), and local farmers from Pinal County. This study took place on Wednesday May 8, 2013, at four different general locations within the Pinal County PM_{10} Nonattainment Area. JBR Environmental Consultants analyzed samples for moisture and silt content at their laboratory in Tempe Arizona[1].

Methods and Equipment:

Materials:

- Sealed Plastic Bags
- Shovels
- Dust Pan
- Dust Brushes
- Duct Tape (Sealing)
- Chain of Custody Forms
- Measuring Tape

The road samples were taken following the basic procedure developed by the Environmental Protection Agency (EPA) and published as appendix C1 in the AP-42 Emission Factor Reference Guide[2]. JBR Environmental Consultants performed laboratory analysis of the samples following the:

- ASTM C-136 Laboratory Sieve Analysis for Silt Content
- ASTM D-2216 Laboratory Determination of Moisture Content of Soil and Rock by Mass

In all, 60 total samples were taken of four different sample types and from four geographically distinct locations within Pinal County.

Results:

The sample domain table was compiled from the chain of custody forms used during sample collection. A sample number, description, date, time, and latitudinal and longitudinal coordinates

[1] JBR Environmental Consultants, 2013. Sierra Research – ADEQ Dust Study: Summary of Silt and Moisture Analyses of Soil Samples from Pinal County, Arizona, Collected on May 8th, 2013.
[2] Environmental Protection Agency (EPA), 1993. http://www.epa.gov/ttn/chief/ap42/appendix/app-c1.pdf

based on the WGS 84 Datum were used to identify each sample. Additionally, the square footage and sampling site specific notes were used to further qualify samples. The sample type refers to:

- $A = Agricultural\ Apron\ Road$
- $C = County\ Maintained\ Road$
- $F = Agricultural\ Field$
- $P = Privately\ Maintained\ Road$

Table 1 summarizes the sampling in a chronological fashion with the only sorting being the separation of the Agricultural Field Samples from the Road Samples.

Table 1: Sample Descriptions:

Sample #	Description	Type	Date	Time	Coordinates	ft^2	Comments
R1.1	Ag Apron Rd	A	5/8/2013	9:45am	32°55'22.1N 111°29'05.2W	11.5	Appearance of Heavily traffic
R1.2	Ag Apron Rd	A	5/8/2013	10:05am	32°55'18.6N 111°29'05.3W	21.0	Appearance of Heavily traffic
R1.3	Ag Apron Rd	A	5/8/2013	10:15am	32°55'16.0N 111°29'05.5W	10.0	Appearance of Heavily traffic
R2.1	Ag Apron Rd	A	5/8/2013	10:25am	32°55'13.3N 111°29'03.4W	13.0	less loose soil, parallel to canal
R2.2	Ag Apron Rd	A	5/8/2013	10:25am	32°55'13.2N 111°28'57.6W	15.6	less loose soil, parallel to canal
R2.3	Ag Apron Rd	A	5/8/2013	10:35am	32°55'13.4N 111°28'53.8W	15.0	less loose soil, parallel to canal
R3.1	Fasttrack S.	P	5/8/2013	10:45am	32°55'20.9N 111°28'49.8W	13.6	
R3.2	Fasttrack S.	P	5/8/2013	10:50am	32°55'14.6N 111°28'49.8W	15.1	
R3.3	Fasttrack S.	P	5/8/2013	10:55am	32°55'06.1N 111°28'50.0W	15.1	
R4.1	Randolph Rd	C	5/8/2013	10:50am	32°55'22.99N 111°28'52.84W	9.3	large amount of loose soil
R4.2	Randolph Rd	C	5/8/2013	10:57am	32°55'23.13N 111°29'13.24W	10.5	large amount of loose soil
R4.3	Randolph Rd	C	5/8/2013	11:05am	32°55'22.81N 111°29'39.34W	8.5	large amount of loose soil
R5.1	Storey W.	C	5/8/2013	11:44am	32°53'39.5N 111°35'36.6W	13.8	
R5.2	Storey W.	C	5/8/2013	11:57am	32°53'39.5N 111°35'49.2W	13.1	
R5.3	Storey W.	C	5/8/2013	12:11pm	32°53'39.5N 111°35'23.7W	14.1	
R6.1	Curry Apron W.	A	5/8/2013	12:23pm	32°54'18.5N 111°35'35.9W	11.1	

Sample #	Description	Type	Date	Time	Coordinates	ft^2	Comments
R6.2	Curry Apron W.	A	5/8/2013	12:36pm	32°54'18.5N 111°35'50.6W	11.1	
R6.3	Curry Apron W.	A	5/8/2013	12:44pm	32°54'18.6N 111°36'01.9W	10.1	
R7.1	Russell Apron E.	A	5/8/2013	2:31pm	32°50'06.8N 111°54'50.2W	10.9	
R7.2	Russell Apron E.	A	5/8/2013	2:37pm	32°50'06.8N 111°54'31.4W	12.2	
R7.3	Russell Apron E.	A	5/8/2013	2:42pm	32°50'06.8N 111°54'24.7W	13.0	
R8.1	Louis Johnson W.	C	5/8/2013	3:34pm	32°56'23.2N 112°03'02.6W	11.7	
R8.2	Louis Johnson W.	C	5/8/2013	3:45pm	32°56'23.2N 112°03'10.2W	10.1	
R8.3	Louis Johnson W.	C	5/8/2013	3:52pm	32°56'23.0N 112°03'50.7W	8.1	
R9.1	Barnes	P	5/8/2013	3:58pm	32°55'48.5N 112°03'54.8W	10.4	parallel to R14, same road as R9 (not Barnes)
R9.2	Barnes	P	5/8/2013	4:03pm	32°55'48.8N 112°03'41.3W	10.8	parallel to R14, same road as R9 (not Barnes)
R9.3	Barnes	P	5/8/2013	4:11pm	32°55'48.5N 112°03'26.1W	10.0	parallel to R14, same road as R9 (not Barnes)
R10.1	Ag Apron (N of Storey)	A	5/8/2013	12:00pm	32°53'43.98N 111°35'34.83W	15.0	
R10.2	Ag Apron (N of Storey)	A	5/8/2013	12:20pm	32°54'07.50N 111°35'34.07W	14.5	
R10.3	Ag Apron (N of Storey)	A	5/8/2013	12:30pm	32°53'29.05N 111°35'33.89W	9.0	
R11.1	Kleck	C	5/8/2013	12:50pm	32°54'31.87N 111°35'17.24W	11.0	
R11.2	Kleck	C	5/8/2013	12:52pm	32°54'32.0N 111°35'34.8W	17.6	
R11.3	Kleck	C	5/8/2013	12:55pm	32°54'32.17N 111°36'09.51W	25.5	
R12.1	Russell Rd	C	5/8/2013	2:36pm	32°49'58.76N 111°54'42.95W	12.0	
R12.2	Russell Rd	C	5/8/2013	2:43pm	32°50'29.24N 111°54'42.96W	11.0	
R12.3	Russell Rd	C	5/8/2013	2:50pm	32°51'06.88N 111°54'43.25W	11.5	
R13.1	Private Rd (E of Russell)	P	5/8/2013	3:00pm	32°50'59.41N 111°54'39.80W	17.0	elevated road, little loose soil
R14.1	Ag Apron (S of Louis Johnson)	A	5/8/2013	3:45pm	32°56'20.62N 112°03'26.80W	10.0	evidence of recent grading

Sample #	Description	Type	Date	Time	Coordinates	ft^2	Comments
R14.2	Ag Apron (S of Louis Johnson)	A	5/8/2013	3:50pm	32°56'02.58N 112°03'26.68W	13.0	evidence of recent grading
R14.3	Ag Apron (S of Louis Johnson)	A	5/8/2013	3:58pm	32°55'52.10N 112°03'26.63W	12.5	evidence of recent grading
R15.1	Ag Apron (S of Louis Johnson)	A	5/8/2013	4:10pm	32°55'48.33N 112°03'07.35W	9.5	located between R9/R16 and crop field
R15.2	Ag Apron (S of Louis Johnson)	A	5/8/2013	4:25pm	32°55'48.49N 112°03'29.08W	11.0	located between R9/R16 and crop field
R15.3	Ag Apron (S of Louis Johnson)	A	5/8/2013	4:30pm	32°55'48.40N 112°03'41.08W	10.5	located between R9/R16 and crop field
R16.1	Ag Apron (S of Louis Johnson)	A	5/8/2013	4:15pm	32°55'48.80N 112°03'07.48W	13.0	parallel to R14, same road as R9
R20.1	Barnes 2	P	5/8/2013	4:30pm	32°55'22.5N 112°03'56.9W	8.6	
R20.2	Barnes 2	P	5/8/2013	4:37pm	32°55'22.5N 112°03'46.2W	9.0	
R20.3	Barnes 2	P	5/8/2013	4:42pm	32°55'22.6N 112°03'28.3W	9.0	
F1.1	Field Ag Apron	F	5/8/2013	9:55am	32°55'21.1N 111°29'05.0W	NA	inactive, previously cotton
F1.2	Field Ag Apron	F	5/8/2013	10:10am	32°55'18.6N 111°29'05.2W	NA	inactive, previously cotton
F1.3	Field Ag Apron	F	5/8/2013	10:15am	32°55'13.3N 111°29'05.4W	NA	inactive, previously cotton
F2.1	Field N of Storey	F	5/8/2013	12:10pm	32°53'45.58N 111°35'35.15W	NA	Active field
F2.2	Field N of Storey	F	5/8/2013	12:25pm	32°54'20.30N 111°35'34.26W	NA	Active field
F2.3	Field N of Storey	F	5/8/2013	12:35pm	32°54'29.02N 111°35'33.93W	NA	Active field
F3.1	Cotton Field	F	5/8/2013	4:40pm	32°55'22.25N 112°03'56.90W	NA	Active field
F3.2	Cotton Field	F	5/8/2013	4:45pm	32°55'22.02N 112°03'45.10W	NA	Active field
F3.3	Cotton Field	F	5/8/2013	4:50pm	32°55'22.10N 112°03'17.60W	NA	Active field

Tables 2-5 report soil/dust moisture and silt content values as determined from the laboratory analysis completed by JBR Environmental Consultants Inc. The tables are separated based on sampling type. This is the same sorting that was used in the analysis of the results.

Due to the time constraints, soil moisture analysis was conducted on a few random samples to assess the variability in soil moisture within sample types. The moisture content was then evaluated from these samples and it was determined that the variation in moisture content was minimal and did not necessitate additional analyses. The silt content values were determined for each sample and those results are presented in these tables as well. ADEQ AQD, PCAQCD, and JBR Environmental Consultants collected, processed and analyzed all of the samples in the same fashion following the methods described in the previous section.

Table 2: Agriculture Apron Road Moisture and Silt Content Percentages:

Ag Apron Road Sample	Soil Moisture Content	Silt Content
R1.1		13.3
R1.2		3.9
R1.3	1	19
R2.1		14.5
R2.2		12.9
R2.3		15.8
R6.1		17.2
R6.2		17
R6.3		9.3
R7.1		6.9
R7.2	0.5	14.9
R7.3		12.9
R10.1		9.4
R10.2	0.6	4.3
R10.3	0.8	9.8
R14.1		22.6
R14.2		3
R14.3		9.4
R15.1		11.7
R15.2	1	32.9
R15.3	1	38.4
R16.1		7.3

Table 3: Private Unpaved Road Moisture and Silt Content Percentages:

Private Road Sample	Moisture Content	Silt Content
R3.1		2.7
R3.2	0.2	12
R3.3		8.5

R9.1	0.2	11.7
R9.2	0.3	16.1
R9.3	0.4	19.9
R13.1		16.5
R20.1		17
R20.2	0.3	18.2
R20.3	0.4	21.2

Table 4: County Maintained Road Moisture and Silt Content Percentages:

County Road Sample	Moisture Content	Silt Content
R4.1		6.6
R4.2		2.7
R4.3		4.7
R5.1	0.3	10.8
R5.2	0.3	3.1
R5.3	0.2	9.9
R8.1	0.2	9.5
R8.2	0.2	9.5
R8.3		6.7
R11.1		12
R11.2	0.3	10.5
R11.3		7.4
R12.1		1.2
R12.2		3.4
R12.3	0.4	8.1

Table 5: Agricultural Field Moisture and Silt Content Percentages:

Field Sample	Moisture Content	Silt Content
F1.1		10.2
F1.2	1.9	12.7
F1.3		5.8
F2.1		13.5
F2.2	5.9	15.5
F2.3		1.1
F3.1		1
F3.2	1.4	32.1

F3.3	17.3

Analysis and Discussion:

ADEQ AQD completed a brief statistical analysis of the silt and soil moisture contents to determine the general tendencies and variability of the study results. The following boxplots and table illustrate and describe the results in a fashion that allows some conclusions to be made about the silt content of different unpaved road types and agricultural fields in Pinal County.

Table 6: Statistical Analysis of the Four Sample Types

Type	Description	Mean Soil Moisture Content (%)	Soil Moisture Content SD	Mean Silt Content (%)	Silt Content SD
A	Agricultural Apron Road	0.8	0.2	13.9	8.7
C	County Maintained Road	0.3	0.1	7.1	3.4
P	Private Road	0.3	0.1	14.4	5.7
F	Agricultural Field	3.1	2.5	12.1	9.5

The moisture contents of the different sample types were generally comparable in the case of the agricultural fields. JBR only analyzed three agricultural field samples for moisture content (one from each field), resulting in a right-skewed distribution. The other sample types had a greater number of samples analyzed for moisture content, and in general exhibited more consistent moisture content percentages than the limited number of field samples.

Private and county maintained roadways had lower average moisture contents than the Agriculture apron roads, which border irrigated agricultural fields. Additionally, the agricultural field samples exhibited greater average moisture content than all sample types. Additionally, the standard deviation indicates that the sample population variance of moisture content is greater for agricultural fields than it is for unpaved road surfaces. This can be expected as different crop types will require different soil moisture contents.

JBR's laboratory performed a complete silt content analysis of all samples across sample types. The statistical tests and plots indicate that county maintained roads had the lowest average silt content, with privately maintained road, agricultural apron road and agricultural field samples having average silt content percentages between 12 and 15 percent. The county maintained roads also had the lowest variance in silt content, followed by privately maintained roads, agricultural apron roads, and agricultural fields respectively.

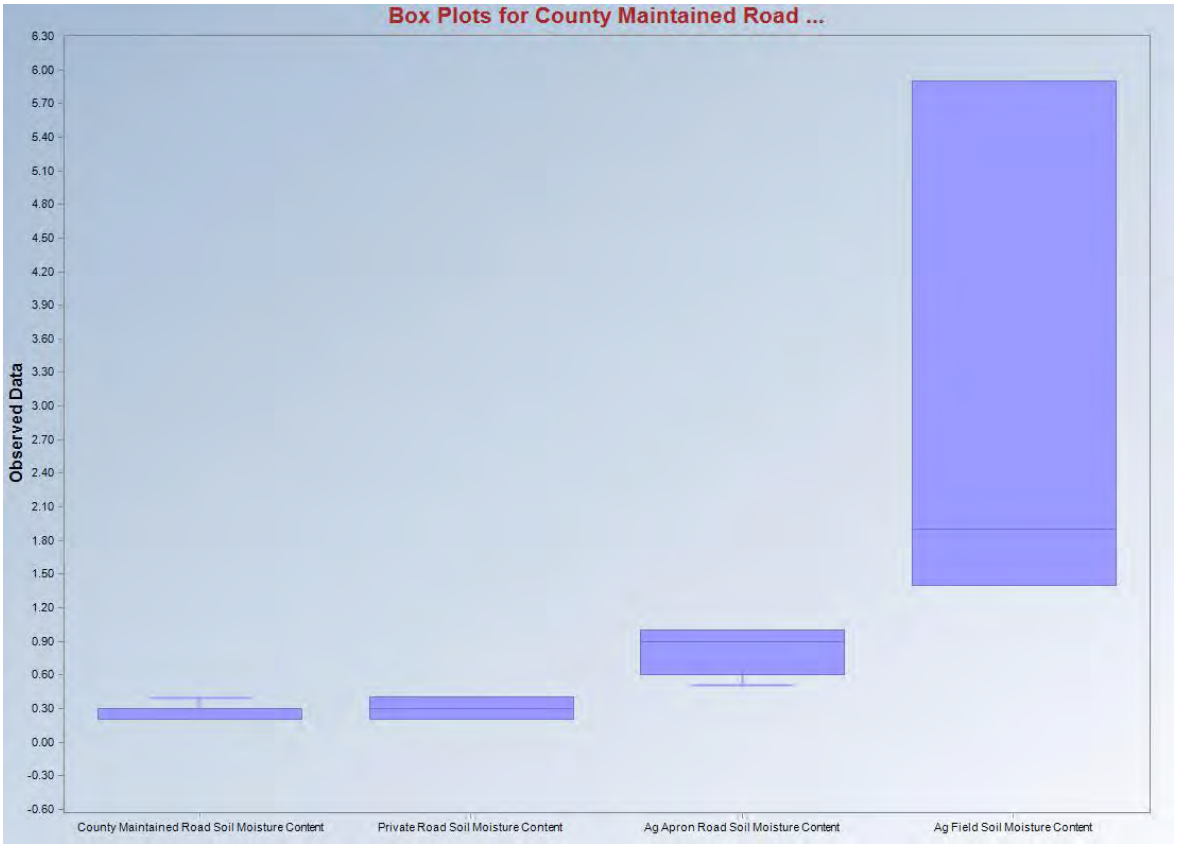

Figure 1: Soil Moisture Box Plot

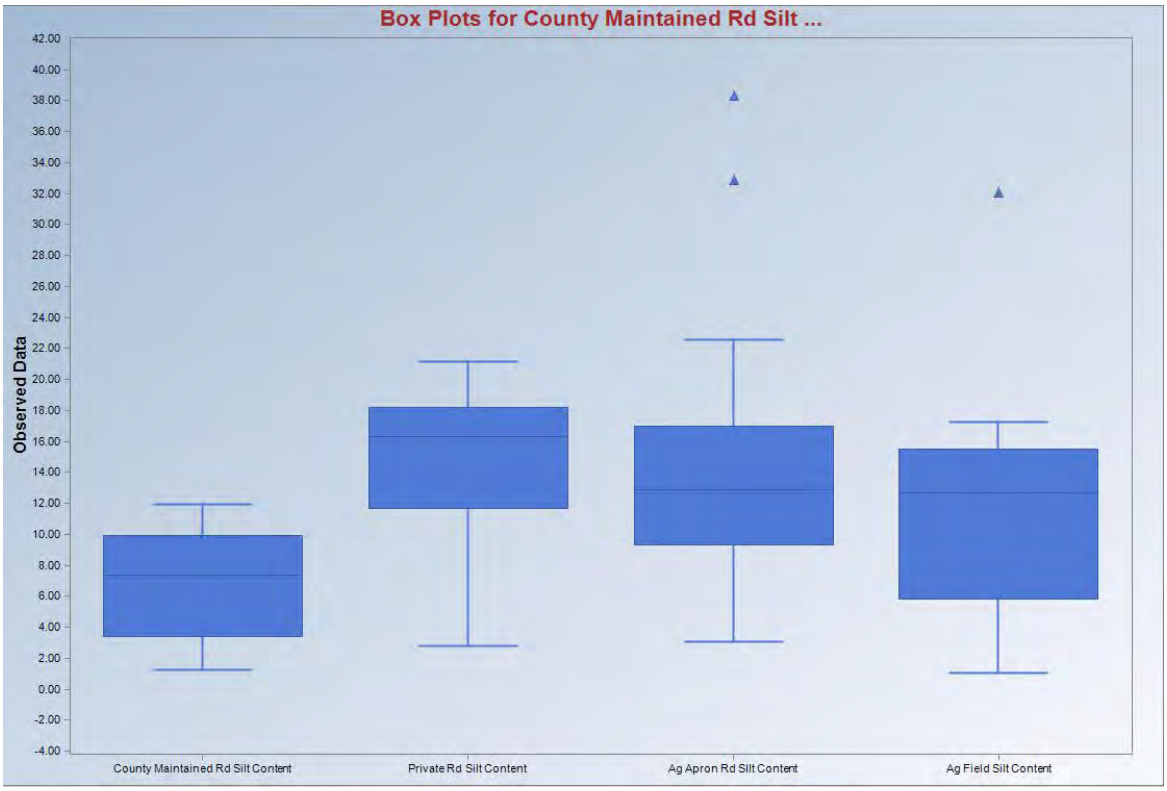

Figure 2: Silt Content

Pinal County Analysis:

PCAQCD expanded upon the analysis of Soil Samples taken on May 8, 2013 by computing the mean silt content per road sampled. Additionally, PCAQCD expanded the sample size by including soil sampling done on two previous dates[3]. ADEQ and PCAQCD analyzed silt content samples for unpaved agricultural apron roads, unpaved county maintained roads, and agricultural fields. Two samples were taken at each of these sites. ADOT also compiled silt content values for unpaved county maintained roads during sampling completed in June of 2005. The work done by PCAQCD summarizes the soil sampling data available from Pinal County since 2005.

In PCAQCD's analysis, sample averages from a given road or field were calculated to determine the mean silt content on both a total sample site basis and road/field basis. The **"site"** mean was the mean as calculated from all samples of the three data sets. The **"road"** was calculated by averaging samples on a given roadway/field to calculated a mean value of that individual roadway/field and then averaging the individual roadway/field means for a given road type/land use type to determine a road/land use type mean silt content. The following table gives the mean of each different road/land use type sampled over the three sampling periods.

[3] PCAQCD, 2013. Analysis of Unpaved Roads in the Pinal County PM10 Nonattainment Area.

Table 7: Three Study Mean Silt Content Values

	Ag Apron Rd		**County Rd**		**Private Rd**		**Ag Fields**	
	Site	Road	Site	Road	Site	Road	Site	Road
Mean (%)	14.9	15.8	7.1	7.2	14.4	14.7	13.1	14.2

Appendix 3

Pinal County Crops Calendar
Provided by Pinal County Air Quality Control District

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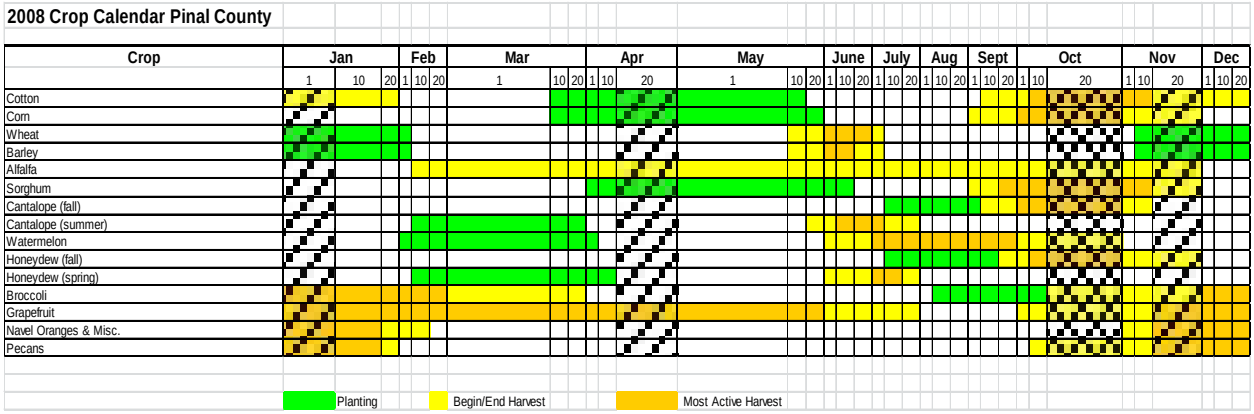
Pinal County Crops Calendar



Source: Pinal County Air Quality Control District

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Appendix 4

Traffic Counts (ADT levels) for the Unpaved Roads in Each of the Modeling Domain

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Figure 1
ADTs of the Unpaved Roads for North Cowtown Stagnation Day and Low wind Hour Modeling Domain

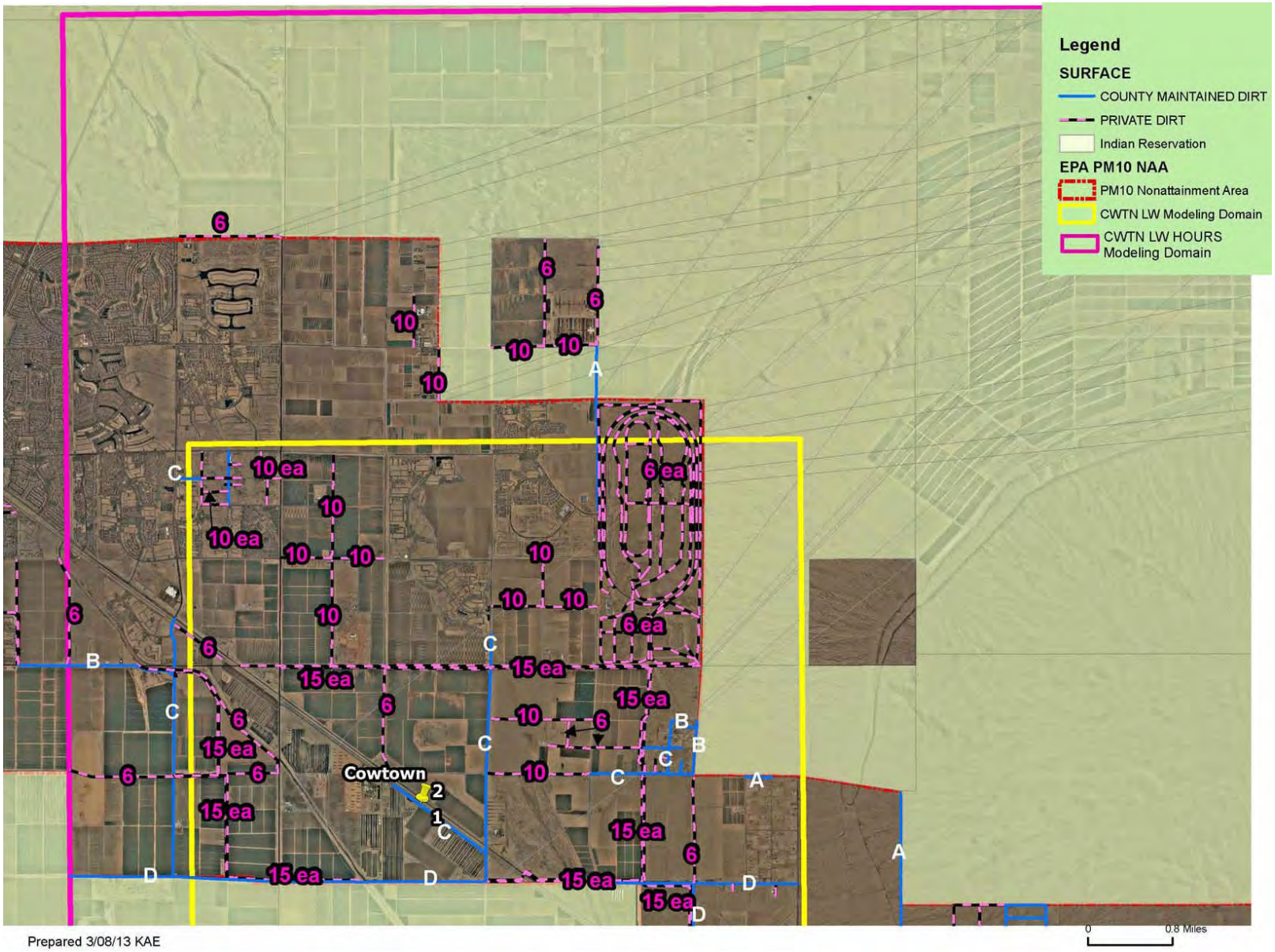


Figure 2
ADTs of the Unpaved Roads for South Cowtown Stagnation Day and Low wind Hour Modeling Domain

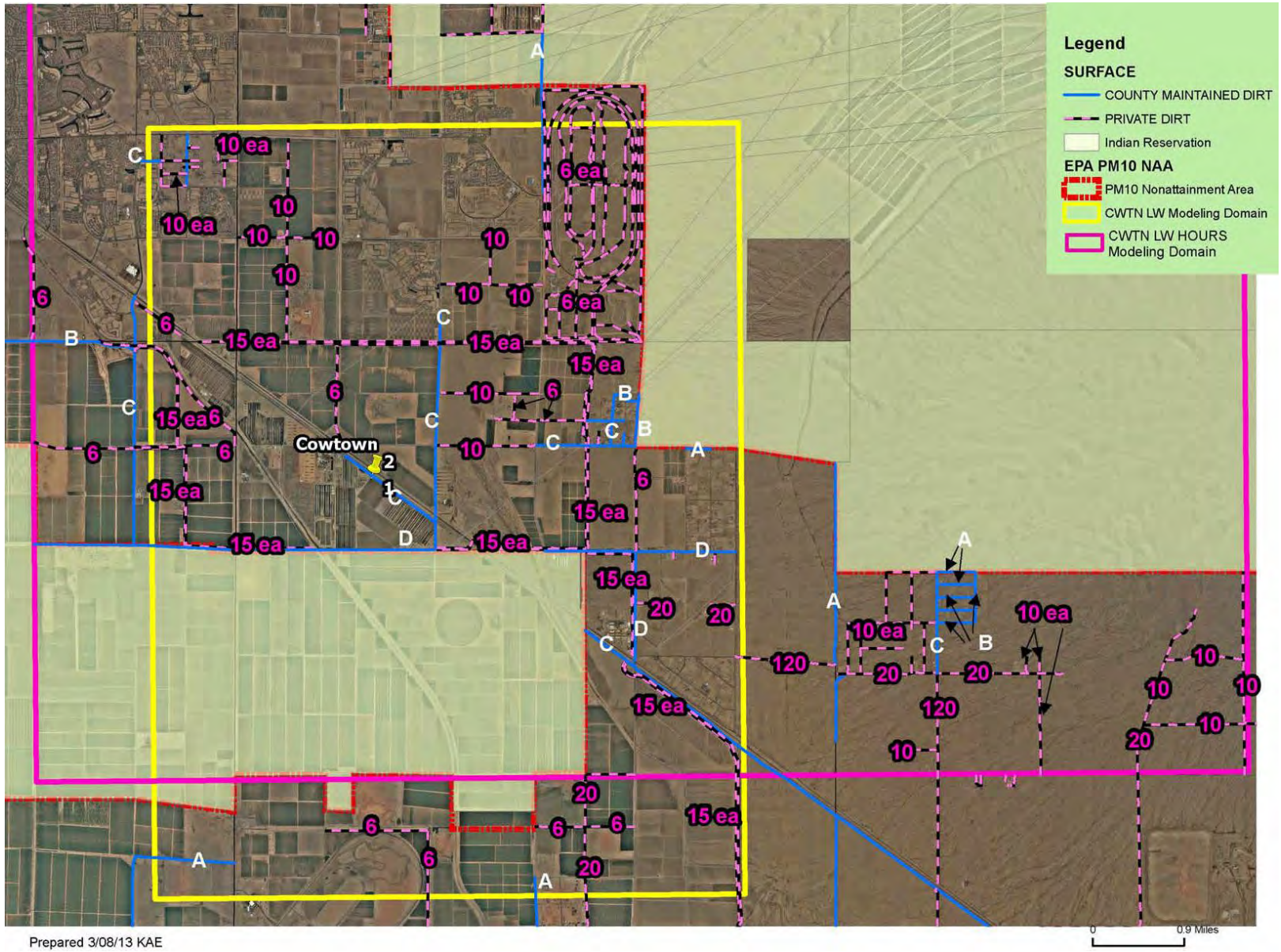
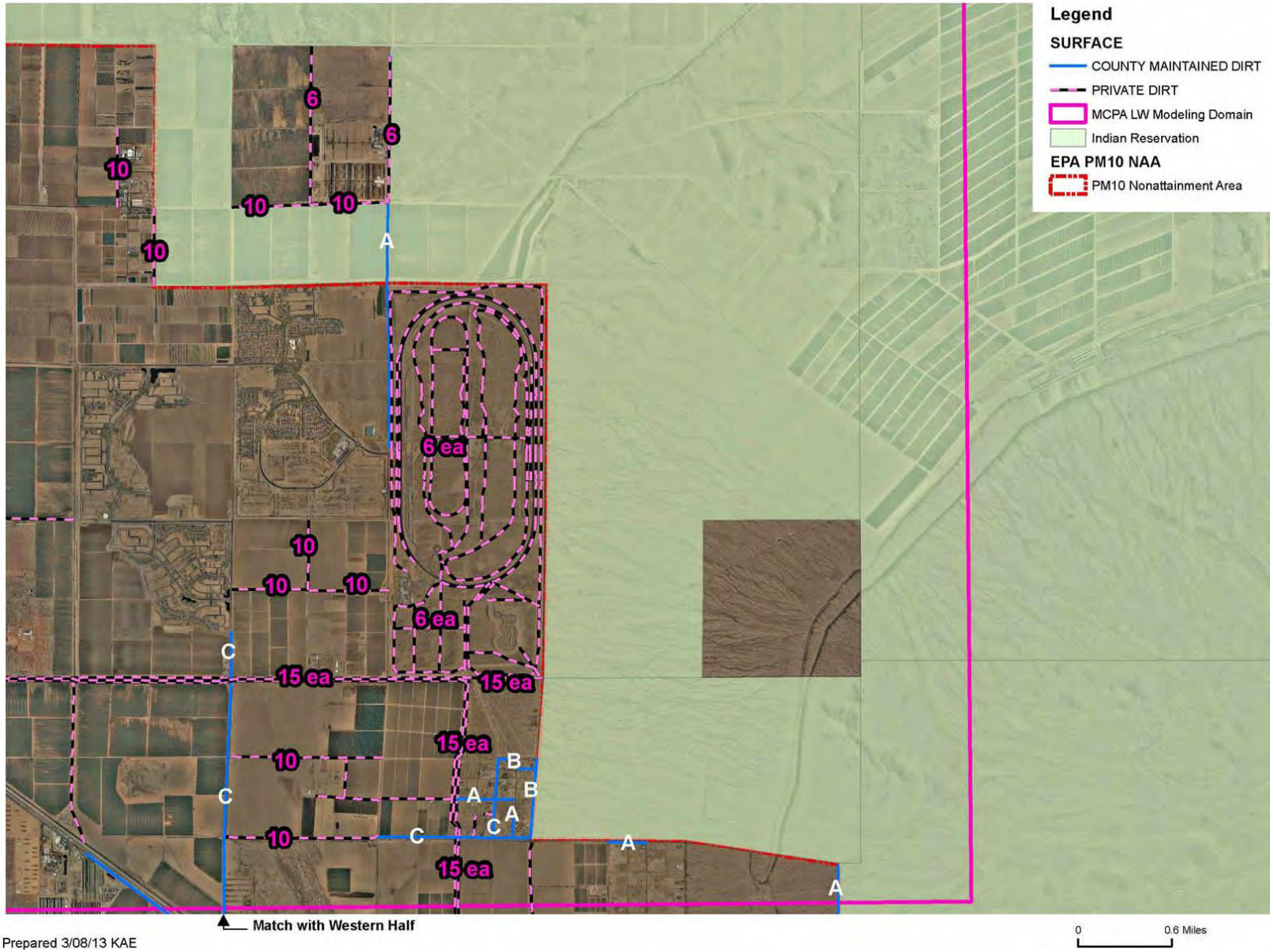
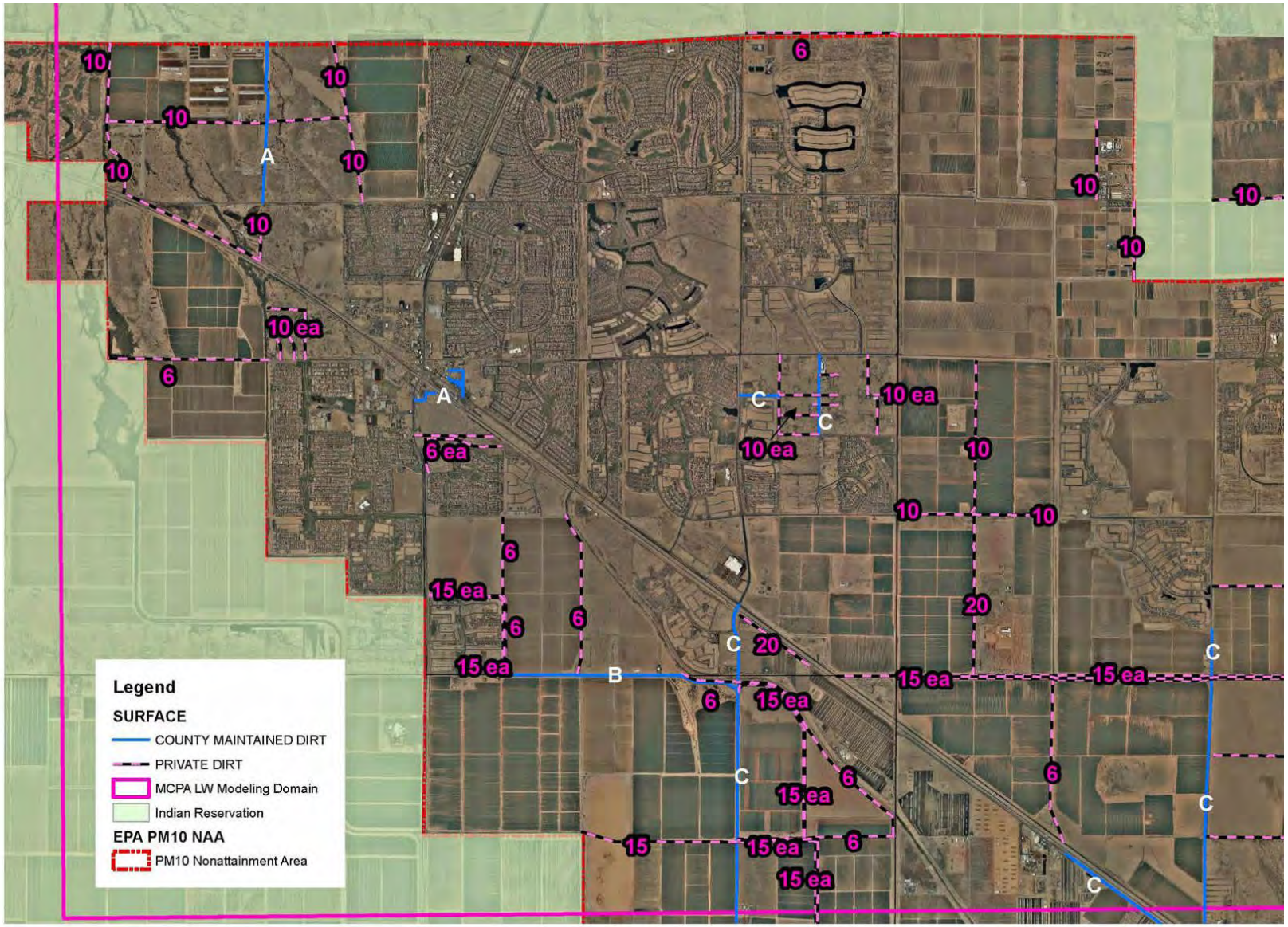


Figure 3
ADTs of the Unpaved Roads for Maricopa Low wind Hour Modeling Domain (Eastern half)



Prepared 3/08/13 KAE

Figure 4
ADTs of the Unpaved Roads for Maricopa Low wind Hour Modeling Domain (Western half)



Prepared 3/08/13 KAE

Figure 5
ADTs of the Unpaved Roads for Pinal County Housing Stagnation Day Modeling Domain

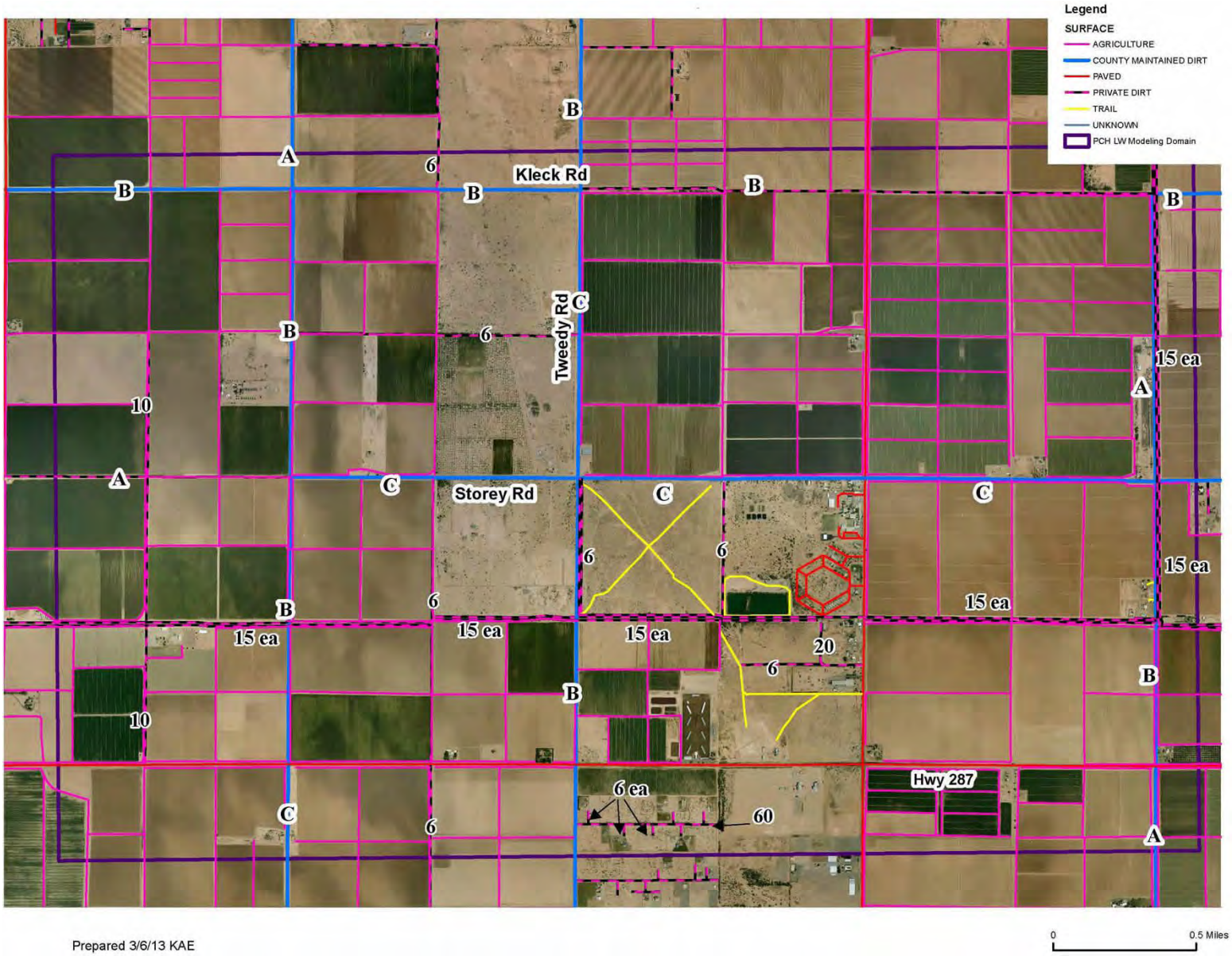


Figure 6
ADTs of the Unpaved Roads for Pinal County Housing Low Wind Hour Modeling Domain

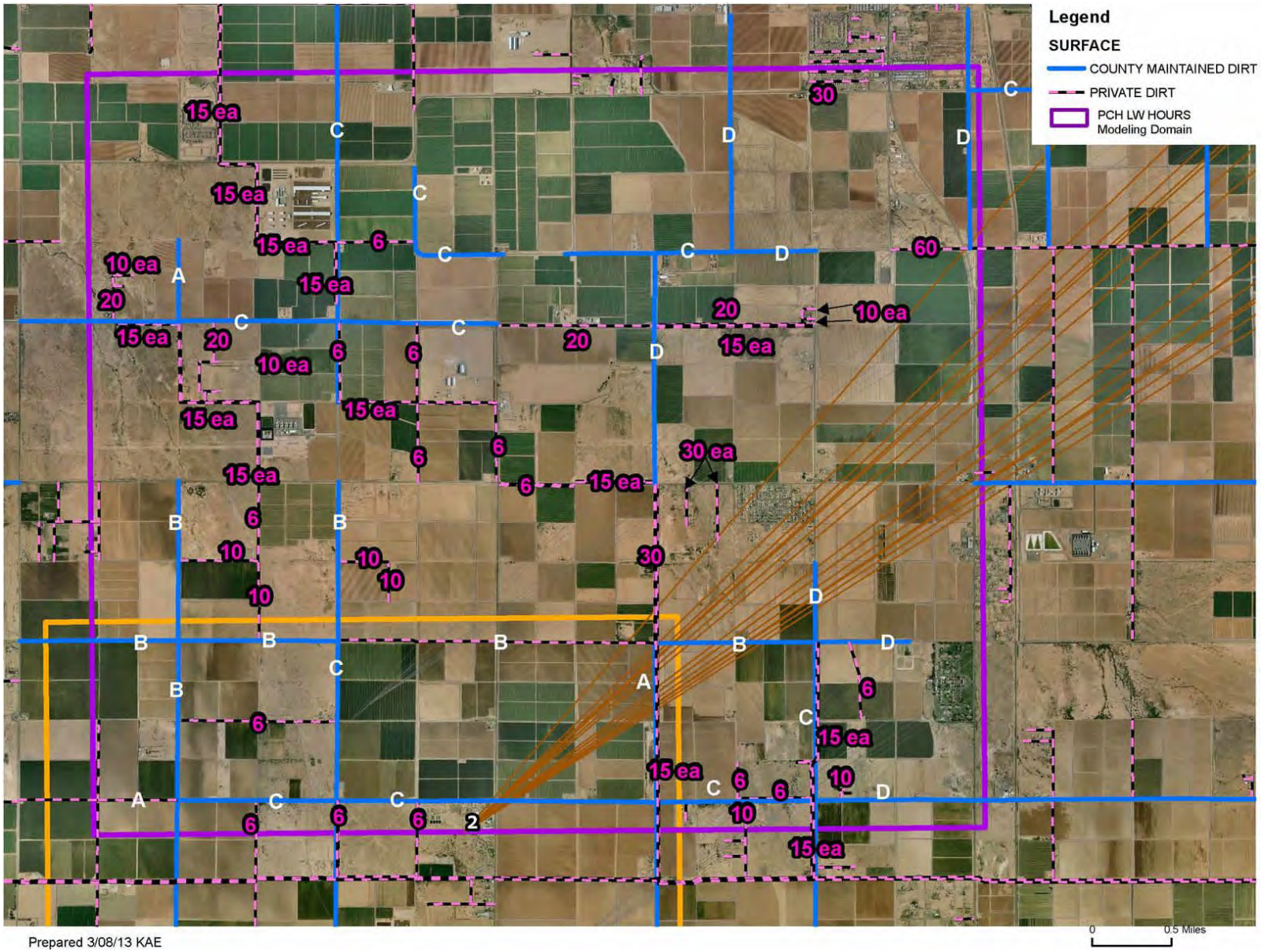


Figure 7
ADTs of the Unpaved Roads for Stanfield Stagnation Day and Low Wind Hour (Western half) Modeling Domain

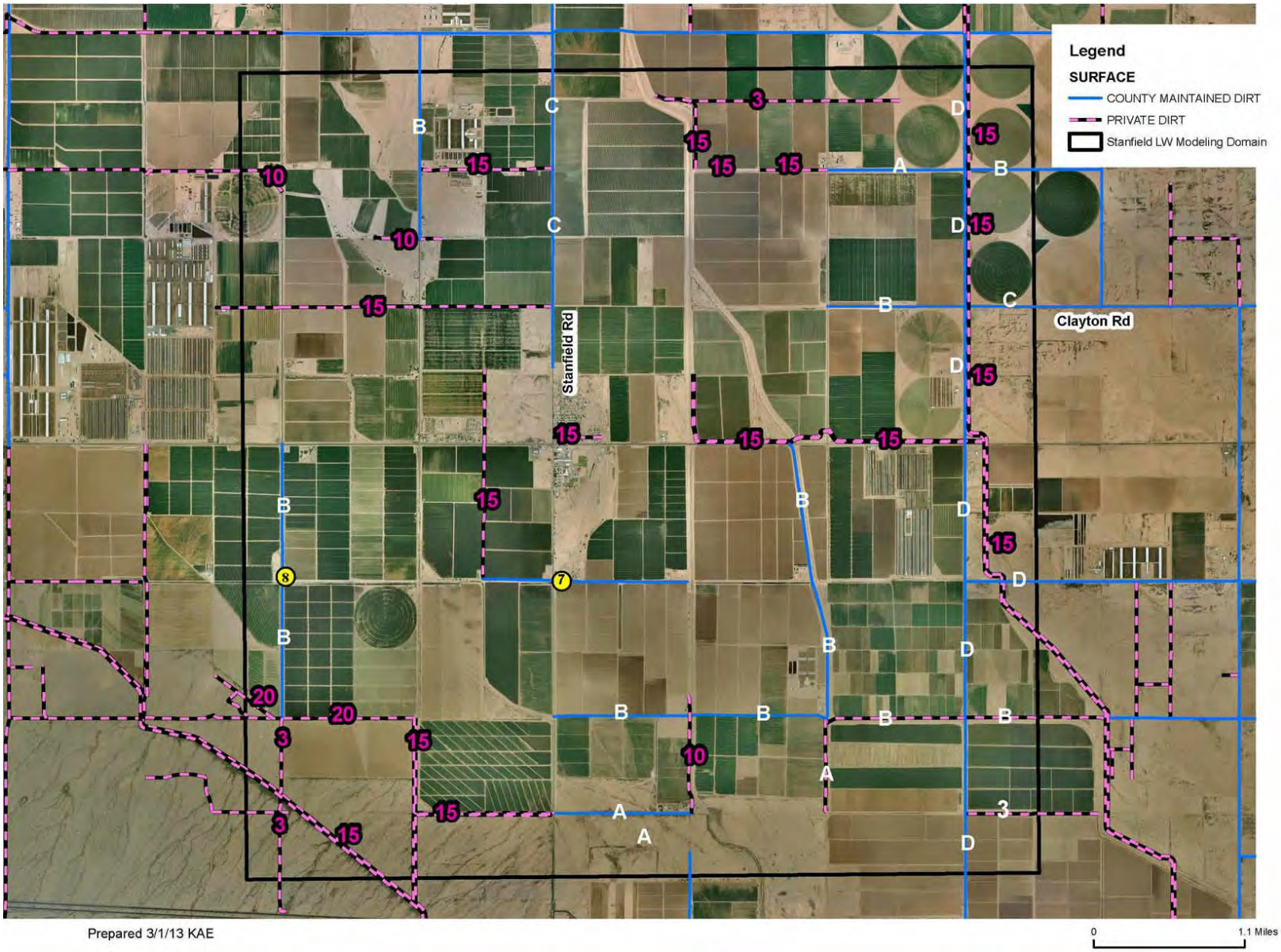
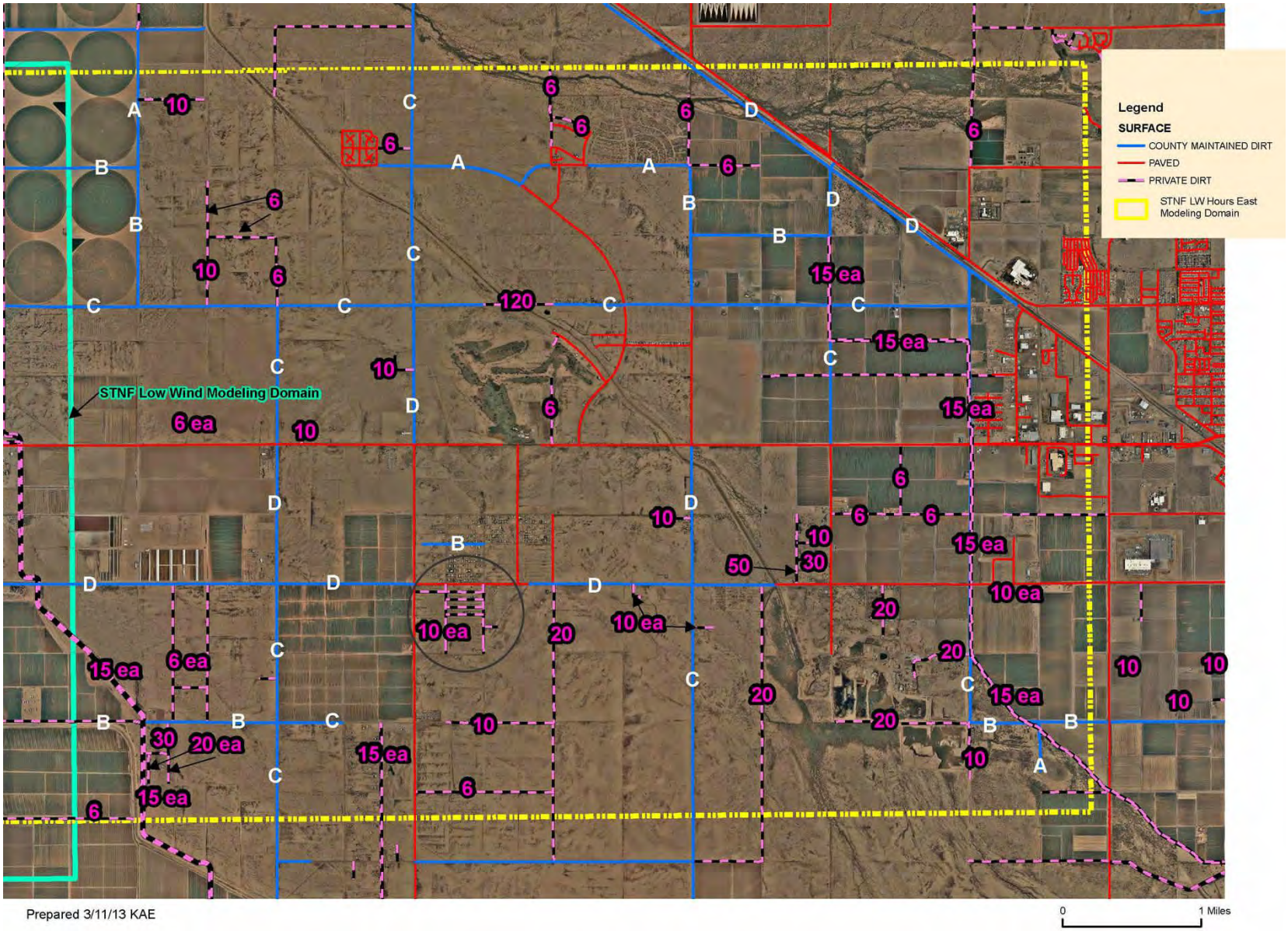


Figure 8
ADTs of the Unpaved Roads for Low Wind Hour (Eastern half) Modeling Domain



Appendix 5

Methodology for Estimating Windblown Emission Factors Within 1 MPH Wind Speed Bins

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Methodology for Estimating Windblown Emission Factors Within 1 MPH Wind Speed Bins

Maricopa Association of Governments' Approach

In the emission inventory for the Maricopa Association of Governments' (MAG) Five Percent PM_{10} Nonattainment Plan, windblown PM_{10} emissions were estimated on an annual basis for the base year of 2008. Because high wind emission rates are more closely correlated with very short-term wind gust velocities than with hourly average wind speeds, due to the power relationship between emission rates and wind speeds, MAG staff used average wind speeds measured over the shortest intervals reported by the Maricopa County Air Quality Department's continuous monitors, which were 5-minute averaging periods. Five-minute average wind speeds exceeding 12 mph, the threshold speed for dust entrainment determined by MAG on the basis of region-wide monitoring data, were extracted from the meteorological datasets and sorted into wind speed bins generally spanning 5 mph intervals. The wind speed bins were set at 12 – 15 mph, 15 – 20 mph, 20 – 25 mph, 25 – 30 mph, and 30 – 35 mph in order to develop disturbed soil emission factors within each wind speed bin. The upper limit of these bins was dictated by the highest 5-minute average wind speed recorded in the MAG PM10 nonattainment area in 2008.

Emission factors were computed for each wind speed bin on the basis of wind tunnel studies of exposed soils in Maricopa and Pinal Counties conducted by Nickling and Gillies.[1] MAG staff concluded from this study that emission factors for the soils categorized by land use type were sufficiently similar to each other as to allow for the use of a single composite emission factor to represent and be used to compute windblown emissions from all soils in the nonattainment area with the exception of those used for agricultural cultivation. The composite emission factor used in the Five Percent Plan for windblown PM_{10} from disturbed non-agricultural soils was $4.36 \times 10^{-15} u^{*4.3961}$ g/cm^2-sec, where u* was the friction velocity reported by Nickling and Gillies for all non-agricultural soils tested.

Since the Five Percent Plan emission inventory was designed to be an annual inventory, windblown PM_{10} emissions were computed on an annual basis. To do this, MAG staff first converted the wind speed representing the midpoint of each wind speed bin to an equivalent friction velocity using the Prandtl equation,[2] and then computed the PM_{10} emission rate for winds within each speed bin from the bin-specific friction velocity using the composite Nickling and Gillies emission factor equation (above). Emission rates, in tons/acre-5 minute period, were multiplied by the total number of 5-minute periods in each speed bin and then summed over all speed bins to develop an annual emission rate for disturbed soils. The ratio of PM_{10} emissions measured in more recent wind tunnel testing near Barstow, California of disturbed and

[1] Evaluation of Aerosol Production Potential of Type Surfaces in Arizona, prepared for Engineering-Science by W.G. Nickling and J.A. Gillies, for EPA Contract No. 68-02-380, September 1986.

[2] The fluid dynamics Prandtl equation: $U = (u^*/k) \times \ln(z/z_0)$, where U is the wind speed measured at an amemometer z meters above the ground surface, u* is the friction velocity, k is the Von Karmen constant approximating 0.4, and z_0 is the roughness height of the ground surface.

undisturbed soils was applied to the annual emission factor for disturbed soils to derive an annual emission factor for undisturbed soils in the MAG nonattainment area. Total annual windblown PM10 emissions in the Plan were then computed by multiplying these emissions factors by the total estimated areas of disturbed and undisturbed soils in the nonattainment area.

Western Pinal County Modifications

In deriving windblown PM_{10} emission factors for the Pinal County PM_{10} design day emission inventories, Sierra used the basic MAG approach as this methodology was previously approved by EPA. Wind speed data reported as hourly averages have been recorded by the Pinal County Air Quality Control District (PCAQCD) for a number of years at each of the Pinal County Housing, Cowtown, and Stanfield monitoring stations for which attainment demonstrations are required. Only in more recent years have the meteorological dataloggers at these sites been programmed to record wind speed averages with 5-minute resolution, however. As a result, to match the MAG approach as best as possible, the available 5-minute high wind data were used to calculate equivalent hourly average emission factors with the same wind speed bins used by MAG, and these factors were then applied to hours on attainment demonstration design days when hourly average wind speeds were within the same speed bin.

The calculation of equivalent hourly emission factors from 5-minute emission factors was done by preparing histograms of 5-minute wind speeds within each hourly average wind speed bin. At each monitor, hourly wind speed data exceeding 12 mph were extracted from the recent year records and sorted into the same wind speed bins used by MAG. Then, the 5-minute average wind speed data recorded during all of the hours listed within a single hourly wind speed bin were extracted from the same database and also sorted into the same wind speed bin design. The numbers of 5-minute averages within each bin were totaled and used to populate the histogram of 5-minute wind speed periods within each hourly wind speed bin. An example table of this distribution for the Pinal County Housing site in 2012 is presented in Table 1.

Table 1
Distribution of 5-Minute Wind Speed Periods in Each Hourly Wind Speed Bin

Count of mph	Column Labels					
Row Labels	0.00	12.00	15.00	20.00	25.00	Grand Total
12.00	200	402	163	3		768
15.00	5	74	323	42		444
20.00			27	44	1	72
Grand Total	**205**	**476**	**513**	**89**	**1**	**1284**

In this example, for the hourly wind speed bin of 12 – 15 mph, approximately 26% of 5-minute wind speed averages were less than 12 mph (= 200/768), 52% were between 12 - 15 mph (= 402/768), 21% were between 15 – 20 mph, and 0.4% were between 20 – 25 mph (= 3/768).

Emission factors were computed for each of the midpoints of these wind speed ranges, and these factors were (1) multiplied by the corresponding fractions of 5-minute periods contained each range, and (2) the products from each range were summed together to produce an equivalent hourly emission factor for each speed bin range that represents the contributions of the 5-minute average emission factors for the same hours.

At the Pinal County Housing site, no hourly wind speed higher than 25 mph was recorded in the recent year data. Thus, the highest hourly wind speed range for which an emission factor was computed was the 20 – 25 mph range. The composite hourly emission factors developed for each wind speed bin were then applied to all disturbed soils in the modeling domain on each hour of the attainment design day of 1/1/2008 at the Pinal County Housing site on which the hourly average wind speed fell within the same speed bin. Corresponding emission factors for undisturbed soils in the modeling domain were computed by applying the Barstow emission factor ratio[3] for disturbed to undisturbed soils to the disturbed soil emission factors in each wind speed bin.

Because the Pinal County Housing 5-minute average wind speed data grouped almost all high wind speeds within only two 5 mph speed bins, the high wind design day modeling for this site reported a limited range of windblown PM_{10} emission rates for disturbed and undisturbed lands. This range did not correspond well with the range of PM_{10} concentrations recorded during high wind hours at the monitor, and the reason was deduced to be the very limited number of speed bins in which PM_{10} emission factors were constant. To improve this correspondence, the MAG method of using 5 mph speed bins for emission calculations was altered to use 1 mph speed bins. This change resulted in 10 wind speed bins, and accompanying emission factors, being used to characterize hourly average windblown PM_{10} emission rates from disturbed and undisturbed lands instead of the two speed bins produced by use of the MAG method.

Histograms of 5-minute average wind speeds within each 1 mph wind speed bin were constructed using the same method used by MAG for 5 mph speed bins. Hourly average wind speeds recorded at the Pinal County Housing monitor at the same time as 5-minute average speeds were sorted into 1 mph speed bins, and the histograms of 5-minute average speeds related to these hours were compiled. The histograms developed from the Pinal County Housing (PCH) and Stanfield wind speed data are shown in Tables 2 and 3, respectively.

Windblown PM_{10} emission factors were calculated from the histograms of 5-minute wind speeds tabulated in Tables 2 and 3. The MAG emission factor equation for disturbed soils (PM_{10} emission factor = 4.36x10-15u*4.3961 g/cm2-sec where u* is the friction velocity) was used to calculate emission factors at the midpoints of 1 mph speed bins and used to represent all 5-minute periods within each bin. Then, within each hourly average 1 mph wind speed bin, the numbers of 5-minute periods were multiplied by the associated emission factors and averaged to produce hourly average emission factors.

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[3] See Appendix 4 of the 2008 Maricopa PM10 Periodic Emission Inventory: "As a surrogate, the ratio of stable to disturbed vertical fluxes found in the wind tunnel studies performed in Barstow, California (Macpherson et al., 2008) was used to develop the vertical flux for stable land uses."
http://www.maricopa.gov/aq/divisions/planning_analysis/docs/2008_PM10/App4_WindblownDust.pdf

Table 2
Distribution of 5-Minute Wind Speed Periods in Each 1 Mph Wind Speed Bin using the Hourly and 5-Minute Wind Speed Data Collected at PCH

Count of 5min Bin	Column Labels															
Row Labels	**0**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**28**	**Grand Total**
12	106	75	46	24	7	4		2								264
13	66	57	53	33	28	14	7	4		1			1			264
14	28	31	41	42	48	27	12	8	2	1						240
15	5	6	12	16	26	24	9	5	4	1						108
16		5	8	19	28	35	32	18	7	3	1					156
17			1	4	12	9	14	8	4	7	1					60
18			2	1	6	11	15	20	15	7	5		2			84
19							6	6	9	11	2		2			36
20						1	2	5	10	4	8	5	1			36
21					1	1	2	2	3	6	7	3	7	3	1	36
Grand Total	**205**	**174**	**163**	**139**	**156**	**126**	**99**	**78**	**54**	**41**	**24**	**8**	**13**	**3**	**1**	**1284**

Table 3
Distribution of 5-Minute Wind Speed Periods in Each 1 Mph Wind Speed Bin using the Hourly and 5-Minute Wind Speed Data Collected at Stanfield

Count of 5MinBin	Column Labels																	
Row Labels	**0**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**27**	**28**	**Grand Total**
12	238	159	110	45	28	13	7	5	3	2	1		1					612
13	67	89	85	80	33	15	7	1	1	2			2	1	1			384
14	60	30	69	83	81	44	28	11	7	3		1		1		1	1	420
15	12	18	28	43	66	42	23	8	7	4		1						252
16	3		5	15	16	17	19	8	7	4	2							96
17					1	4	4	1	2									12
18	1		1	1	2	4	3	11	3	5	2		2	1				36
19					1	1	3	1	1	1	3	1						12
Grand Total	**381**	**296**	**298**	**267**	**228**	**140**	**94**	**46**	**31**	**21**	**8**	**3**	**5**	**3**	**1**	**1**	**1**	**1824**

Tables 4 and 5 present the resulting emission factors, by 1 mph hourly average wind speed bin, derived from the PCH and Stanfield 5-minute and hourly average wind speed data using the composite Nickling and Gillies emission equation for all land uses.

Table 4
High Wind Emission Factors Based on PCH 5-Minute Wind Speed Data

Wind Speed Bins (mph)	Disturbed Soil	Stable Soil
	EF (g/m^2-sec)	EF (g/m^2-sec)
12	4.06E-05	8.20E-06
13	6.97E-05	1.41E-05
14	9.87E-05	1.99E-05
15	1.33E-04	2.68E-05
16	1.72E-04	2.98E-05
17	2.17E-04	3.76E-05
18	2.73E-04	4.74E-05
19	3.57E-04	6.19E-05
20	4.11E-04	7.12E-05
21	5.48E-04	8.19E-05
22	4.06E-04	6.06E-05
23	4.93E-04	7.37E-05
24	5.95E-04	8.89E-05
25	7.12E-04	1.06E-04
26	8.46E-04	1.11E-04
27	9.99E-04	1.31E-04
28	1.17E-03	1.54E-04
29	1.37E-03	1.79E-04
30	1.59E-03	2.08E-04

Table 5
High Wind Emission Factors Based on STF 5-Minute Wind Speed Data

Wind Speed Bins (mph)	Disturbed Soil	Stable Soil
	EF (g/m^2-sec)	EF (g/m^2-sec)
12	1.11E-05	2.24E-06
13	3.13E-05	6.31E-06
14	4.93E-05	9.94E-06
15	7.16E-05	1.44E-05
16	1.01E-04	1.76E-05
17	1.31E-04	2.27E-05
18	1.33E-04	2.31E-05
19	1.95E-04	3.38E-05
20	2.63E-04	3.93E-05
21	3.24E-04	4.85E-05
22	3.96E-04	5.92E-05
23	4.80E-04	7.17E-05
24	5.76E-04	8.61E-05
25	6.87E-04	9.13E-05
26	8.13E-04	1.08E-04
27	9.57E-04	1.27E-04
28	1.12E-03	1.49E-04
29	5.18E-03	6.78E-04
30	5.71E-03	7.48E-04

Appendix 6

Evaluation of a Wind Erosion PM10 Emission Equation for Agricultural Lands in the Western Pinal County PM10 Nonattainment Area

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Evaluation of a Wind Erosion PM_{10} Emission Equation for Agricultural Lands in the Western Pinal County PM_{10} Nonattainment Area

In the compilation of emission factors for windblown PM_{10} in the Maricopa County Air Quality Department's (MCAQD) 2008 Periodic Emission Inventory (PEI) for PM_{10} and the Maricopa Association of Government's (MAG) 2012 Five Percent Plan for PM_{10} for the Maricopa County Nonattainment Area, different equations were used to compute factors for agricultural and non-agricultural lands. The equation chosen for agricultural lands did not account for wind speed, which the bulk of windblown dust research has demonstrated is one of the dominant factors influencing the magnitude emissions rates. Because of the clear relationship between hourly-average wind speed and PM_{10} concentrations at each of the Pinal County PM_{10} monitoring stations for which a 24-hour attainment demonstration was proposed, Sierra Research concluded that the MAG equation for agricultural lands was not satisfactory and the development of a windspeed-based equation was undertaken. This appendix summarizes the effort to evaluate and select a substitute equation for quantifying windblown PM_{10} emissions in the Pinal County PM_{10} nonattainment area.

Nickling and Gillies Study – In 1986, W.G Nickling and J.A. Gillies[1] conducted portable wind tunnel tests of the windblown PM_{10} potential of soil surfaces at 13 sites in Arizona to assess emission thresholds and rates in support of several objectives. These objectives included the development of an analytical tool for estimating total PM_{10} emissions of anthropogenically disturbed soils during a regional high event, and to quantify the particle size distribution of windblown dust from these surfaces for use in constructing emission inventories for the then-proposed PM_{10} national ambient air quality standard. Sites that were tested were located primarily in Maricopa and Pinal Counties in central Arizona.

Many of the wind tunnel tests were conducted on soils that had been freshly disturbed for economic or recreational reasons. Such lands included active construction sites, agricultural fields, mine tailings piles, off-road vehicle use areas, and disturbed desert lands. The remainder of tests were conducted on soils that were relatively undisturbed, such as dry river bottoms, isolated desert lands, and abandoned agricultural lands. In each test, measurements were made of threshold velocities for the wind entrainment of dust, and vertical and horizontal particulate and sand flux rates as functions of wind speed. At the conclusion of data collection and analysis, the authors attempted to relate PM_{10} emissions rates to different soil characteristics with limited success.

MCAQD 2008 PEI Windblown PM_{10} Methodology – The windblown PM_{10} emission inventory that is contained in the MCAQD 2008 Periodic Emission Inventory (PEI)[2] is calculated using two different emission factor equations: one equation, derived from the Nickling and Gillies 1986 study, was applied to all non-agricultural lands; a second equation, derived from research conducted by the U.S. Department of Agriculture's Soil Conservation Service, was applied to agricultural lands.

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[1] "Evaluation of Aerosol Production Potential of Type Surfaces in Arizona," prepared for Engineering-Science by W.G. Nickling and J.A. Gillies, for EPA Contract No. 68-02-380, September 1986.

[2] "2008 PM10 Periodic Emissions Inventory for the Maricopa County, Arizona, Nonattainment Area," Maricopa County Air Quality Department.

Analysis conducted by MCAQD of the relationships between shear velocity (a measure of the rate at which wind speed near the ground increases with height above the ground) and PM_{10} emissions concluded that agricultural soils behaved differently than non-agricultural soils. This conclusion was based on an analysis that combined data from three tests conducted on agricultural soils at University of Arizona Experimental Farms in Mesa, Maricopa, and Yuma, Arizona. As described in the Nickling and Gillies report, the surface roughness values of the three sites varied significantly. The Maricopa site had been recently tilled while the soil was moist and the surface was extremely cloddy. The Mesa and Yuma sites had also been recently tilled, but the soil moistures there were extremely low and the roughness heights were in the middle of the range representing the non-agricultural sites. Elimination of the data from the Maricopa site resulted in a relationship between shear velocity and PM_{10} emissions for the remaining two agricultural sites that was similar to the relationship for non-agricultural soils.

Conclusion – Because the soil textures, roughness heights, and relationships between shear velocity and PM_{10} emissions of the agricultural soils, with the exception of the Maricopa roughness height, were similar to those of the non-agricultural soils, the agricultural soils should behave much like the non-agricultural soils with respect to PM_{10} emission rates. As a result, the emission equation developed by MCAQD for use in the 2008 PEI in Maricopa County was determined to be reasonably representative of windblown PM_{10} emissions from disturbed soils on both agricultural and non-agricultural lands within the Pinal County PM_{10} nonattainment area.

Appendix 7

Ambient Monitoring Data Based
Emission Factor Adjustment
Arizona Department of Environmental Quality (ADEQ)
Air Quality Division
4/10/2013

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Ambient Monitoring Data Based Emission Factor Adjustments

April 10th, 2013

FINAL REPORT

Arizona Department of

Environmental Quality

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Introduction

This document provides an overview of the development and testing of a method which attempts to account for particulate matter concentration variation in Pinal County, Arizona during sustained high wind (>12 mph) events. Emission factors (EFs) are often an estimation of maximum emission potential and are not always representative of the actual environment. This adjustment methodology would be applied to the emission factors developed in the Maricopa Association of Governments (MAG) 5% Plan high wind methodology which has already been approved by EPA[1]. Land use dependent EFs derived from literature assume static emission rates, usually altering with wind speed, but do not account for temporal variation of these EFs. The method outlined below attempts to account for environmental factors, ranging from the lack of substantial airborne particles available for dust re-entrainment in the early hours of a high wind event to reservoir depletion in the later hours of a sustained high wind event, in an attempt to address temporal changes in emission rates during windblown dust events. To this end, PM_{10} atmospheric concentrations measured at Pinal County, Arizona monitors during high wind events were utilized to create emission factor adjustment curves at each of the four design day monitors for the Pinal County PM_{10} State Implementation Plan creation (Cowtown, Maricopa, Stanfield, and Pinal County Housing). These adjustment curves are presented as a method of altering the MAG 5% Plan high wind EFs for each of the 4 monitors in the modeling of design days for the Pinal County State Implementation Plan Emission Inventory. These adjustment curves will be applied to emission factors in future design day modeling in an attempt to account for the temporal variability in particulate emissions during sustained high wind events.

Methodology

This section outlines the methods used to create the adjustment curves.

Hourly monitor measurements of PM_{10} concentrations and meteorology were compiled for 4 monitors (Cowtown, Maricopa, Stanfield, and Pinal County Housing) located in the Pinal County nonattainment area for the year 2008. Data sets for each monitor were processed separately. Datasets were screened for high wind events meeting the following criteria:

1. An event begins when an hourly wind speed exceeds 12 mph and ends when a consecutive hourly wind speed drops below 12 mph (wind speeds were adjusted to standardized 10 m height equivalents),
2. Events must contain five or more consecutive hours of wind speeds greater than 12 mph,
3. Only one event could occur on a given day and must be the first event to occur on that day,

[1] Maricopa Association of Governments (MAG), 2012. MAG 2012 Five Percent Plan for PM-10 for the Maricopa County Nonattainment Area.

4. Events must contain peak monitor PM_{10} concentrations which exceed 200 μg/m^3, and
5. Events which occurred during the monsoon summer months of July, August, and September must not be tagged as 'Exceptional Events' by Pinal County Air Quality Department (PCAQD).

For each monitor, events were separated based on the above criteria and were normalized on an hourly basis to percentages of peak PM_{10} concentrations measured. This calculation was performed by assuming the peak measured monitor concentration was equal to 100% for a given event and each previous and subsequent hourly measured concentration was some percentage of the event peak concentration. A sample is given below:

Example1: Cowtown 5/5/2008 High Wind Hours

Table 1 presents the high wind hours for 5/5/2008 and the calculated adjustment distribution.

Table 1: Cowtown 5/5/2008 High Wind Event

DATE	TIME	Peak Relative Time	Monitor PM_{10} [μg/m^3]	Adjustment Distribution [%]
5-May-08	12:00	-2	278.5	82%
5-May-08	13:00	-1	187.3	55%
5-May-08	14:00	0	340.5	100%
5-May-08	15:00	1	155.0	46%
5-May-08	16:00	2	167.7	49%
5-May-08	17:00	3	67.1	20%

In the case of this example, the event lasted 6 hours with a peak concentration of 340.5 μg/m^3 measured at 14:00 hours. Peak Relative Time (PRT) [hr] was calculated as the number of hours prior to or following the peak concentration hour. Adjustment distribution percentage was calculated using the following equation:

$$D_n = 100 * \left(\frac{C_n}{C_{pk}} \right)$$

where:
D_n is the percentage of the event peak concentration for a monitor concentration on a given hour, n;
C_{pk} is the peak PM_{10} concentration measured at the monitor for a given event [μg/m^3]; and
C_n is the PM_{10} concentration measured at the monitor for a given hour, n.

Once all events for a given monitor within the year of 2008 had been processed, a

standard adjustment distribution curve for the monitor was created by averaging all events by hour, based on the PRT. Examples of how these averages occurred can be found in Tables 2-5.

Results

The following subsections present the average adjustment distribution curves for each of the 4 monitors (Cowtown, Maricopa, Pinal County Housing (PCH), and Stanfield). Tables 2, 3, 4, and 5 show the adjustment distribution curves [% of peak] for each event identified using the criteria previously presented and the average adjustment distribution for Cowtown, Maricopa, PCH, and Stanfield respectively. Figures 1, 3, 5, and 7 present graphical representations of the average adjustment distribution curves for each site with calculated error in the form of one standard deviation of the mean for each hour calculated. Figures 2, 4, 6, and 8 present comparisons of the adjustment distribution curves and hourly measured PM_{10} concentrations for the Cowtown, Maricopa, PCH, and Stanfield design days. For these figures, the adjustment distribution curves were scaled so that the peak of the adjustment curve matched the peak of the monitor measured concentrations and the adjustment curves were cut to only those hours on the design days which experienced winds greater than 12 mph.

Cowtown EF Adjustment Curve

Table 2: Cowtown high wind event day distributions. Columns represent separate events. All events were normalized so that event peak monitor measured concentrations occurred at a PRT=0.

PRT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg	Std Dev
-5																			19%							19%	
-4						23%				43%				77%			44%		12%							40%	25%
-3			73%			82%				82%				39%			54%		20%		33%					55%	25%
-2	15%		29%	62%	45%	96%				31%				45%	82%	76%	88%		35%	18%	35%				50%	51%	26%
-1	51%	20%	20%	22%	33%	93%				51%			69%	55%	55%	18%	70%	98%	78%	27%	24%		24%		34%	47%	26%
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%
1	28%	54%	52%	70%	37%		85%	95%	23%		23%	12%	45%		46%	18%		36%	60%	44%	23%	44%	48%	45%	53%	45%	21%
2	23%	10%	46%	54%	21%		70%	73%	8%		17%	14%	56%		49%	22%		44%	57%	28%	6%	13%	44%	27%	9%	33%	21%
3	39%	86%	13%	78%	85%		46%	82%	16%		28%	8%	92%		20%	54%		60%	30%	10%	7%	36%	64%	27%	7%	42%	30%
4	20%	21%		43%			53%	25%	3%		42%	4%						81%	22%	42%	6%	51%	67%	24%	5%	32%	24%
5	7%	17%		73%			94%	26%			28%	4%						38%	49%		4%	14%		11%	6%	29%	28%
6	12%	19%		66%			48%				26%	3%										22%		9%		26%	21%
7	16%	39%					91%					8%												7%		32%	35%
8	17%	52%					60%																	5%		33%	27%
9	10%						43%																	6%		20%	20%
10	8%																							6%		7%	2%
11	11%																							3%		7%	5%
12	19%																							4%		12%	10%
13	12%																							4%		8%	5%
14	10%																									10%	
15	10%																									10%	
16	11%																									11%	
17	7%																									7%	
18	9%																									9%	
19	5%																									5%	
20	2%																									2%	
21	3%																									3%	

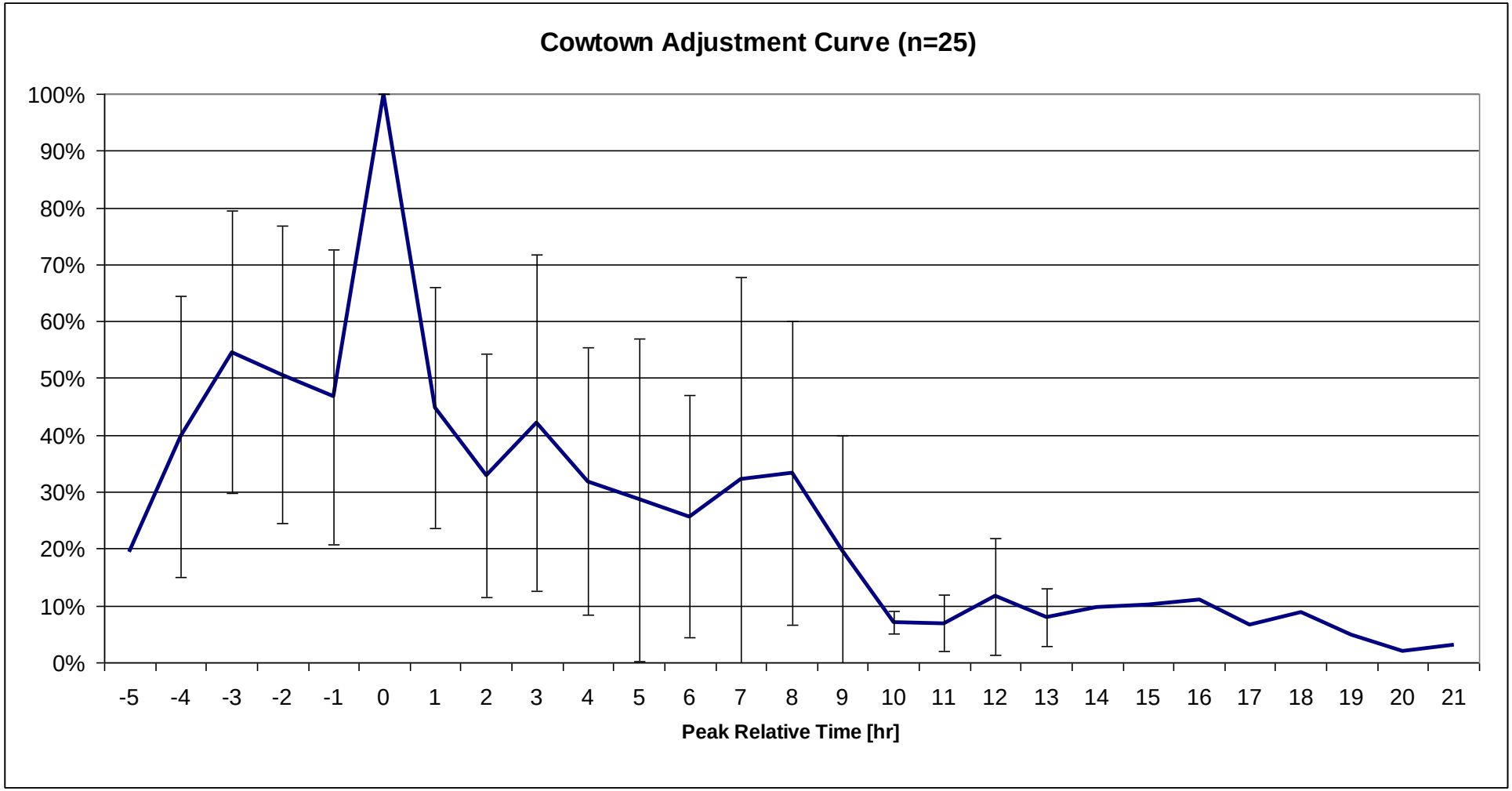

Figure 1: Cowtown adjustment curve for the year of 2008. Event sample size was 25. Error bars represent one standard deviation.

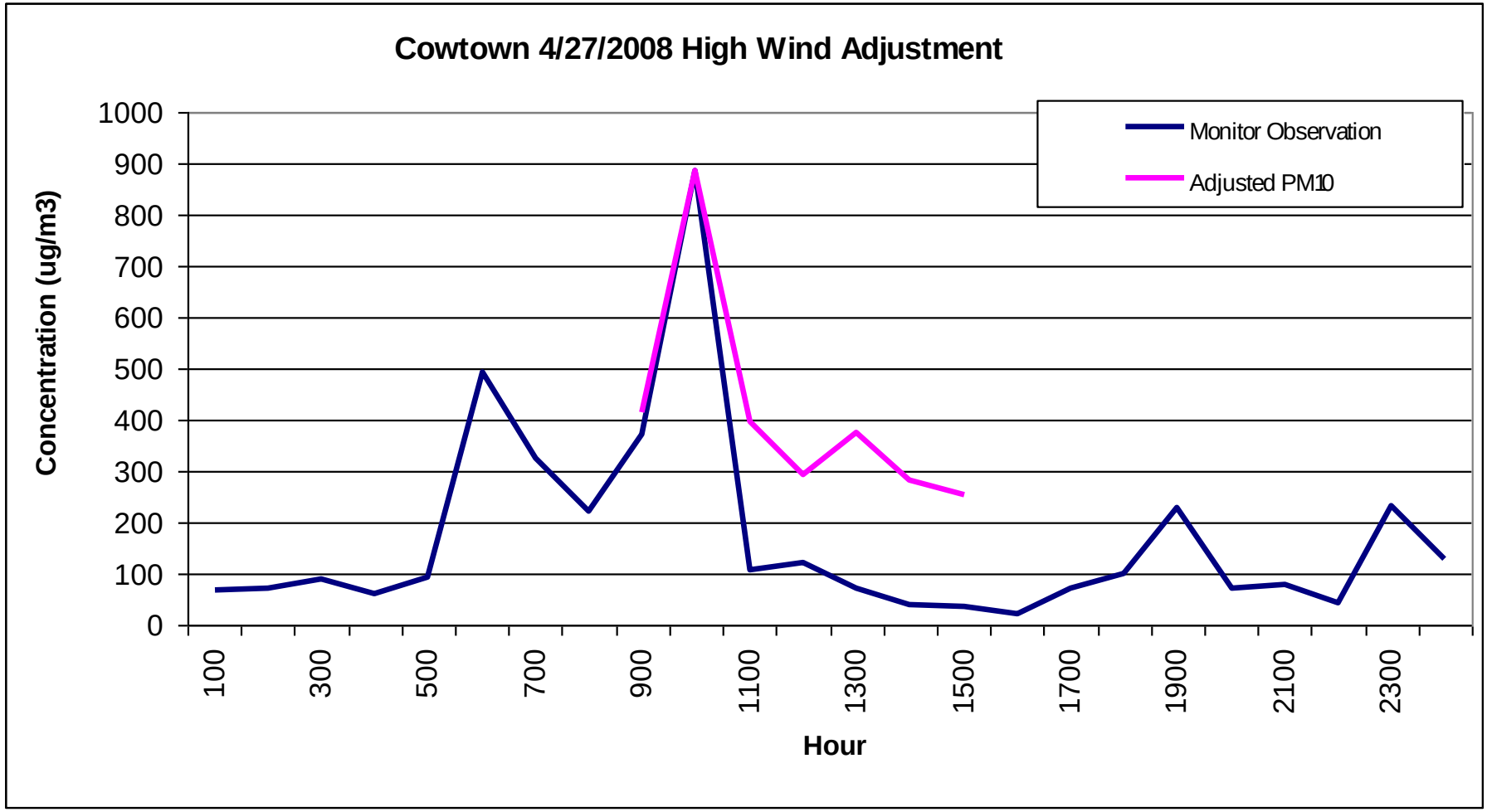

Figure 2: Cowtown adjustment curve (pink) for the year of 2008 normalized to the peak concentration for the 4/27/2008 design day. Monitor observed concentrations are shown in blue for curve comparison.

Maricopa EF Adjustment Curve

Table 3: Maricopa high wind event day distributions. Columns represent separate events. All events were normalized so that event peak monitor measured concentrations occurred at a PRT=0.

PRT	1	2	3	4	5	6	7	8	9	10	11	12	13	Average	Std Dev
-13	6%													6%	
-12	6%													6%	
-11	7%													7%	
-10	38%													38%	
-9	36%													36%	
-8	20%													20%	
-7	11%													11%	
-6	6%						9%							8%	2%
-5	8%						9%			75%				31%	38%
-4	8%						22%	26%		31%			66%	30%	22%
-3	19%	39%					51%	28%		54%			83%	46%	23%
-2	39%	13%	12%	31%	40%	37%	28%	32%		52%			75%	36%	18%
-1	97%	8%	20%	27%	82%	61%	54%	52%	8%	64%		46%	59%	48%	28%
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%
1	91%	14%	75%	54%	31%	39%	40%	70%	50%	15%	58%	47%		49%	23%
2	56%	57%	35%	27%	28%	43%	34%	72%	18%	14%	34%	48%		39%	17%
3	34%	9%	21%	14%	20%		19%	96%	12%	24%	21%	28%		27%	24%
4	23%			15%			9%	59%	5%		17%	18%		21%	18%
5	13%						9%	33%	5%		10%	14%		14%	10%
6	8%						4%	31%	3%		9%	14%		12%	10%
7	13%								4%		8%			8%	4%
8	7%								6%		7%			7%	1%
9	5%								5%		7%			5%	1%
10	5%										5%			5%	0%
11											4%			4%	
12											4%			4%	
13											4%			4%	

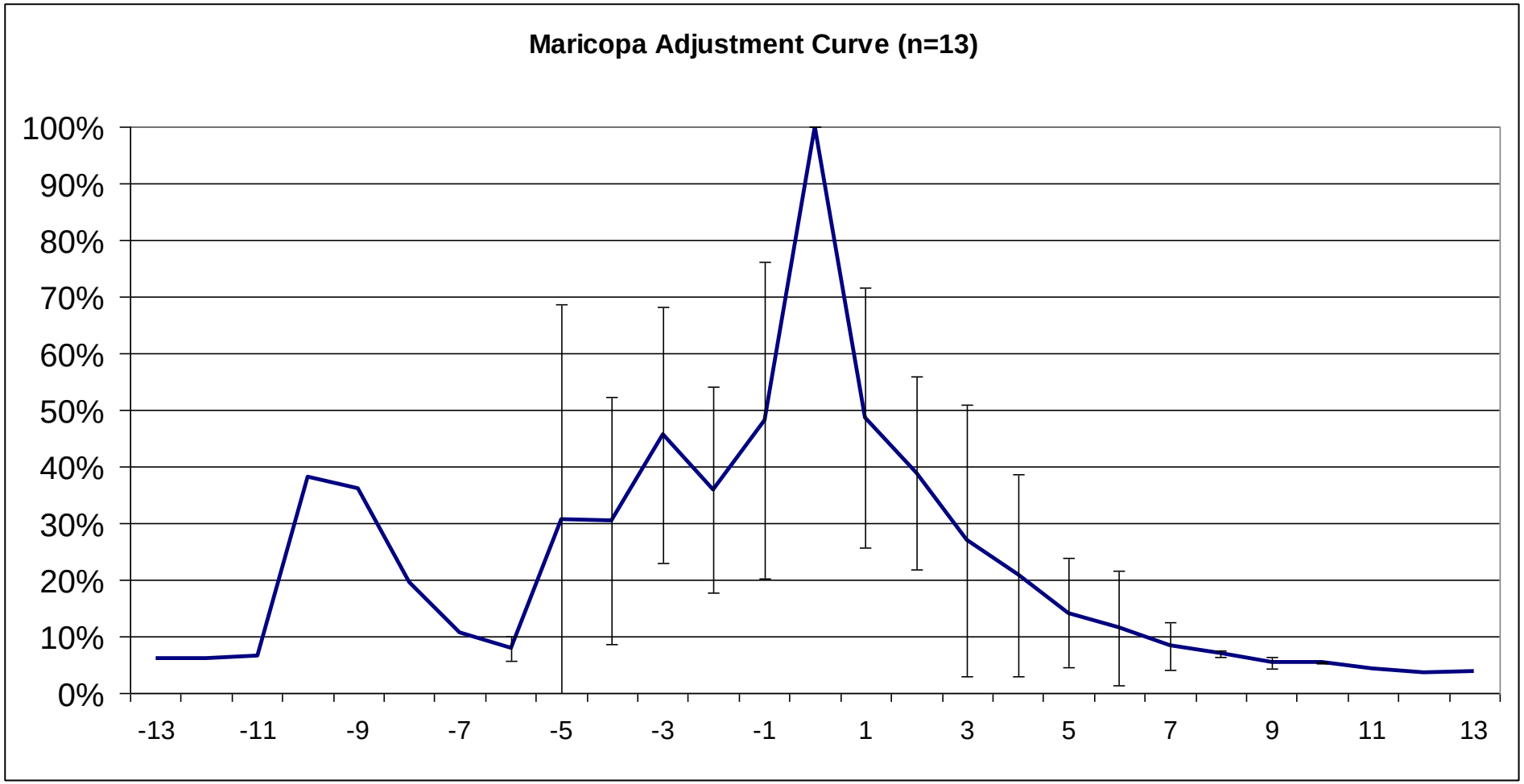

Figure 3: Maricopa EF adjustment curve for the year of 2008. Event sample size was 13. Error bars represent one standard deviation.

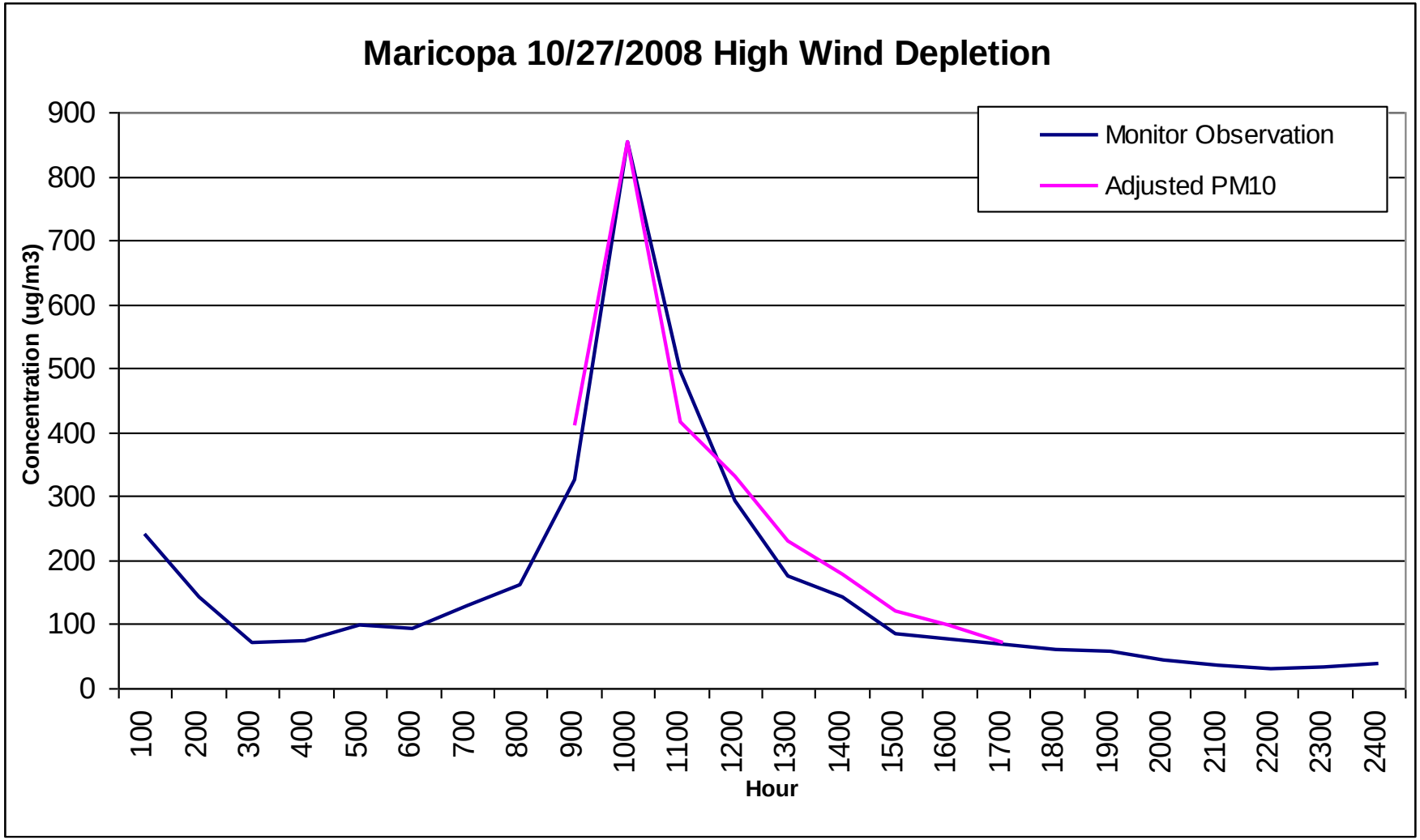

Figure 4: Maricopa adjustment curve (pink) for the year of 2008 normalized to the peak concentration for the 4/27/2008 design day. Monitor observed concentrations are shown in blue for curve comparison.

PCH EF Adjustment Curve

Table 4: Maricopa high wind event day distributions. Columns represent separate events. All events were normalized so that event peak monitor measured concentrations occurred at a PRT=0.

PRT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Avg	S.D.
-6											19%								19%	
-5		17%									19%					22%			19%	3%
-4		14%		23%							33%					49%			30%	15%
-3		13%		15%						8%	17%					39%			18%	12%
-2	77%	6%		38%						15%	34%	22%				38%		59%	36%	23%
-1	81%	4%		69%	70%	55%	80%		66%	6%	21%	36%	35%	64%		72%	62%	81%	54%	26%
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%
1	70%	13%	58%	67%	36%	40%	65%	48%	53%	11%	8%	76%	19%	66%	70%	61%	89%	62%	51%	24%
2	83%	12%	16%	55%	10%	33%	37%	39%	20%		20%	52%	3%	5%	10%	42%	46%	39%	31%	22%
3	28%		0%	35%	9%	50%	38%	19%	14%		17%	63%		2%	8%	51%	23%	27%	26%	19%
4	35%		31%		8%	40%		14%			11%	96%		2%	7%	24%	49%	33%	29%	26%
5	25%		45%		6%	71%		13%			8%	25%					36%	32%	29%	20%
6	6%		51%			43%		10%				21%					27%		26%	18%
7	4%											11%					16%		10%	6%
8	5%											17%							11%	8%
9	6%											13%							10%	5%
10	6%											10%							8%	3%
11	3%											10%							6%	5%
12	12%											11%							12%	1%
13	3%											12%							7%	7%
14	3%																		3%	
15	3%																		3%	
16	2%																		2%	
17	1%																		1%	
18	3%																		3%	
19	5%																		5%	
20	4%																		4%	
21	4%																		4%	
22	6%																		6%	
23	11%																		11%	
24	13%																		13%	

PRT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Avg	S.D.
25	16%																		16%	
26	11%																		11%	
27	5%																		5%	
28	3%																		3%	
29	3%																		3%	
30	45%																		45%	
31	3%																		3%	

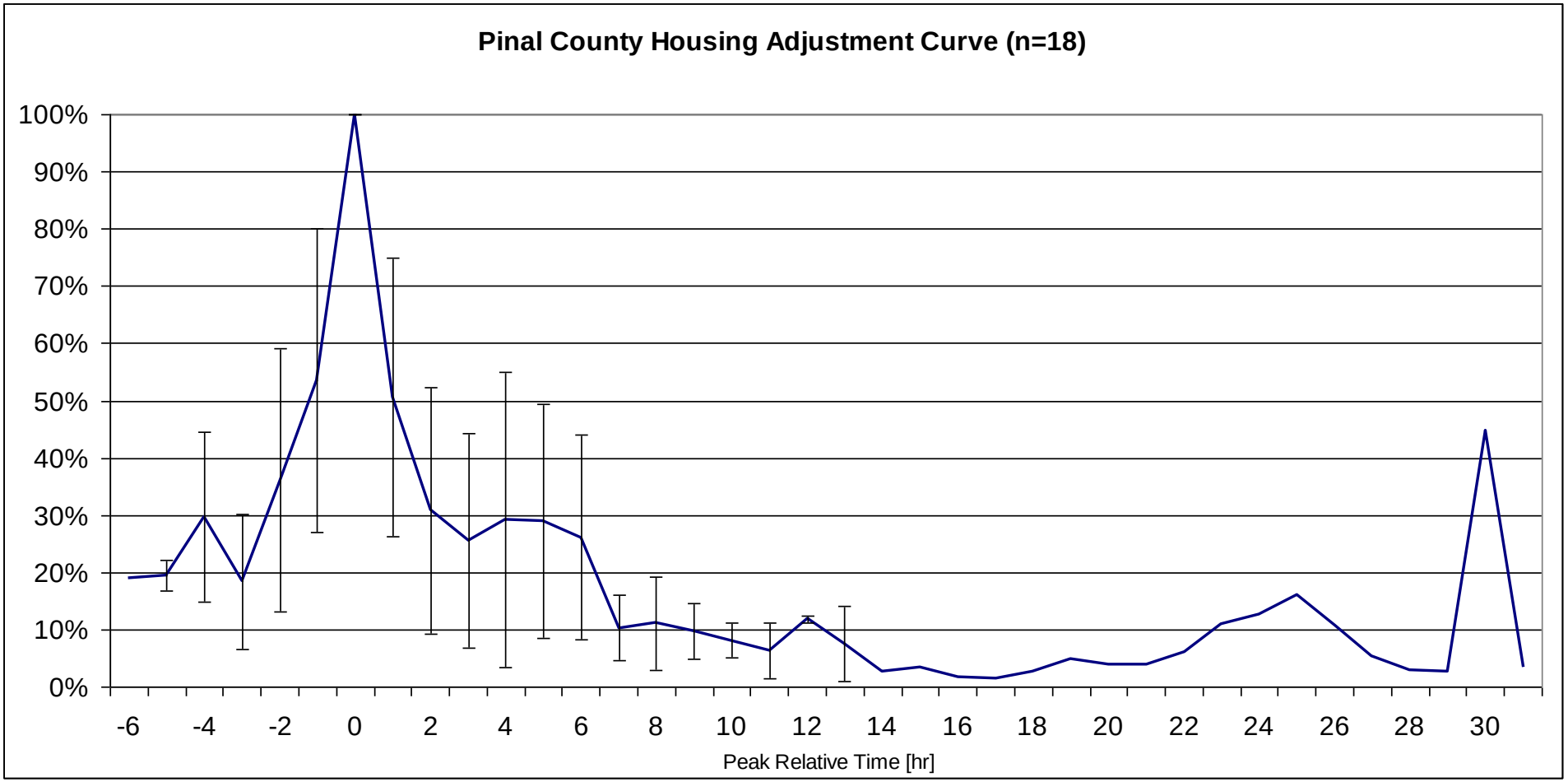

Figure 5: Pinal County Housing EF adjustment curve for the year of 2008. Event sample size was 18. Error bars represent one standard deviation.

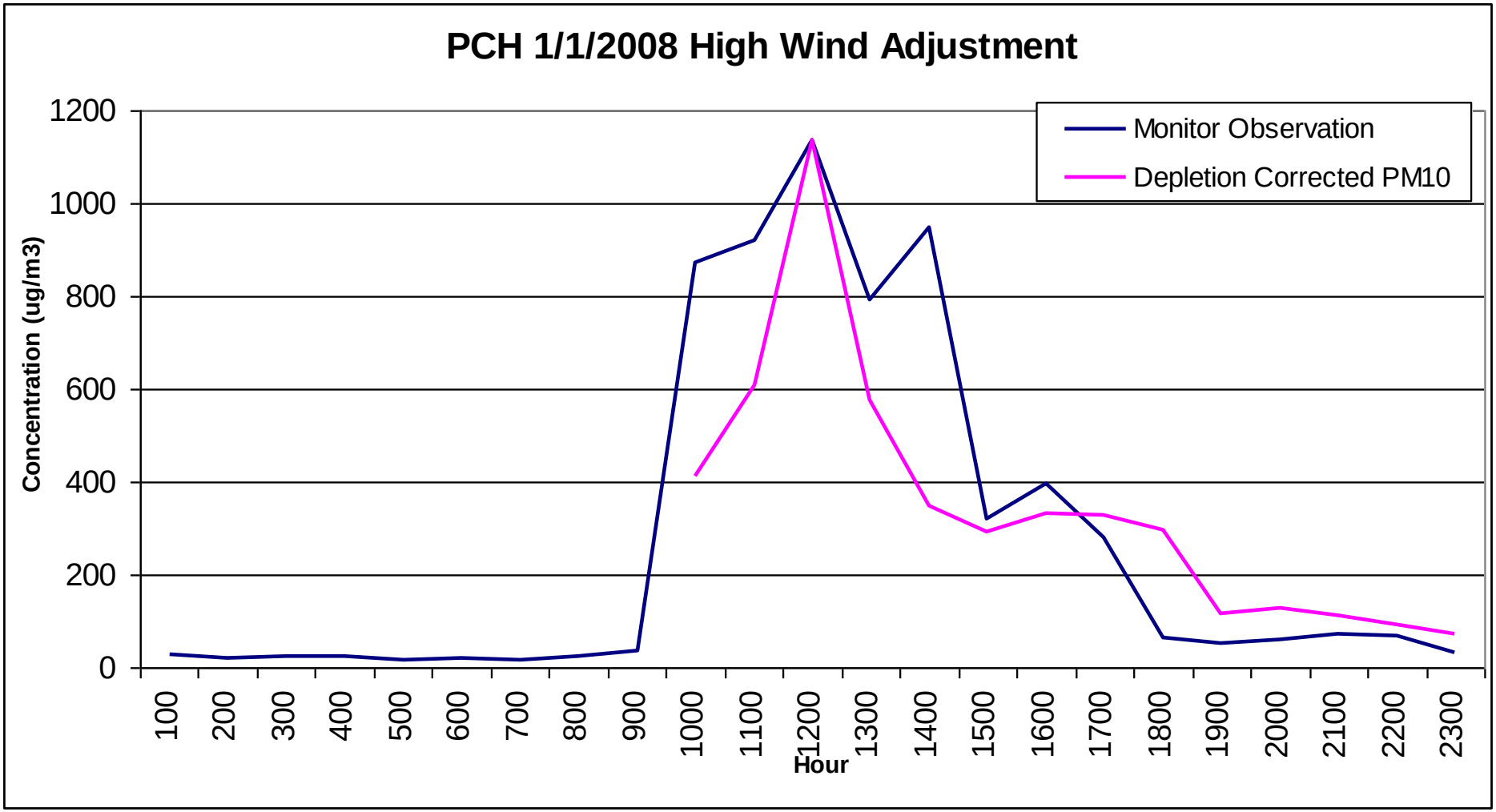

Figure 6: Pinal County Housing EF adjustment curve (pink) for the year of 2008 normalized to the peak concentration for the 4/27/2008 design day. Monitor observed concentrations are shown in blue for curve comparison.

Stanfield EF Adjustment Curve

Table 5: Maricopa high wind event day distributions. Columns represent separate vents. All events were normalized so that event peak monitor measured concentrations occurred at a PRT=0.

PRT	1	2	3	4	5	6	7	8	9	10	11	12	13	Average	Std Dev
-10					9%									9%	
-9					10%									10%	
-8					13%									13%	
-7					6%									6%	
-6					16%									16%	
-5			5%		17%			36%						19%	16%
-4		33%	5%		23%			39%	45%					29%	16%
-3		24%	7%		39%			55%	54%					36%	20%
-2		18%	50%		29%			78%	70%				61%	51%	24%
-1	37%	22%	13%	40%	21%	60%		72%	66%		30%	76%	56%	45%	22%
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%
1	43%	29%	26%	29%		47%	88%	22%	24%	76%	96%	44%	73%	50%	27%
2	11%	8%	3%	11%		22%	37%	68%	16%	79%	76%	15%	57%	34%	29%
3	5%	10%		3%		14%	9%	60%	35%	35%	35%	10%	32%	23%	18%
4	5%						22%	44%	34%	21%	19%	6%	16%	21%	13%
5	2%						24%	34%	14%	8%		5%	11%	14%	11%
6	2%						38%	34%	7%	14%		3%	11%	16%	14%
7	5%							31%		9%				15%	14%
8	20%							25%		11%				19%	7%
9	3%							25%		10%				13%	11%
10	2%													2%	
11	2%													2%	
12	1%													1%	
13	1%													1%	
14	1%													1%	
15	1%													1%	
16	1%													1%	
17	1%													1%	
18	1%													1%	
19	1%													1%	

PRT	1	2	3	4	5	6	7	8	9	10	11	12	13	Average	Std Dev
20	1%													1%	
21	4%													4%	
22	17%													17%	
23	9%													9%	
24	5%													5%	
25	3%													3%	
26	2%													2%	
27	2%													2%	
28	2%													2%	
29	1%													1%	
30	1%													1%	

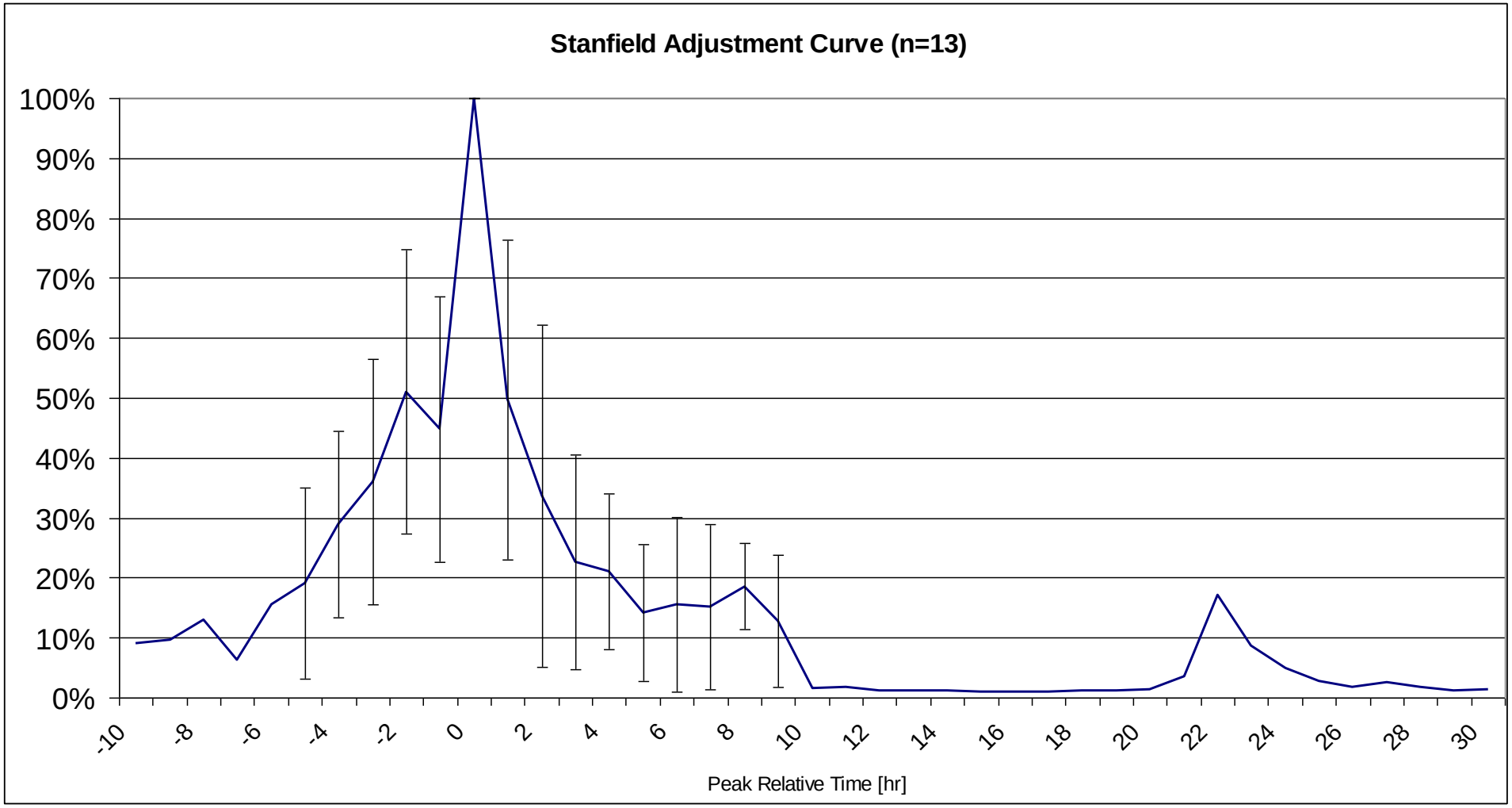

Figure 7: Stanfield EF adjustment curve for the year of 2008. Event sample size was 13. Error bars represent one standard deviation.

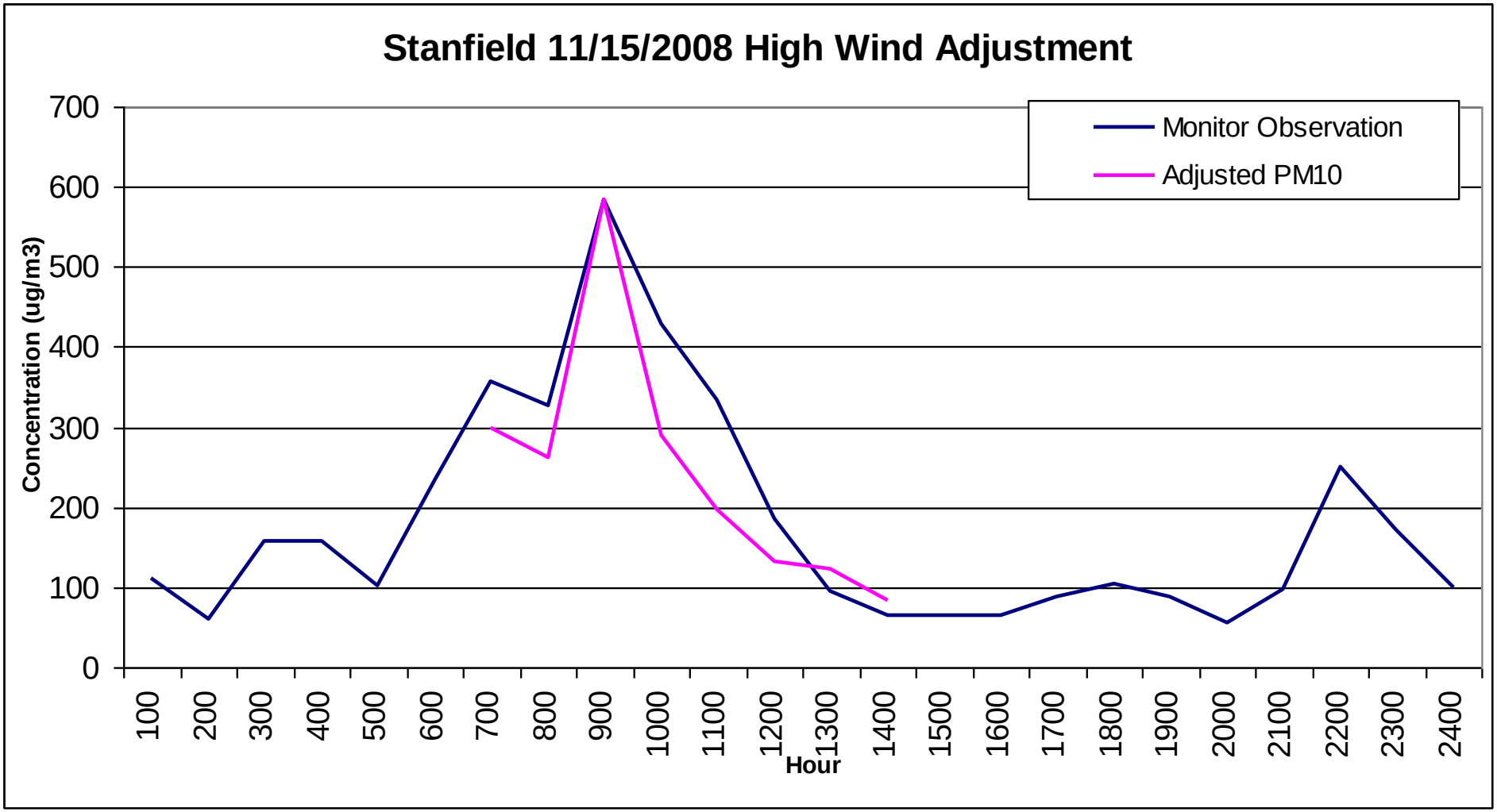

Figure 8: Stanfield EF adjustment curve (pink) for the year of 2008 normalized to the peak concentration for the 4/27/2008 design day. Monitor observed concentrations are shown in blue for curve comparison.

EF Adjustment Curve Comparison

EF adjustment curves for the four monitors are presented in tabular (Table 6) and graphical (Figure 9) form in this section for comparison of how local conditions alter the adjustment curves throughout the nonattainment area. Future modeling would apply these curves to all land use emission factors for high wind events at a particular monitor by assuming peak monitor concentrations occur at PRT = 0 and applying emission factors which are multiplied by the percentages listed below for each previous and subsequent hour prior to modeling individual hours of the day.

Table 6: This table shows the EF adjustment curves for each of the monitoring locations. The EF adjustment curves exhibited are truncated to those hours for each monitor for which standard deviations could be calculated.

PRT	Stanfield	PCH	Maricopa	Cowtown
-6			8%	
-5	19%	19%	31%	
-4	29%	30%	30%	40%
-3	36%	18%	46%	55%
-2	51%	36%	36%	51%
-1	45%	54%	48%	47%
0	100%	100%	100%	100%
1	50%	51%	49%	45%
2	34%	31%	39%	33%
3	23%	26%	27%	42%
4	21%	29%	21%	32%
5	14%	29%	14%	29%
6	16%	26%	12%	26%
7	15%	10%	8%	32%
8	19%	11%	7%	33%
9	13%	10%	5%	20%
10		8%	5%	7%
11		6%		7%
12		12%		12%
13		7%		8%
14				10%

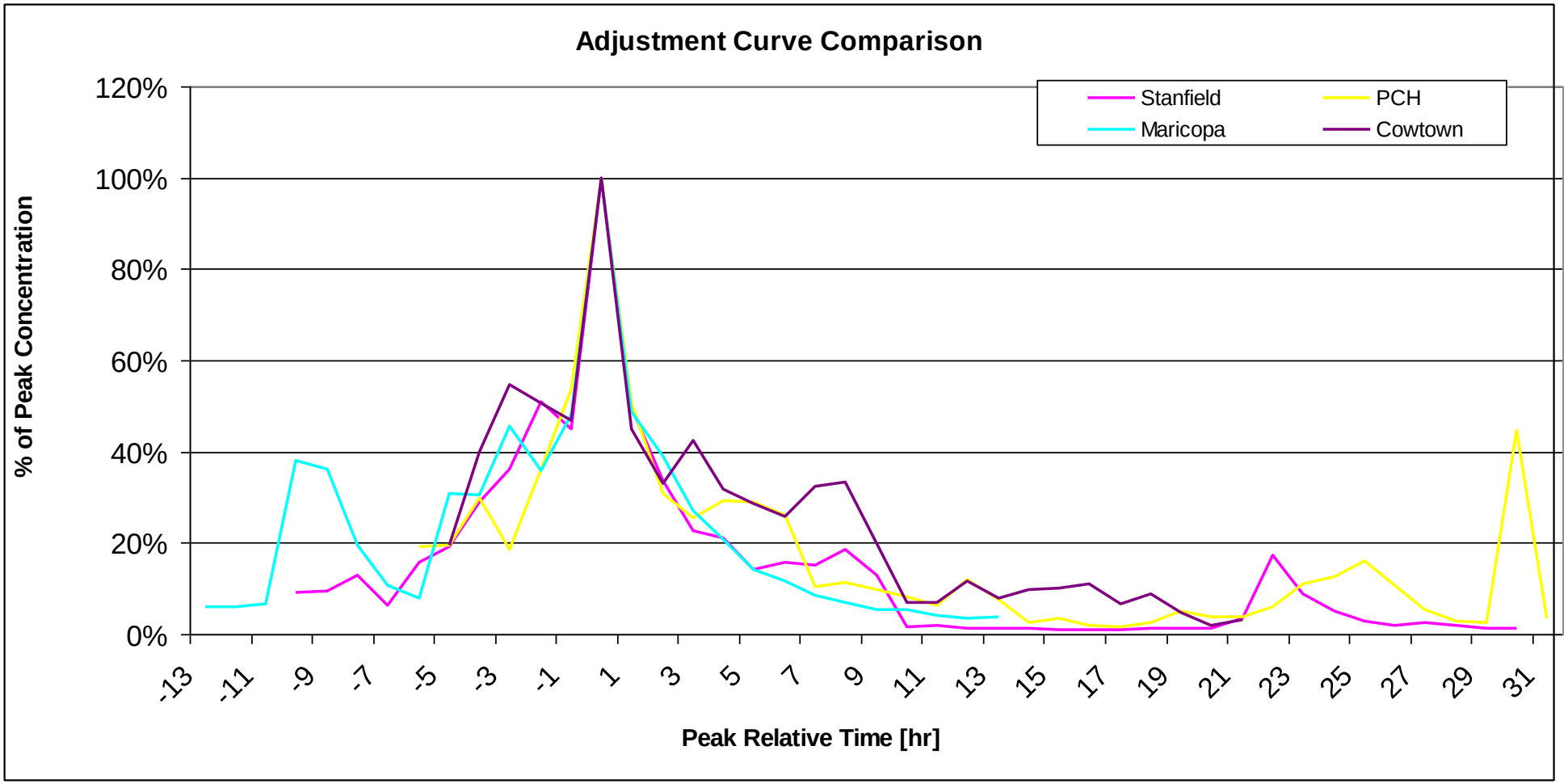

Figure 9: Site specific adjustment curve comparison for 4 monitors within the Pinal County nonattainment area.

PCH Test

Examination of Figures 2, 4, 6, and 8 revealed that the EF adjustment curve for Maricopa matched the design day concentration curve very well and Cowtown and Stanfield EF adjustment curves matched design day concentration curves well, while the Pinal County Housing EF adjustment curve failed to account for the multiple PM_{10} concentration spikes seen on the design day. Therefore, PCH can be considered a worse case scenario when applying the EF adjustment curve. With this information in mind, ADEQ decided to take AERMOD modeling results for the PCH design day and apply the EF adjustment curve to the modeling results to determine if the modeling accuracy would improve with the application of these hourly adjustments.

Previous AERMOD modeling of the PCH design day tested two sets of EFs (MAG EFs and Back Calculation EFs). This testing showed that the MAG EFs calculated PM_{10} concentrations better in the early high wind hours of the design day, while failing to do so in later high wind hours when monitor measured concentrations decreased despite sustained high winds. The Back Calculation EFs overestimated PM_{10} concentrations during early high wind hours of the design day, but better estimated the later high wind hours when monitor measured concentrations decreased.

While the intent is to apply the EF adjustment curve to EFs prior to modeling, below ADEQ provides the results of a quick test of the PCH adjustment curve application to the MAG PM_{10} concentrations output from the AERMOD model. In this exercise the EF adjustment curve was applied by examining the monitor PM_{10} concentrations and determining the PM_{10} peak concentration hour, 12:00. This was assumed to be equal to a Peak Relative Time (PRT) of zero. The EF adjustment curve was then applied on an hour by hour basis so that the MAG PM_{10} hourly AERMOD concentrations were multiplied by the corresponding adjustment curve %. The equation used is given below:

$$PM_{MAG\text{-}adj} = PM_{MAG} * (D/100)$$

where $PM_{MAG\text{-}adj}$ is the adjustment curve corrected MAG AERMOD concentration for an individual hour [$\mu g/m^3$], PM_{MAG} is the MAG AERMOD concentration for the same hour, and D is the adjustment curve value [%] for the PRT which corresponds to the same hour.

The monitor observed PM_{10} concentrations (PM_{obs}) and results for the PCH design day AERMOD run using the Back Calculation EFs ($PM_{BackCalc}$), the MAG EFs (PM_{MAG}), and EF adjustment curve correcting the MAG AERMOD results ($PM_{MAG\text{-}adj}$) are presented in Table 7 and in Figure 10. The average absolute modeling bias for the back calculation, MAG, and MAG adjusted AERMOD results were 271%, 587%, and 53% showing the drastic improvement that the application of the EF adjustment curve can have for the MAG EFs. However, it is seen that the $PM_{MAG\text{-}adj}$ have fairly consistently under predicted early high wind PM_{10} concentrations. This problem should easily be addressed during design day model calibration. The PCH design day is unique in that there are 3 distinct spikes in monitor observed PM_{10} concentrations at 12:00, 14:00, and 16:00. The 12:00 and 16:00 peaks are captured by the PCH adjustment curve, but the 14:00 is not. While this may be a small concern for the PCH design day, Maricopa, Cowtown, and

Stanfield exhibited much better agreement between the monitor observed concentration curve and the adjustment curve; therefore, this is believed to be a problem unique to the PCH design day.

Table 7: Pinal County Housing (1/1/2008) AERMOD modeling and EF adjustment results and the calculated biases for each hour of high wind (>12 mph) activity.

		PM_{10} Concentrations [µg/m^3]				Modeling Bias [%]		
Hour	Adjustment Curve	PM_{obs}	$PM_{BackCalc}$	PM_{MAG}	$PM_{MAG\text{-}adj}$	$PM_{BackCalc}$	PM_{MAG}	$PM_{MAG\text{-}adj}$
10:00	36%	871	946	648	234	8.6%	-25.6%	-73.1%
11:00	54%	919	2182	1112	596	137.4%	21.0%	-35.2%
12:00	100%	1136	1867	951	951	64.3%	-16.3%	-16.3%
13:00	51%	791	1986	1012	512	151.1%	27.9%	-35.3%
14:00	31%	946	2049	1044	321	116.6%	10.4%	-66.0%
15:00	26%	320	2445	575	147	664.1%	79.7%	-54.0%
16:00	29%	398	138	1072	314	-65.3%	169.3%	-21.2%
17:00	29%	282	211	666	193	-25.2%	136.2%	-31.7%
18:00	26%	66	409	864	226	519.7%	1209.1%	242.1%
19:00	10%	51	395	826	85	674.5%	1519.6%	66.9%
20:00	11%	62	222	676	76	258.1%	990.3%	21.8%
21:00	10%	71	221	682	66	211.3%	860.6%	-6.8%
22:00	8%	68	223	685	55	227.9%	907.4%	-18.6%
23:00	6%	33	253	772	49	666.7%	2239.4%	48.3%
					Average	**270.8%**	**586.6%**	**52.7%**

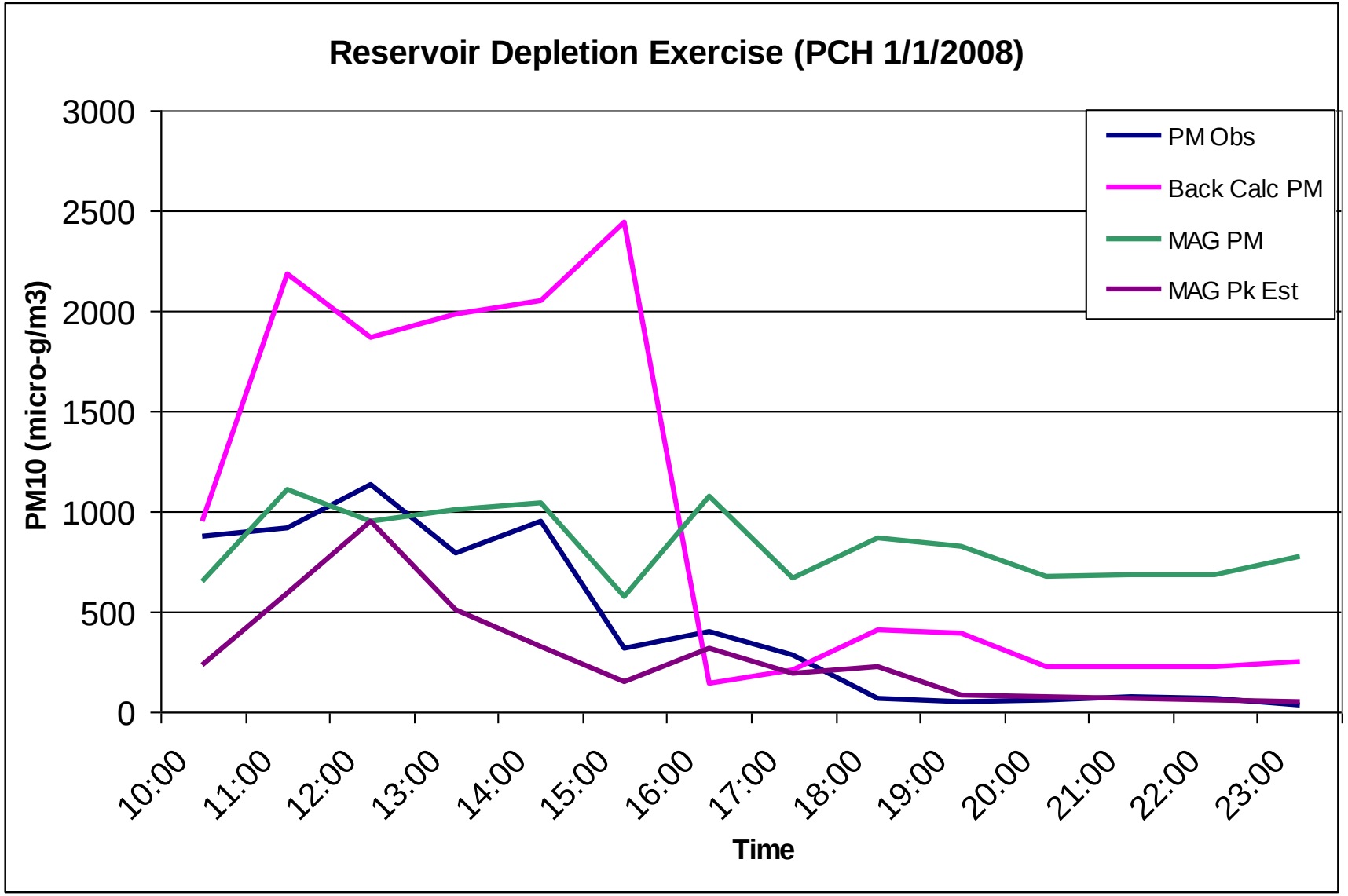

Figure 10: Modeled PM_{10} concentrations [$\mu g/m^3$] for the Back Calculation EFs (Back Calc PM), MAG EFs (MAG PM), and EF adjustment curve corrected MAG results (MAG Pk Est) as compared to monitor measured concentrations (PM Obs).

Appendix 8

NONROAD Input Files

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```
Written by Nonroad interface at 7/23/2013 5:15:01 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information.  Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

9/2005 epa: Add growth & tech years to PERIOD packet
  and Counties & Retrofit files to RUNFILES packet.

-------------------------------------------------------

                  PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated.  The order of the
records matter.  The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1  - Char 10  - Period type for this simulation.
                  Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2  - Char 10  - Type of inventory produced.
                  Valid responses are: TYPICAL DAY and PERIOD TOTAL
3  - Integer  - year of episode (4 digit year)
4  - Char 10  - Month of episode (use complete name of month)
5  - Char 10  - Type of day
                  Valid responses are: WEEKDAY and WEEKEND
-------------------------------------------------------
/PERIOD/
Period type        : Monthly
Summation type     : Period total
Year of episode    : 2008
Season of year     :
Month of year      : January
Weekday or weekend : Weekday
Year of growth calc:
Year of tech sel   :
/END/

-------------------------------------------------------

                  OPTIONS PACKET

This is the packet that defines some of the user
options that drive the model.  Most parameters are
used to make episode specific emission factor
adjustments. The order of the records is fixed.
The order is as follows.

1  -  Char 80  - First title on reports
2  -  Char 80  - Second title on reports
3  -  Real 10  - Fuel RVP of gasoline for this simulation
4  -  Real 10  - Oxygen weight percent of gasoline for simulation
5  -  Real 10  - Percent sulfur for gasoline
6  -  Real 10  - Percent sulfur for diesel
7  -  Real 10  - Percent sulfur for LPG/CNG
8  -  Real 10  - Minimum daily temperature (deg. F)
9  -  Real 10  - maximum daily temperature (deg. F)
10 -  Real 10  - Representative average daily temperature (deg. F)
11 -  Char 10  - Flag to determine if region is high altitude
                     Valid responses are: HIGH and LOW
12 -  Char 10  - Flag to determine if RFG adjustments are made
```

Valid responses are: YES and NO

```
-------------------------------------------------------
/OPTIONS/
Title 1            : PINAL COUNTY, AZ
Title 2            : JANUARY 2008
Fuel RVP for gas   : 8.8
Oxygen Weight %    : 3.5
Gas sulfur %       : 0.0015
Diesel sulfur %    : 0.0006
Marine Dsl sulfur %: 0.0006
CNG/LPG sulfur %   : 0.003
Minimum temper. (F): 42
Maximum temper. (F): 67
Average temper. (F): 55
Altitude of region : LOW
EtOH Blend % Mkt   : 100
EtOH Vol %         : 10
/END/

-------------------------------------------------------
```

REGION PACKET

This is the packet that defines the region for which emissions are to be estimated.

The first record tells the type of region and allocation to perform.

Valid responses are:

US TOTAL - emissions are for entire USA without state breakout.

50STATE - emissions are for all 50 states and Washington D.C., by state.

STATE - emissions are for a select group of states and are state-level estimates

COUNTY - emissions are for a select group of counties and are county level estimates. If necessary, allocation from state to county will be performed.

SUBCOUNTY - emissions are for the specified sub counties and are subcounty level estimates. If necessary, county to subcounty allocation will be performed.

The remaining records define the regions to be included. The type of data which must be specified depends on the region level.

US TOTAL - Nothing needs to be specified. The FIPS code 00000 is used automatically.

50STATE - Nothing needs to be specified. The FIPS code 00000 is used automatically.

STATE - state FIPS codes

COUNTY - state or county FIPS codes. State FIPS code means include all counties in the state.

SUBCOUNTY - county FIPS code and subregion code.

```
-------------------------------------------------------
/REGION/
Region Level       : COUNTY
Pinal County AZ    : 04021
/END/

or use -
Region Level       : STATE
Michigan           : 26000
-------------------------------------------------------
```

SOURCE CATEGORY PACKET

```
This packet is used to tell the model which source
categories are to be processed.  It is optional.
If used, only those source categories list will
appear in the output data file.  If the packet is
not found, the model will process all source
categories in the population files.
-------------------------------------------------------


Diesel Only -
                   :2270000000
                   :2282020000
                   :2285002015
Spark Ignition Only -
                   :2260000000
                   :2265000000
                   :2267000000
                   :2268000000
                   :2282005010
                   :2282005015
                   :2282010005
                   :2285004015
                   :2285006015
-------------------------------------------------------
 This is the packet that lists the names of output files
 and some of the input data files read by the model.  If
 a drive:\path\ is not given, the location of the
 NONROAD.EXE file itself is assumed.  You will probably
 want to change the names of the Output and Message files
 to match that of the OPTion file, e.g., MICH-97.OPT,
 MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.
-------------------------------------------------------
/RUNFILES/
ALLOC XREF         : data\allocate\allocate.xrf
ACTIVITY           : data\activity\activity.dat
EXH TECHNOLOGY     : data\tech\tech-exh.dat
EVP TECHNOLOGY     : data\tech\tech-evp.dat
SEASONALITY        : data\season\season.dat
REGIONS            : data\season\season.dat
MESSAGE            : c:\nonroad\outputs\p08_jan.msg
OUTPUT DATA        : c:\nonroad\outputs\p08_jan.out
EPS2 AMS           :
US COUNTIES FIPS   : c:\nonroad\data\allocate\fips.dat
RETROFIT           :
/END/

-------------------------------------------------------
This is the packet that defines the equipment population
files read by the model.
-------------------------------------------------------
```

```
/POP FILES/
Population File    : c:\nonroad\data\pop\az.pop
/END/

POPULATION FILE    : c:\nonroad\data\POP\MI.POP


-------------------------------------------------------
This is the packet that defines the growth files
files read by the model.
-------------------------------------------------------
/GROWTH FILES/
National defaults  : data\growth\nation.grw
/END/


/ALLOC FILES/
Air trans. empl.   :c:\nonroad\data\allocate\az_airtr.alo
Undergrnd coal prod:c:\nonroad\data\allocate\az_coal.alo
Construction cost  :c:\nonroad\data\allocate\az_const.alo
Harvested acres    :c:\nonroad\data\allocate\az_farms.alo
Golf course estab. :c:\nonroad\data\allocate\az_golf.alo
Wholesale estab.   :c:\nonroad\data\allocate\az_holsl.alo
Family housing     :c:\nonroad\data\allocate\az_house.alo
Logging employees  :c:\nonroad\data\allocate\az_loggn.alo
Landscaping empl.  :c:\nonroad\data\allocate\az_lscap.alo
Manufacturing empl.:c:\nonroad\data\allocate\az_mnfg.alo
Oil & gas employees:c:\nonroad\data\allocate\az_oil.alo
Census population  :c:\nonroad\data\allocate\az_pop.alo
Allocation File    :c:\nonroad\data\allocate\az_rail.alo
RV Park establish. :c:\nonroad\data\allocate\az_rvprk.alo
Snowblowers comm.  :c:\nonroad\data\allocate\az_sbc.alo
Snowblowers res.   :c:\nonroad\data\allocate\az_sbr.alo
Snowmobiles        :c:\nonroad\data\allocate\az_snowm.alo
Rec marine inboard :c:\nonroad\data\allocate\az_wib.alo
Rec marine outboard:c:\nonroad\data\allocate\az_wob.alo
/END/
-------------------------------------------------------
This is the packet that defines the emssions factors
files read by the model.
-------------------------------------------------------
/EMFAC FILES/
THC exhaust        : data\emsfac\exhthc.emf
CO exhaust         : data\emsfac\exhco.emf
NOX exhaust        : data\emsfac\exhnox.emf
PM exhaust         : data\emsfac\exhpm.emf
BSFC               : data\emsfac\bsfc.emf
Crankcase          : data\emsfac\crank.emf
Spillage           : data\emsfac\spillage.emf
Diurnal            : data\emsfac\evdiu.emf
Tank Perm          : data\emsfac\evtank.emf
Non-RM Hose Perm   : data\emsfac\evhose.emf
RM Fill Neck Perm  : data\emsfac\evneck.emf
RM Supply/Return   : data\emsfac\evsupret.emf
RM Vent Perm       : data\emsfac\evvent.emf
Hot Soaks          : data\emsfac\evhotsk.emf
RuningLoss         : data\emsfac\evrunls.emf
/END/

-------------------------------------------------------
This is the packet that defines the deterioration factors
files read by the model.
-------------------------------------------------------
```

```
/DETERIORATE FILES/
THC exhaust        : data\detfac\exhthc.det
CO exhaust         : data\detfac\exhco.det
NOX exhaust        : data\detfac\exhnox.det
PM exhaust         : data\detfac\exhpm.det
Diurnal            : data\detfac\evdiu.det
Tank Perm          : data\detfac\evtank.det
Non-RM Hose Perm   : data\detfac\evhose.det
RM Fill Neck Perm  : data\detfac\evneck.det
RM Supply/Return   : data\detfac\evsupret.det
RM Vent Perm       : data\detfac\evvent.det
Hot Soaks          : data\detfac\evhotsk.det
RuningLoss         : data\detfac\evrunls.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
Control Factor     : 0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

/MODELYEAR OUT/
EXHAUST BMY OUT    :
EVAP BMY OUT       :
/END/

SI REPORT/
SI report file-CSV :OUTPUTS\NRPOLLUT.CSV
/END/

/DAILY FILES/
DAILY TEMPS/RVP    :
/END/

PM Base Sulfur
 cols 1-10: dsl tech type;
 11-20: base sulfur wt%; or '1.0' means no-adjust (cert= in-use)
/PM BASE SULFUR/
T2        0.0350    0.02247
T3        0.2000    0.02247
T3B       0.0500    0.02247
T4A       0.0500    0.02247
T4B       0.0015    0.02247
T4        0.0015    0.30
T4N       0.0015    0.30
T2M       0.0350    0.02247
T3M       1.0       0.02247
T4M       1.0       0.02247
/END/
```

```
Written by Nonroad interface at 7/23/2013 3:45:00 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information.  Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

9/2005 epa: Add growth & tech years to PERIOD packet
  and Counties & Retrofit files to RUNFILES packet.

-------------------------------------------------------

                  PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated.  The order of the
records matter.  The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1  - Char 10  - Period type for this simulation.
                  Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2  - Char 10  - Type of inventory produced.
                  Valid responses are: TYPICAL DAY and PERIOD TOTAL
3  - Integer  - year of episode (4 digit year)
4  - Char 10  - Month of episode (use complete name of month)
5  - Char 10  - Type of day
                  Valid responses are: WEEKDAY and WEEKEND
-------------------------------------------------------
/PERIOD/
Period type        : Monthly
Summation type     : Period total
Year of episode    : 2008
Season of year     :
Month of year      : April
Weekday or weekend : Weekday
Year of growth calc:
Year of tech sel   :
/END/

-------------------------------------------------------

                  OPTIONS PACKET

This is the packet that defines some of the user
options that drive the model.  Most parameters are
used to make episode specific emission factor
adjustments. The order of the records is fixed.
The order is as follows.

1  -  Char 80  - First title on reports
2  -  Char 80  - Second title on reports
3  -  Real 10  - Fuel RVP of gasoline for this simulation
4  -  Real 10  - Oxygen weight percent of gasoline for simulation
5  -  Real 10  - Percent sulfur for gasoline
6  -  Real 10  - Percent sulfur for diesel
7  -  Real 10  - Percent sulfur for LPG/CNG
8  -  Real 10  - Minimum daily temperature (deg. F)
9  -  Real 10  - maximum daily temperature (deg. F)
10 -  Real 10  - Representative average daily temperature (deg. F)
11 -  Char 10  - Flag to determine if region is high altitude
                     Valid responses are: HIGH and LOW
12 -  Char 10  - Flag to determine if RFG adjustments are made
```

Valid responses are: YES and NO

```
-------------------------------------------------------
/OPTIONS/
Title 1            : PINAL COUNTY, AZ
Title 2            : APRIL 2008
Fuel RVP for gas   : 8.8
Oxygen Weight %    : 3.5
Gas sulfur %       : 0.0015
Diesel sulfur %    : 0.0006
Marine Dsl sulfur %: 0.0006
CNG/LPG sulfur %   : 0.003
Minimum temper. (F): 53
Maximum temper. (F): 86
Average temper. (F): 69
Altitude of region : LOW
EtOH Blend % Mkt   : 100
EtOH Vol %         : 10
/END/

-------------------------------------------------------
```

REGION PACKET

This is the packet that defines the region for which emissions are to be estimated.

The first record tells the type of region and allocation to perform.

Valid responses are:

US TOTAL - emissions are for entire USA without state breakout.

50STATE - emissions are for all 50 states and Washington D.C., by state.

STATE - emissions are for a select group of states and are state-level estimates

COUNTY - emissions are for a select group of counties and are county level estimates. If necessary, allocation from state to county will be performed.

SUBCOUNTY - emissions are for the specified sub counties and are subcounty level estimates. If necessary, county to subcounty allocation will be performed.

The remaining records define the regions to be included. The type of data which must be specified depends on the region level.

US TOTAL - Nothing needs to be specified. The FIPS code 00000 is used automatically.

50STATE - Nothing needs to be specified. The FIPS code 00000 is used automatically.

STATE - state FIPS codes

COUNTY - state or county FIPS codes. State FIPS code means include all counties in the state.

SUBCOUNTY - county FIPS code and subregion code.

```
-------------------------------------------------------
/REGION/
Region Level       : COUNTY
Pinal County AZ    : 04021
/END/

or use -
Region Level       : STATE
Michigan           : 26000
-------------------------------------------------------
```

SOURCE CATEGORY PACKET

```
This packet is used to tell the model which source
categories are to be processed.  It is optional.
If used, only those source categories list will
appear in the output data file.  If the packet is
not found, the model will process all source
categories in the population files.
-------------------------------------------------------


Diesel Only -
                   :2270000000
                   :2282020000
                   :2285002015
Spark Ignition Only -
                   :2260000000
                   :2265000000
                   :2267000000
                   :2268000000
                   :2282005010
                   :2282005015
                   :2282010005
                   :2285004015
                   :2285006015
-------------------------------------------------------
 This is the packet that lists the names of output files
 and some of the input data files read by the model.  If
 a drive:\path\ is not given, the location of the
 NONROAD.EXE file itself is assumed.  You will probably
 want to change the names of the Output and Message files
 to match that of the OPTion file, e.g., MICH-97.OPT,
 MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.
-------------------------------------------------------
/RUNFILES/
ALLOC XREF         : data\allocate\allocate.xrf
ACTIVITY           : data\activity\activity.dat
EXH TECHNOLOGY     : data\tech\tech-exh.dat
EVP TECHNOLOGY     : data\tech\tech-evp.dat
SEASONALITY        : data\season\season.dat
REGIONS            : data\season\season.dat
MESSAGE            : c:\nonroad\outputs\p08_apr.msg
OUTPUT DATA        : c:\nonroad\outputs\p08_apr.out
EPS2 AMS           :
US COUNTIES FIPS   : c:\nonroad\data\allocate\fips.dat
RETROFIT           :
/END/

-------------------------------------------------------
This is the packet that defines the equipment population
files read by the model.
-------------------------------------------------------
```

```
/POP FILES/
Population File    : c:\nonroad\data\pop\az.pop
/END/

POPULATION FILE    : c:\nonroad\data\POP\MI.POP


-------------------------------------------------------
This is the packet that defines the growth files
files read by the model.
-------------------------------------------------------
/GROWTH FILES/
National defaults  : data\growth\nation.grw
/END/


/ALLOC FILES/
Air trans. empl.   :c:\nonroad\data\allocate\az_airtr.alo
Undergrnd coal prod:c:\nonroad\data\allocate\az_coal.alo
Construction cost  :c:\nonroad\data\allocate\az_const.alo
Harvested acres    :c:\nonroad\data\allocate\az_farms.alo
Golf course estab. :c:\nonroad\data\allocate\az_golf.alo
Wholesale estab.   :c:\nonroad\data\allocate\az_holsl.alo
Family housing     :c:\nonroad\data\allocate\az_house.alo
Logging employees  :c:\nonroad\data\allocate\az_loggn.alo
Landscaping empl.  :c:\nonroad\data\allocate\az_lscap.alo
Manufacturing empl.:c:\nonroad\data\allocate\az_mnfg.alo
Oil & gas employees:c:\nonroad\data\allocate\az_oil.alo
Census population  :c:\nonroad\data\allocate\az_pop.alo
Allocation File    :c:\nonroad\data\allocate\az_rail.alo
RV Park establish. :c:\nonroad\data\allocate\az_rvprk.alo
Snowblowers comm.  :c:\nonroad\data\allocate\az_sbc.alo
Snowblowers res.   :c:\nonroad\data\allocate\az_sbr.alo
Snowmobiles        :c:\nonroad\data\allocate\az_snowm.alo
Rec marine inboard :c:\nonroad\data\allocate\az_wib.alo
Rec marine outboard:c:\nonroad\data\allocate\az_wob.alo
/END/
-------------------------------------------------------
This is the packet that defines the emssions factors
files read by the model.
-------------------------------------------------------
/EMFAC FILES/
THC exhaust        : data\emsfac\exhthc.emf
CO exhaust         : data\emsfac\exhco.emf
NOX exhaust        : data\emsfac\exhnox.emf
PM exhaust         : data\emsfac\exhpm.emf
BSFC               : data\emsfac\bsfc.emf
Crankcase          : data\emsfac\crank.emf
Spillage           : data\emsfac\spillage.emf
Diurnal            : data\emsfac\evdiu.emf
Tank Perm          : data\emsfac\evtank.emf
Non-RM Hose Perm   : data\emsfac\evhose.emf
RM Fill Neck Perm  : data\emsfac\evneck.emf
RM Supply/Return   : data\emsfac\evsupret.emf
RM Vent Perm       : data\emsfac\evvent.emf
Hot Soaks          : data\emsfac\evhotsk.emf
RuningLoss         : data\emsfac\evrunls.emf
/END/

-------------------------------------------------------
This is the packet that defines the deterioration factors
files read by the model.
-------------------------------------------------------
```

```
/DETERIORATE FILES/
THC exhaust        : data\detfac\exhthc.det
CO exhaust         : data\detfac\exhco.det
NOX exhaust        : data\detfac\exhnox.det
PM exhaust         : data\detfac\exhpm.det
Diurnal            : data\detfac\evdiu.det
Tank Perm          : data\detfac\evtank.det
Non-RM Hose Perm   : data\detfac\evhose.det
RM Fill Neck Perm  : data\detfac\evneck.det
RM Supply/Return   : data\detfac\evsupret.det
RM Vent Perm       : data\detfac\evvent.det
Hot Soaks          : data\detfac\evhotsk.det
RuningLoss         : data\detfac\evrunls.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
Control Factor     : 0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

/MODELYEAR OUT/
EXHAUST BMY OUT    :
EVAP BMY OUT       :
/END/

SI REPORT/
SI report file-CSV :OUTPUTS\NRPOLLUT.CSV
/END/

/DAILY FILES/
DAILY TEMPS/RVP    :
/END/

PM Base Sulfur
 cols 1-10: dsl tech type;
 11-20: base sulfur wt%; or '1.0' means no-adjust (cert= in-use)
/PM BASE SULFUR/
T2        0.0350    0.02247
T3        0.2000    0.02247
T3B       0.0500    0.02247
T4A       0.0500    0.02247
T4B       0.0015    0.02247
T4        0.0015    0.30
T4N       0.0015    0.30
T2M       0.0350    0.02247
T3M       1.0       0.02247
T4M       1.0       0.02247
/END/
```

```
Written by Nonroad interface at 7/23/2013 5:04:04 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information.  Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

9/2005 epa: Add growth & tech years to PERIOD packet
  and Counties & Retrofit files to RUNFILES packet.

-------------------------------------------------------

                  PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated.  The order of the
records matter.  The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1  - Char 10  - Period type for this simulation.
                  Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2  - Char 10  - Type of inventory produced.
                  Valid responses are: TYPICAL DAY and PERIOD TOTAL
3  - Integer  - year of episode (4 digit year)
4  - Char 10  - Month of episode (use complete name of month)
5  - Char 10  - Type of day
                  Valid responses are: WEEKDAY and WEEKEND
-------------------------------------------------------
/PERIOD/
Period type        : Monthly
Summation type     : Period total
Year of episode    : 2008
Season of year     :
Month of year      : October
Weekday or weekend : Weekday
Year of growth calc:
Year of tech sel   :
/END/

-------------------------------------------------------

                  OPTIONS PACKET

This is the packet that defines some of the user
options that drive the model.  Most parameters are
used to make episode specific emission factor
adjustments. The order of the records is fixed.
The order is as follows.

1  -  Char 80  - First title on reports
2  -  Char 80  - Second title on reports
3  -  Real 10  - Fuel RVP of gasoline for this simulation
4  -  Real 10  - Oxygen weight percent of gasoline for simulation
5  -  Real 10  - Percent sulfur for gasoline
6  -  Real 10  - Percent sulfur for diesel
7  -  Real 10  - Percent sulfur for LPG/CNG
8  -  Real 10  - Minimum daily temperature (deg. F)
9  -  Real 10  - maximum daily temperature (deg. F)
10 -  Real 10  - Representative average daily temperature (deg. F)
11 -  Char 10  - Flag to determine if region is high altitude
                     Valid responses are: HIGH and LOW
12 -  Char 10  - Flag to determine if RFG adjustments are made
```

Valid responses are: YES and NO

```
-------------------------------------------------------
/OPTIONS/
Title 1            : PINAL COUNTY, AZ
Title 2            : OCTOBER 2008
Fuel RVP for gas   : 8.8
Oxygen Weight %    : 3.5
Gas sulfur %       : 0.0015
Diesel sulfur %    : 0.0006
Marine Dsl sulfur %: 0.0006
CNG/LPG sulfur %   : 0.003
Minimum temper. (F): 59
Maximum temper. (F): 88
Average temper. (F): 73
Altitude of region : LOW
EtOH Blend % Mkt   : 100
EtOH Vol %         : 10
/END/

-------------------------------------------------------
```

REGION PACKET

This is the packet that defines the region for which emissions are to be estimated.

The first record tells the type of region and allocation to perform.

Valid responses are:

US TOTAL - emissions are for entire USA without state breakout.

50STATE - emissions are for all 50 states and Washington D.C., by state.

STATE - emissions are for a select group of states and are state-level estimates

COUNTY - emissions are for a select group of counties and are county level estimates. If necessary, allocation from state to county will be performed.

SUBCOUNTY - emissions are for the specified sub counties and are subcounty level estimates. If necessary, county to subcounty allocation will be performed.

The remaining records define the regions to be included. The type of data which must be specified depends on the region level.

US TOTAL - Nothing needs to be specified. The FIPS code 00000 is used automatically.

50STATE - Nothing needs to be specified. The FIPS code 00000 is used automatically.

STATE - state FIPS codes

COUNTY - state or county FIPS codes. State FIPS code means include all counties in the state.

SUBCOUNTY - county FIPS code and subregion code.

```
-------------------------------------------------------
/REGION/
Region Level       : COUNTY
Pinal County AZ    : 04021
/END/

or use -
Region Level       : STATE
Michigan           : 26000
-------------------------------------------------------
```

SOURCE CATEGORY PACKET

```
This packet is used to tell the model which source
categories are to be processed.  It is optional.
If used, only those source categories list will
appear in the output data file.  If the packet is
not found, the model will process all source
categories in the population files.
-------------------------------------------------------


Diesel Only -
                   :2270000000
                   :2282020000
                   :2285002015
Spark Ignition Only -
                   :2260000000
                   :2265000000
                   :2267000000
                   :2268000000
                   :2282005010
                   :2282005015
                   :2282010005
                   :2285004015
                   :2285006015
-------------------------------------------------------
 This is the packet that lists the names of output files
 and some of the input data files read by the model.  If
 a drive:\path\ is not given, the location of the
 NONROAD.EXE file itself is assumed.  You will probably
 want to change the names of the Output and Message files
 to match that of the OPTion file, e.g., MICH-97.OPT,
 MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.
-------------------------------------------------------
/RUNFILES/
ALLOC XREF         : data\allocate\allocate.xrf
ACTIVITY           : data\activity\activity.dat
EXH TECHNOLOGY     : data\tech\tech-exh.dat
EVP TECHNOLOGY     : data\tech\tech-evp.dat
SEASONALITY        : data\season\season.dat
REGIONS            : data\season\season.dat
MESSAGE            : c:\nonroad\outputs\p08_oct.msg
OUTPUT DATA        : c:\nonroad\outputs\p08_oct.out
EPS2 AMS           :
US COUNTIES FIPS   : c:\nonroad\data\allocate\fips.dat
RETROFIT           :
/END/

-------------------------------------------------------
This is the packet that defines the equipment population
files read by the model.
-------------------------------------------------------
```

```
/POP FILES/
Population File    :c:\nonroad\data\pop\az.pop
/END/

POPULATION FILE    : c:\nonroad\data\POP\MI.POP


-------------------------------------------------------
This is the packet that defines the growth files
files read by the model.
-------------------------------------------------------
/GROWTH FILES/
National defaults  : data\growth\nation.grw
/END/


/ALLOC FILES/
Air trans. empl.   :c:\nonroad\data\allocate\az_airtr.alo
Undergrnd coal prod:c:\nonroad\data\allocate\az_coal.alo
Construction cost  :c:\nonroad\data\allocate\az_const.alo
Harvested acres    :c:\nonroad\data\allocate\az_farms.alo
Golf course estab. :c:\nonroad\data\allocate\az_golf.alo
Wholesale estab.   :c:\nonroad\data\allocate\az_holsl.alo
Family housing     :c:\nonroad\data\allocate\az_house.alo
Logging employees  :c:\nonroad\data\allocate\az_loggn.alo
Landscaping empl.  :c:\nonroad\data\allocate\az_lscap.alo
Manufacturing empl.:c:\nonroad\data\allocate\az_mnfg.alo
Oil & gas employees:c:\nonroad\data\allocate\az_oil.alo
Census population  :c:\nonroad\data\allocate\az_pop.alo
Allocation File    :c:\nonroad\data\allocate\az_rail.alo
RV Park establish. :c:\nonroad\data\allocate\az_rvprk.alo
Snowblowers comm.  :c:\nonroad\data\allocate\az_sbc.alo
Snowblowers res.   :c:\nonroad\data\allocate\az_sbr.alo
Snowmobiles        :c:\nonroad\data\allocate\az_snowm.alo
Rec marine inboard :c:\nonroad\data\allocate\az_wib.alo
Rec marine outboard:c:\nonroad\data\allocate\az_wob.alo
/END/
-------------------------------------------------------
This is the packet that defines the emssions factors
files read by the model.
-------------------------------------------------------
/EMFAC FILES/
THC exhaust        : data\emsfac\exhthc.emf
CO exhaust         : data\emsfac\exhco.emf
NOX exhaust        : data\emsfac\exhnox.emf
PM exhaust         : data\emsfac\exhpm.emf
BSFC               : data\emsfac\bsfc.emf
Crankcase          : data\emsfac\crank.emf
Spillage           : data\emsfac\spillage.emf
Diurnal            : data\emsfac\evdiu.emf
Tank Perm          : data\emsfac\evtank.emf
Non-RM Hose Perm   : data\emsfac\evhose.emf
RM Fill Neck Perm  : data\emsfac\evneck.emf
RM Supply/Return   : data\emsfac\evsupret.emf
RM Vent Perm       : data\emsfac\evvent.emf
Hot Soaks          : data\emsfac\evhotsk.emf
RuningLoss         : data\emsfac\evrunls.emf
/END/

-------------------------------------------------------
This is the packet that defines the deterioration factors
files read by the model.
-------------------------------------------------------
```

```
/DETERIORATE FILES/
THC exhaust        : data\detfac\exhthc.det
CO exhaust         : data\detfac\exhco.det
NOX exhaust        : data\detfac\exhnox.det
PM exhaust         : data\detfac\exhpm.det
Diurnal            : data\detfac\evdiu.det
Tank Perm          : data\detfac\evtank.det
Non-RM Hose Perm   : data\detfac\evhose.det
RM Fill Neck Perm  : data\detfac\evneck.det
RM Supply/Return   : data\detfac\evsupret.det
RM Vent Perm       : data\detfac\evvent.det
Hot Soaks          : data\detfac\evhotsk.det
RuningLoss         : data\detfac\evrunls.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
Control Factor     : 0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

/MODELYEAR OUT/
EXHAUST BMY OUT    :
EVAP BMY OUT       :
/END/

SI REPORT/
SI report file-CSV :OUTPUTS\NRPOLLUT.CSV
/END/

/DAILY FILES/
DAILY TEMPS/RVP    :
/END/

PM Base Sulfur
 cols 1-10: dsl tech type;
 11-20: base sulfur wt%; or '1.0' means no-adjust (cert= in-use)
/PM BASE SULFUR/
T2        0.0350    0.02247
T3        0.2000    0.02247
T3B       0.0500    0.02247
T4A       0.0500    0.02247
T4B       0.0015    0.02247
T4        0.0015    0.30
T4N       0.0015    0.30
T2M       0.0350    0.02247
T3M       1.0       0.02247
T4M       1.0       0.02247
/END/
```

```
Written by Nonroad interface at 7/23/2013 5:12:06 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information.  Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

9/2005 epa: Add growth & tech years to PERIOD packet
  and Counties & Retrofit files to RUNFILES packet.

-------------------------------------------------------

                  PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated.  The order of the
records matter.  The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1  - Char 10  - Period type for this simulation.
                  Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2  - Char 10  - Type of inventory produced.
                  Valid responses are: TYPICAL DAY and PERIOD TOTAL
3  - Integer  - year of episode (4 digit year)
4  - Char 10  - Month of episode (use complete name of month)
5  - Char 10  - Type of day
                  Valid responses are: WEEKDAY and WEEKEND
-------------------------------------------------------
/PERIOD/
Period type        : Monthly
Summation type     : Period total
Year of episode    : 2008
Season of year     :
Month of year      : November
Weekday or weekend : Weekday
Year of growth calc:
Year of tech sel   :
/END/

-------------------------------------------------------

                  OPTIONS PACKET

This is the packet that defines some of the user
options that drive the model.  Most parameters are
used to make episode specific emission factor
adjustments. The order of the records is fixed.
The order is as follows.

1  -  Char 80  - First title on reports
2  -  Char 80  - Second title on reports
3  -  Real 10  - Fuel RVP of gasoline for this simulation
4  -  Real 10  - Oxygen weight percent of gasoline for simulation
5  -  Real 10  - Percent sulfur for gasoline
6  -  Real 10  - Percent sulfur for diesel
7  -  Real 10  - Percent sulfur for LPG/CNG
8  -  Real 10  - Minimum daily temperature (deg. F)
9  -  Real 10  - maximum daily temperature (deg. F)
10 -  Real 10  - Representative average daily temperature (deg. F)
11 -  Char 10  - Flag to determine if region is high altitude
                     Valid responses are: HIGH and LOW
12 -  Char 10  - Flag to determine if RFG adjustments are made
```

Valid responses are: YES and NO

```
-------------------------------------------------------
/OPTIONS/
Title 1            : PINAL COUNTY, AZ
Title 2            : NOVEMBER 2008
Fuel RVP for gas   : 8.8
Oxygen Weight %    : 3.5
Gas sulfur %       : 0.0015
Diesel sulfur %    : 0.0006
Marine Dsl sulfur %: 0.0006
CNG/LPG sulfur %   : 0.003
Minimum temper. (F): 47
Maximum temper. (F): 75
Average temper. (F): 61
Altitude of region : LOW
EtOH Blend % Mkt   : 100
EtOH Vol %         : 10
/END/

-------------------------------------------------------
```

REGION PACKET

This is the packet that defines the region for which emissions are to be estimated.

The first record tells the type of region and allocation to perform.

Valid responses are:

US TOTAL - emissions are for entire USA without state breakout.

50STATE - emissions are for all 50 states and Washington D.C., by state.

STATE - emissions are for a select group of states and are state-level estimates

COUNTY - emissions are for a select group of counties and are county level estimates. If necessary, allocation from state to county will be performed.

SUBCOUNTY - emissions are for the specified sub counties and are subcounty level estimates. If necessary, county to subcounty allocation will be performed.

The remaining records define the regions to be included. The type of data which must be specified depends on the region level.

US TOTAL - Nothing needs to be specified. The FIPS code 00000 is used automatically.

50STATE - Nothing needs to be specified. The FIPS code 00000 is used automatically.

STATE - state FIPS codes

COUNTY - state or county FIPS codes. State FIPS code means include all counties in the state.

SUBCOUNTY - county FIPS code and subregion code.

```
-------------------------------------------------------
/REGION/
Region Level       : COUNTY
Pinal County AZ    : 04021
/END/

or use -
Region Level       : STATE
Michigan           : 26000
-------------------------------------------------------
```

SOURCE CATEGORY PACKET

```
This packet is used to tell the model which source
categories are to be processed.  It is optional.
If used, only those source categories list will
appear in the output data file.  If the packet is
not found, the model will process all source
categories in the population files.
-------------------------------------------------------


Diesel Only -
                   :2270000000
                   :2282020000
                   :2285002015
Spark Ignition Only -
                   :2260000000
                   :2265000000
                   :2267000000
                   :2268000000
                   :2282005010
                   :2282005015
                   :2282010005
                   :2285004015
                   :2285006015
-------------------------------------------------------
 This is the packet that lists the names of output files
 and some of the input data files read by the model.  If
 a drive:\path\ is not given, the location of the
 NONROAD.EXE file itself is assumed.  You will probably
 want to change the names of the Output and Message files
 to match that of the OPTion file, e.g., MICH-97.OPT,
 MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.
-------------------------------------------------------
/RUNFILES/
ALLOC XREF         : data\allocate\allocate.xrf
ACTIVITY           : data\activity\activity.dat
EXH TECHNOLOGY     : data\tech\tech-exh.dat
EVP TECHNOLOGY     : data\tech\tech-evp.dat
SEASONALITY        : data\season\season.dat
REGIONS            : data\season\season.dat
MESSAGE            : c:\nonroad\outputs\p08_nov.msg
OUTPUT DATA        : c:\nonroad\outputs\p08_nov.out
EPS2 AMS           :
US COUNTIES FIPS   : c:\nonroad\data\allocate\fips.dat
RETROFIT           :
/END/

-------------------------------------------------------
This is the packet that defines the equipment population
files read by the model.
-------------------------------------------------------
```

```
/POP FILES/
Population File    :c:\nonroad\data\pop\az.pop
/END/

POPULATION FILE    : c:\nonroad\data\POP\MI.POP


-------------------------------------------------------
This is the packet that defines the growth files
files read by the model.
-------------------------------------------------------
/GROWTH FILES/
National defaults  : data\growth\nation.grw
/END/


/ALLOC FILES/
Air trans. empl.   :c:\nonroad\data\allocate\az_airtr.alo
Undergrnd coal prod:c:\nonroad\data\allocate\az_coal.alo
Construction cost  :c:\nonroad\data\allocate\az_const.alo
Harvested acres    :c:\nonroad\data\allocate\az_farms.alo
Golf course estab. :c:\nonroad\data\allocate\az_golf.alo
Wholesale estab.   :c:\nonroad\data\allocate\az_holsl.alo
Family housing     :c:\nonroad\data\allocate\az_house.alo
Logging employees  :c:\nonroad\data\allocate\az_loggn.alo
Landscaping empl.  :c:\nonroad\data\allocate\az_lscap.alo
Manufacturing empl.:c:\nonroad\data\allocate\az_mnfg.alo
Oil & gas employees:c:\nonroad\data\allocate\az_oil.alo
Census population  :c:\nonroad\data\allocate\az_pop.alo
Allocation File    :c:\nonroad\data\allocate\az_rail.alo
RV Park establish. :c:\nonroad\data\allocate\az_rvprk.alo
Snowblowers comm.  :c:\nonroad\data\allocate\az_sbc.alo
Snowblowers res.   :c:\nonroad\data\allocate\az_sbr.alo
Snowmobiles        :c:\nonroad\data\allocate\az_snowm.alo
Rec marine inboard :c:\nonroad\data\allocate\az_wib.alo
Rec marine outboard:c:\nonroad\data\allocate\az_wob.alo
/END/
-------------------------------------------------------
This is the packet that defines the emssions factors
files read by the model.
-------------------------------------------------------
/EMFAC FILES/
THC exhaust        : data\emsfac\exhthc.emf
CO exhaust         : data\emsfac\exhco.emf
NOX exhaust        : data\emsfac\exhnox.emf
PM exhaust         : data\emsfac\exhpm.emf
BSFC               : data\emsfac\bsfc.emf
Crankcase          : data\emsfac\crank.emf
Spillage           : data\emsfac\spillage.emf
Diurnal            : data\emsfac\evdiu.emf
Tank Perm          : data\emsfac\evtank.emf
Non-RM Hose Perm   : data\emsfac\evhose.emf
RM Fill Neck Perm  : data\emsfac\evneck.emf
RM Supply/Return   : data\emsfac\evsupret.emf
RM Vent Perm       : data\emsfac\evvent.emf
Hot Soaks          : data\emsfac\evhotsk.emf
RuningLoss         : data\emsfac\evrunls.emf
/END/

-------------------------------------------------------
This is the packet that defines the deterioration factors
files read by the model.
-------------------------------------------------------
```

```
/DETERIORATE FILES/
THC exhaust        : data\detfac\exhthc.det
CO exhaust         : data\detfac\exhco.det
NOX exhaust        : data\detfac\exhnox.det
PM exhaust         : data\detfac\exhpm.det
Diurnal            : data\detfac\evdiu.det
Tank Perm          : data\detfac\evtank.det
Non-RM Hose Perm   : data\detfac\evhose.det
RM Fill Neck Perm  : data\detfac\evneck.det
RM Supply/Return   : data\detfac\evsupret.det
RM Vent Perm       : data\detfac\evvent.det
Hot Soaks          : data\detfac\evhotsk.det
RuningLoss         : data\detfac\evrunls.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
Control Factor     : 0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

/MODELYEAR OUT/
EXHAUST BMY OUT    :
EVAP BMY OUT       :
/END/

SI REPORT/
SI report file-CSV :OUTPUTS\NRPOLLUT.CSV
/END/

/DAILY FILES/
DAILY TEMPS/RVP    :
/END/

PM Base Sulfur
 cols 1-10: dsl tech type;
 11-20: base sulfur wt%; or '1.0' means no-adjust (cert= in-use)
/PM BASE SULFUR/
T2        0.0350    0.02247
T3        0.2000    0.02247
T3B       0.0500    0.02247
T4A       0.0500    0.02247
T4B       0.0015    0.02247
T4        0.0015    0.30
T4N       0.0015    0.30
T2M       0.0350    0.02247
T3M       1.0       0.02247
T4M       1.0       0.02247
/END/
```

Appendix 9

Agricultural Unpaved Road Activity and Speed Notes

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Notes from Pinal County Agricultural meeting on 10/21/2013

Updated 10/24/13 @ 4:15 pm to add speed assumption calculation for non-harvest operations

This meeting discussed some of the assumptions made during inventory and modeling development with the Agricultural community. The following information was clarified for ADEQ during this meeting by Dan Thelander, Kevin Rogers, and Bas Aja. Where the word "trips" are used, we are assuming a one-way trip either to or from a field. Therefore, trips are equivalent to ADT, not round-trips.

On 10/29/2008, it can be assumed that ~50% of cotton farmers were performing night tilling. We can also assume that tilling practices have not changed between 2008 and 2013. For harvesting of 100 acres of cotton, the following travel on Ag roads was given:

- Four module trucks will be needed, combining for 8 total trips at an average speed between 10 and 15 mph.
- Three pickers will be needed, combining for 6 total trips at an average speed of 10-15 mph.
- Module hauler trucks will combine for a total of 46 trips and average 30 mph.
- Maintenance/pickup trucks and watering trucks will combine for 8-10 total trips at an average speed of 30 mph.

Alfalfa harvesting generally occurs once every month and occurs over a period of four days. For harvesting of 100 acres of alfalfa, the following travel on Ag roads was given:

- Swathers combine for 3 total trips at an average speed between 10 and 15 mph.
- Bailers combine for 6 total trips at an average speed of 10-15 mph.
- Road siders will combine for a total of 2 trips and average 10-15 mph.
- Semis will combine for 8 total trips at an average speed of 25 mph.
- Squeeze will account for 2 total trips at an average speed of 30 mph.

For non-harvest operations, the farmers estimated that for a 2500 acre farm running 4 maintenance trucks at an average speed of 30 mph, each truck would log a VMT of 70 miles, for a total of 280 miles per day for non-harvest operations. In addition, tractors would account for 8 additional trips each day at a speed of 10-15 mph.

ADEQ was asked to perform calculations for non-harvest maintenance trucks using the following assumptions:

- 2500 acre farm
- 4 trucks
- 30 mph
- Truck is parked 75% of the time and driving 25% of the time OR parked 90% of the time and driving 10% of the time.
- 12 hours per day

Assuming a 75/25 split, the total daily truck mileage would be 360 miles (i.e. 90 miles/truck/day). Assuming a 90/10 split, the total daily truck mileage would be 144 miles (i.e. 36 miles/truck/day). Seeing as the farmers estimated that each truck would travel 70 miles per day and this estimation is in line with average miles of daily truck traffic calculated above, 70 miles/ truck/day will be assumed.

ADEQ was also informed that a 2500 acre farm uses four maintenance trucks; therefore, ADEQ infers that a 1336 acre farm (assumed average farm size in the EI) would use two trucks for maintenance. Based on these assumptions, an average farm would drive 140 miles per day for maintenance. Since the average percentage of ag roads, in relation to total road, on a farm was calculated by ADEQ to be 63.27%, it was determined that maintenance trucks would travel 88.58 miles (i.e. 140 miles * .6327) on Ag roads per day. ADEQ further calculated that the average total ag road length per farm is 8.695 miles. Therefore, maintenance trucks make an average of 10.19 trips (i.e. 88.58 miles of ag road driven / 8.695 of ag road on a farm) across all farm roads per day, or maintenance trucks account for 10.19 ADT. In addition, ADEQ was informed that tractors average 8 trips per day. ADEQ assumes that each trip is limited to an average of one ag road. ADEQ has calculated that there is an average of 7 ag roads on an individual farm through GIS observation sampling. Therefore, tractors account for an additional average 1.14 ADT (i.e. 8 trips / 7 ag roads per farm). If these numbers are added together, we can estimate the base, non-harvest ADT on ag roads, which is found to be 11.33 ADT (i.e. 10.19 ADT + 1.14 ADT).

Therefore, ADEQ proposes to use a base, non-harvest ADT of 11.33 for ag roads and adjust this ADT to account for additional traffic during harvest periods.

Average speed for a base, non-harvest ADT was calculated to be 28.24 mph using the equation below:

[(10.19*30)+(1.14*12.5)]/11.33

Average Agricultural Roadway Harvest ADT Increase on 10/29/2013

This document outlines the assumptions and calculations used for determining an average ADT for harvesting operations on Agricultural Roadways.

During a meeting with the Agricultural community on 10/21/2013, the following information was provided to ADEQ describing Ag road travel during the harvesting period of 10/29/2008.

- For 100 acres of cotton harvesting, the number of trips for harvesting equipment vehicles is 69 with a weighted average vehicle speed of 26.4mph.
- For 100 acres of alfalfa harvesting, the number of trips for harvesting equipment vehicles is 21 with a weighted average vehicle speed of 18.9mph.
- Harvesting 100 acres of alfalfa would take 4 days and alfalfa is harvested once per month.

ADEQ performed a survey of 20 crop fields in the Stanfield modeling domain to determine the average mileage of agricultural roads per 100 acres of cropland. This survey revealed that per 100 acres of cropland, there was an average of 2.43 miles of bordering roads, of which 1.54 miles were agricultural roads.

ADEQ has used this information to calculate an average Ag road ADT formula based on cotton and alfalfa harvesting for the 10/29/2008 design day.

Cotton Harvesting

An average farm size of 1,334 acres was assumed in the Pinal County PM_{10} Emission Inventory document. It was determined from this information that on average 100 acres or 7.5% of a farm could be harvested for cotton on any one day of the cotton harvesting season. ADEQ assumed that 25% of the roadway immediately surrounding a crop field will be accessed on average for a harvesting trip[1]. On average 69 trips are taken for 100 acres of cotton harvesting. The total mileage of Ag roadway bordering a 100 acre harvesting operation is 1.54 miles[2]. This only accounts for the mileage driven on those ag roads immediately bordering the crop field; however, the vehicles must travel to and from equipment areas and/or public roadways to access these fields. In these transport periods, ADEQ observed an average distance between public access roadways of ~1 mile. Therefore, ADEQ assumed an average access distance

[1] This assumption is based on a rectangular crop field of 100 acres where, at most, an individual would need to drive 50% of the perimeter of the field to access the furthest point, and on average a driver would only need to drive halfway to the furthest point.

[2] This was determined by surveying the GIS land use layer in the Stanfield area for 20 crop fields and calculating the bordering roadway mileage to the surveyed fields. This roadway mileage was then adjusted to remove public roads and only account for agricultural roadways.

traveled of 0.25 miles per trip. This means that the average total distance traveled per harvesting trip is 1.79 miles (i.e. 1.54 miles + 0.25 miles). The total estimated mileage of Ag roadways in a 1,334-acre farm was calculated to be 8.7 miles. Therefore, on an average trip, 20.6% of the ag roadways are accessed (i.e. 1.79 miles / 8.7 miles).

Since ADEQ does not know which fields are harvesting on which days, an average cotton harvest ADT across ag roadways must be calculated. Therefore, ADEQ assumed that cotton harvesting would result in an increase in ADT of 14.2 (or 20.6% of 69 trips).

Alfalfa Harvesting

An average farm size of 1,334 acres was assumed in the Pinal County PM_{10} Emission Inventory document. The agricultural community informed ADEQ that harvesting of 100 acres of alfalfa would take approximately 4 days and would be performed once per month. ADEQ assumed that 25% of the roadway immediately surrounding a crop field will be accessed on average for a harvesting trip[3]. On average 21 trips are taken for 100 acres of alfalfa harvesting. The total mileage of Ag roadway bordering a 100 acre harvesting operation is 1.54 miles. This only accounts for the mileage driven on those ag roads immediately bordering the crop field; however, the vehicles must travel to and from equipment areas and/or public roadways to access these fields. In these transport periods, ADEQ observed an average distance between public access roadways of ~1 mile. Therefore, ADEQ estimated an average access distance traveled of 0.25 miles per trip. This means that the average total distance traveled per harvesting trip is 1.79 miles (i.e. 1.54 miles + 0.25 miles). The total calculated mileage of Ag roadways in a 1,334 farm is estimated to be 8.7 miles. Therefore, on an average trip, 20.6% of the ag roadways are accessed (i.e. 1.79 miles / 8.7 miles).

Since ADEQ does not know which fields are harvesting on which days, an average alfalfa harvest ADT across ag roadways must be calculated. While 20.6% of the ag roadways are accessed per harvesting trip, the frequency of harvesting and the number of days over which a 100 acre alfalfa field are harvested must be accounted for. Therefore, ADEQ assumed that alfalfa harvesting would result in an increase in ADT of 2.43.

$$ADT = \frac{(\%\ of\ Ag\ Roadways\ accessed) * (\#of\ trips/harvest) * (30\ day\ farm\ rotations)}{(4\ days\ per\ harvest) * (13.34\ rotations\ for\ a\ farm)}$$

Where farm rotations and rotations for a farm are dependent on the days between harvests and the average number of 100 acre plots each farm must harvest respectively.

[3] This assumption is based on a rectangular crop field of 100 acres where, at most, an individual would need to drive 50% of the perimeter of the field to access the furthest point, and on average a driver would only need to drive halfway to the furthest point.

Harvest ADT application

Above, ADEQ has estimated that Cotton Harvest increases base ADT by 14.2 and Alfalfa harvesting increases base ADT by 2.43; however, these numbers should be proportional increases based on the percentage of cotton and alfalfa cropland within a given modeling domain. For instance, if no cotton is grown within a given modeling domain, it would stand to reason that no additional cotton harvesting ADT should be applied. Therefore, ADEQ proposes to use these ADT increases on a modeling domain basis based on the weighted average of cotton and alfalfa harvested in the given modeling domain. Below, an example of the application of this is shown for some modeling domain "X".

EXAMPLE: Assuming the crop distribution in modeling domain X is:

- 30% Cotton
- 15% Alfalfa
- 55% Other Crops

We can calculate the proportional ADT harvest increase as:

$$harvest\ ADT\ increase = (0.3 * 14.2) + (0.15 * 2.43) = 4.62$$

Assuming a base, non-harvest average ADT for Ag roads of 11.33 (calculated in "Notes from Pinal County Agricultural meeting on 10-21-2013.docx"), total average ADT is equal to:

$$total\ ADT = base\ ADT + harvest\ ADT\ increase = 11.33 + 4.62 = 15.95$$

Cowtown

Crop	Acreage	% of modeling domain Ag land
Alfalfa	2413.07	35.37%
Cotton	653.19	9.57%
Other Crops	3755.76	55.05%
TOTAL	6822.01	100.00%

Please note that for these calculations I am only focusing on identified ag lands

Using the values calculated in "Average Agricultural Roadway Harvest ADT Increase.docx", Base ADT is 11.33, Cotton harvest ADT is 14.2, and Alfalfa harvest ADT is 2.43.

Operation	Fractional ADT	Speed (mph)
Cotton Harvest	1.36	26.4
Alfalfa Harvest	0.86	18.9
Base Operations	11.33	28.23919

Average Ag Road ADT for Modeling Domain	**13.55**	27.46217

Pinal County Housing (PCH)

Crop	Acreage	% of modeling domain Ag land
Alfalfa	931.88	21.95%
Cotton	1522.31	35.86%
Other Crops	1791.02	42.19%
TOTAL	4245.20	100.00%

Please note that for these calculations I am only focusing on identified ag lands

Using the values calculated in "Average Agricultural Roadway Harvest ADT Increase.docx", Base ADT is 11.33, Cotton harvest ADT is 14.2, and Alfalfa harvest ADT is 2.43.

Operation	Fractional ADT	Speed (mph)
Cotton Harvest	5.09	26.4
Alfalfa Harvest	0.53	18.9
Base Operations	11.33	28.23919

Average Ag Road ADT for Modeling Domain	**16.96**	27.39303

Stanfield

Crop	Acreage	% of modeling domain Ag land
Alfalfa	6647.86	49.15%
Cotton	2554.54	18.89%
Other Crops	4324.31	31.97%
TOTAL	13526.71	100.00%

Please note that for these calculations I am only focusing on identified ag lands

Using the values calculated in "Average Agricultural Roadway Harvest ADT Increase.docx", Base ADT is 11.33, Cotton harvest ADT is 14.2, and Alfalfa harvest ADT is 2.43.

Operation	Fractional ADT	Speed (mph)
Cotton Harvest	2.68	26.4
Alfalfa Harvest	1.19	18.9
Base Operations	11.33	28.23919

Average Ag Road ADT for Modeling Domain	**15.21**	27.18135

Appendix 10

Listing of Diurnal Profiles for Windblown, Activity-Based, and Total Emissions on High Wind Days

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Table 4-4A
Emissions Inventory (lbs/hour) for the High Wind Day at PCH on 1/1/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Paved Road	Permitted Point Sources	Dairies	Cleared Area	Desert Shrub-land	Develop-ed Rural Lands	Develop-ed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	1.6	303.8	28.2	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	12.8	2.0	0.0	48.5
2	1.5	318.0	21.0	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	10.4	9.8	0.0	53.8
3	2.0	335.4	22.2	0.4	33.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	12.3	4.9	0.0	51.1
4	2.5	333.7	24.5	0.5	33.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	45.8
5	5.9	352.2	16.4	1.0	33.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	26.8	5.9	0.0	68.7
6	3.2	299.6	19.1	3.4	33.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	60.8	20.6	0.0	119.8
7	3.9	339.3	16.2	5.5	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	119.4	41.3	2.8	474.8
8	5.7	5.0	22.7	4.9	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	177.7	25.5	2.8	516.8
9	4.8	53.9	34.7	4.1	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	162.1	34.4	2.8	509.2
10	16.3	41.2	871.2	0.0	0.0	2.0	119.0	297.2	42.6	11.0	2521.4	352.2	230.0	107.5	15.6	3698.5
11	21.4	46.3	919.3	0.0	0.0	1.6	355.2	823.7	118.2	37.3	8165.9	755.1	315.6	187.1	45.9	10805.6
12	25.1	49.6	1136.1	0.0	0.0	1.6	641.0	1486.2	213.3	67.3	14663.9	1215.6	463.7	326.4	80.5	19159.6
13	23.6	48.5	790.7	0.0	0.0	1.2	275.3	638.4	91.6	28.9	6348.8	626.3	284.8	159.6	36.2	8491.2
14	22.9	48.3	946.1	0.0	0.0	1.2	135.1	313.3	45.0	14.2	3160.4	400.3	245.5	131.3	19.2	4465.5
15	19.2	47.6	320.0	0.0	0.0	1.2	65.5	163.5	23.5	6.1	1427.0	275.9	229.5	84.4	9.9	2286.4
16	22.3	53.6	397.9	0.0	0.0	1.6	87.6	203.2	29.2	9.2	2081.0	323.8	245.1	100.3	13.5	3094.4
17	19.9	53.6	281.9	0.0	0.0	2.0	80.0	199.8	28.7	7.4	1724.6	296.7	219.5	75.8	11.4	2645.9
18	15.0	50.6	65.8	0.0	0.0	2.8	20.5	53.3	7.7	1.8	480.7	209.6	172.7	46.1	4.9	1000.0
19	15.5	54.6	50.9	0.0	0.0	3.6	14.6	38.1	5.5	1.3	280.3	19.3	95.4	46.1	1.5	505.7
20	19.4	58.1	61.5	0.0	0.0	3.6	18.2	45.4	6.5	1.7	371.9	25.9	55.8	37.9	1.9	568.8
21	19.3	56.7	70.6	0.0	0.0	2.8	21.8	54.5	7.8	2.0	446.3	31.1	58.8	43.2	2.3	670.6
22	19.2	57.4	67.6	0.0	0.0	2.0	21.8	54.5	7.8	2.0	446.3	31.1	49.5	17.6	2.3	635.0
23	17.2	55.7	32.7	0.0	0.0	0.6	6.6	16.6	2.4	0.6	135.5	9.4	31.4	11.2	0.7	215.0
24	14.9	54.6	139.3	0.0	0.0	0.6	13.0	33.9	4.9	1.1	249.3	17.2	27.0	7.3	1.3	355.6
Average			264.9	0.9	12.4	1.6	78.1	184.2	26.4	8.0	1782.0	214.1	138.3	63.6	10.7	2520.3
Percentage Contribution				0.0%	0.5%	0.1%	3.1%	7.3%	1.0%	0.3%	70.7%	8.5%	5.5%	2.5%	0.4%	100.0%

Shaded Area = High Wind Hours

Table 4-4B
Emissions Inventory (lbs/hour) for the High Wind Day (High Wind Hour) at PCH on 1/1/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Paved Road	Permitted Point Sources	Dairies	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	1.6	303.8	28.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5	318.0	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	2.0	335.4	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	2.5	333.7	24.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	5.9	352.2	16.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	3.2	299.6	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	3.9	339.3	16.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	5.7	5.0	22.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	4.8	53.9	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	16.3	41.2	871.2	0.0	0.0	0.0	119.0	297.2	42.6	11.0	2433.3	169.6	43.9	42.6	12.8	3172.0
11	21.4	46.3	919.3	0.0	0.0	0.0	355.2	823.7	118.2	37.3	8077.8	572.5	148.1	143.9	43.0	10319.7
12	25.1	49.6	1136.1	0.0	0.0	0.0	641.0	1486.2	213.3	67.3	14575.7	1033.0	267.2	259.6	77.7	18621.1
13	23.6	48.5	790.7	0.0	0.0	0.0	275.3	638.4	91.6	28.9	6260.7	443.7	114.8	111.5	33.4	7998.2
14	22.9	48.3	946.1	0.0	0.0	0.0	135.1	313.3	45.0	14.2	3072.2	217.7	56.3	54.7	16.4	3924.9
15	19.2	47.6	320.0	0.0	0.0	0.0	65.5	163.5	23.5	6.1	1338.9	93.3	24.1	23.5	7.0	1745.3
16	22.3	53.6	397.9	0.0	0.0	0.0	87.6	203.2	29.2	9.2	1992.8	141.2	36.5	35.5	10.6	2545.9
17	19.9	53.6	281.9	0.0	0.0	0.0	80.0	199.8	28.7	7.4	1636.4	114.1	29.5	28.7	8.6	2133.2
18	15.0	50.6	65.8	0.0	0.0	0.0	20.5	53.3	7.7	1.8	392.5	27.0	7.0	6.8	2.0	518.6
19	15.5	54.6	50.9	0.0	0.0	0.0	14.6	38.1	5.5	1.3	280.3	19.3	5.0	4.9	1.5	370.4
20	19.4	58.1	61.5	0.0	0.0	0.0	18.2	45.4	6.5	1.7	371.9	25.9	6.7	6.5	1.9	484.8
21	19.3	56.7	70.6	0.0	0.0	0.0	21.8	54.5	7.8	2.0	446.3	31.1	8.0	7.8	2.3	581.8
22	19.2	57.4	67.6	0.0	0.0	0.0	21.8	54.5	7.8	2.0	446.3	31.1	8.0	7.8	2.3	581.8
23	17.2	55.7	32.7	0.0	0.0	0.0	6.6	16.6	2.4	0.6	135.5	9.4	2.4	2.4	0.7	176.7
24	14.9	54.6	139.3	0.0	0.0	0.0	13.0	33.9	4.9	1.1	249.3	17.2	4.4	4.3	1.3	329.5
Average			264.9	0.0	0.0	0.0	78.1	184.2	26.4	8.0	1737.9	122.8	31.8	30.9	9.2	2229.3
Percentage Contribution				0.0%	0.0%	0.0%	3.5%	8.3%	1.2%	0.4%	78.0%	5.5%	1.4%	1.4%	0.4%	100.0%

Table 4-4C
Emissions Inventory (lbs/hour) for the High Wind Day (Low Wind Hours) at PCH on 1/1/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Paved Road	Permitted Point Sources	Dairies	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	1.6	303.8	28.2	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	12.8	2.0	0.0	48.5
2	1.5	318.0	21.0	0.5	33.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	10.4	9.8	0.0	53.8
3	2.0	335.4	22.2	0.4	33.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	12.3	4.9	0.0	51.1
4	2.5	333.7	24.5	0.5	33.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	45.8
5	5.9	352.2	16.4	1.0	33.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	26.8	5.9	0.0	68.7
6	3.2	299.6	19.1	3.4	33.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	60.8	20.6	0.0	119.8
7	3.9	339.3	16.2	5.5	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	119.4	41.3	2.8	474.8
8	5.7	5.0	22.7	4.9	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	177.7	25.5	2.8	516.8
9	4.8	53.9	34.7	4.1	33.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	162.1	34.4	2.8	509.2
10	16.3	41.2	871.2	0.0	0.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	186.1	64.8	2.8	526.6
11	21.4	46.3	919.3	0.0	0.0	1.6	0.0	0.0	0.0	0.0	88.2	182.6	167.5	43.2	2.8	485.9
12	25.1	49.6	1136.1	0.0	0.0	1.6	0.0	0.0	0.0	0.0	88.2	182.6	196.6	66.8	2.8	538.5
13	23.6	48.5	790.7	0.0	0.0	1.2	0.0	0.0	0.0	0.0	88.2	182.6	170.0	48.1	2.8	493.0
14	22.9	48.3	946.1	0.0	0.0	1.2	0.0	0.0	0.0	0.0	88.2	182.6	189.2	76.6	2.8	540.6
15	19.2	47.6	320.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	88.2	182.6	205.3	60.9	2.8	541.0
16	22.3	53.6	397.9	0.0	0.0	1.6	0.0	0.0	0.0	0.0	88.2	182.6	208.6	64.8	2.8	548.6
17	19.9	53.6	281.9	0.0	0.0	2.0	0.0	0.0	0.0	0.0	88.2	182.6	190.0	47.1	2.8	512.7
18	15.0	50.6	65.8	0.0	0.0	2.8	0.0	0.0	0.0	0.0	88.2	182.6	165.7	39.3	2.8	481.3
19	15.5	54.6	50.9	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	90.4	41.3	0.0	135.3
20	19.4	58.1	61.5	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	49.0	31.4	0.0	84.0
21	19.3	56.7	70.6	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	50.7	35.4	0.0	88.9
22	19.2	57.4	67.6	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	41.5	9.8	0.0	53.3
23	17.2	55.7	32.7	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	28.9	8.8	0.0	38.4
24	14.9	54.6	139.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	22.5	2.9	0.0	26.1
Average			264.9	0.9	12.4	1.6	0.0	0.0	0.0	0.0	44.1	91.3	106.5	32.7	1.4	290.9
Percentage Contribution				0.3%	4.3%	0.6%	0.0%	0.0%	0.0%	0.0%	15.2%	31.4%	36.6%	11.3%	0.5%	100.0%

Table 4-5A
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Cowtown on 04/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Rail Road	Permitt-ed Point Sources	Paved Road	Con-struction	Cleared Area	Desert Shrubland		Develop-ed Rural Lands	Develop-ed Urban Lands	Un-known	CAFOs	Agriculture		Unpaved Road					Total
									County	Tribal					County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	6.1	332.4	68.3	1.2	10.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	3.5	1.5	0.0	19.6	3.0	0.0	2.3	79.0
2	0.7	320.5	73.0	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	3.5	1.5	0.0	22.2	14.8	0.0	4.8	96.0
3	5.9	314.7	88.1	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.2	3.5	1.5	0.0	18.1	7.4	0.0	2.8	119.5
4	3.9	84.4	59.7	1.2	10.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.4	3.5	1.5	0.0	18.3	0.0	0.0	1.5	185.3
5	2.2	25.7	92.3	1.2	10.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	39.7	8.9	0.0	5.1	442.8
6	2.4	156.6	492.9	1.2	10.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	84.1	31.2	0.0	13.7	522.5
7	1.6	229.1	326.4	1.2	10.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	185.9	62.3	2.2	39.8	1045.0
8	2.1	11.6	222.0	1.2	10.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	268.9	38.6	2.2	42.0	1105.3
9	10.9	33.2	372.4	1.2	10.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	249.1	51.9	2.2	43.2	1098.5
10	20.0	52.9	886.8	0.0	0.0	0.0	621.2	59.8	1156.3	451.0	101.0	3.5	0.2	370.9	2022.3	52.1	415.5	301.2	385.2	6.3	53.3	5999.8
11	17.6	44.4	107.7	0.0	0.0	0.0	164.7	15.8	306.5	119.5	26.8	0.9	0.1	296.7	582.7	52.1	291.4	256.7	141.5	3.3	45.8	2304.5
12	15.7	43.0	122.3	0.0	0.0	0.0	75.2	7.2	140.0	54.6	12.2	0.4	0.0	296.7	300.6	52.1	267.1	291.8	135.7	2.7	55.9	1692.4
13	17.7	37.0	72.0	0.0	0.0	0.0	153.7	14.8	286.0	111.5	25.0	0.9	0.1	222.5	548.0	52.1	288.5	261.6	143.8	3.3	49.4	2161.1
14	14.7	44.0	38.4	0.0	0.0	0.0	51.6	5.2	105.1	41.0	9.2	0.3	0.0	222.5	230.8	52.1	260.3	285.7	139.0	2.6	59.1	1464.5
15	16.1	49.6	36.4	0.0	0.0	0.0	76.2	7.3	141.8	55.3	12.4	0.4	0.0	222.5	303.7	52.1	267.4	315.6	127.3	2.7	56.1	1640.8
16	15.1	50.7	23.1	0.0	0.0	0.0	60.9	6.2	124.1	48.4	10.8	0.3	0.0	296.7	261.1	52.1	262.8	330.5	125.4	2.6	58.2	1640.1
17	12.1	59.4	69.7	0.0	0.0	0.0	11.6	1.2	23.7	9.2	2.1	0.1	0.0	370.9	101.2	52.1	249.8	314.0	76.5	2.3	50.9	1265.6
18	9.2	68.9	101.2	1.2	10.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	519.2	63.5	52.1	246.7	272.8	59.4	2.2	45.4	1279.8
19	5.2	40.9	230.1	1.2	10.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	667.6	3.5	1.5	0.0	152.8	62.3	0.0	24.8	927.8
20	4.0	8.0	72.9	1.2	10.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	667.6	3.5	1.5	0.0	88.7	47.5	0.0	16.3	839.6
21	2.9	37.2	79.7	1.2	10.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	519.2	3.5	1.5	0.0	94.2	53.4	0.0	17.8	703.6
22	3.0	35.3	42.6	1.2	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	76.2	14.8	0.0	9.0	489.2
23	3.8	111.6	232.5	1.2	10.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.3	3.5	1.5	0.0	50.7	13.4	0.0	6.5	199.5
24	4.7	9.3	127.5	1.2	10.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.3	3.5	1.5	0.0	36.6	4.5	0.0	3.6	173.3
Average			168.3	0.8	6.7	2.5	50.6	4.9	95.1	37.1	8.3	0.3	0.0	309.1	193.6	26.8	137.1	168.1	72.8	1.5	29.5	1144.8
Percentage Contribution				0.1%	0.6%	0.2%	4.4%	0.4%	8.3%	3.2%	0.7%	0.0%	0.0%	27.0%	16.9%	2.3%	12.0%	14.7%	6.4%	0.1%	2.6%	100.0%

Shaded Area = High Wind Hours

Table 4-5B
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain (high wind hours) at Cowtown on 04/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Rail Road	Permitt-ed Point Sources	Paved Road	Cons-truction	Cleared Area	Desert Shrub-land	Develop-ed Rural Lands	Develop-ed Urban Lands	Un-known	CAFOs	Agriculture		Unpaved Road					Total
														County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	6.1	332.4	68.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.7	320.5	73.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	5.9	314.7	88.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.9	84.4	59.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	2.2	25.7	92.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	2.4	156.6	492.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.6	229.1	326.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.1	11.6	222.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	10.9	33.2	372.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	20.0	52.9	886.8	0.0	0.0	0.0	621.2	59.8	1607.3	101.0	3.5	0.2	0.0	1958.9	0.0	168.8	29.6	287.3	4.1	0.0	4841.6
11	17.6	44.4	107.7	0.0	0.0	0.0	164.7	15.8	426.0	26.8	0.9	0.1	0.0	519.2	0.0	44.7	7.9	76.1	1.1	0.0	1283.3
12	15.7	43.0	122.3	0.0	0.0	0.0	75.2	7.2	194.6	12.2	0.4	0.0	0.0	237.2	0.0	20.4	3.6	34.8	0.5	0.0	586.2
13	17.7	37.0	72.0	0.0	0.0	0.0	153.7	14.8	397.6	25.0	0.9	0.1	0.0	484.5	0.0	41.8	7.3	71.1	1.0	0.0	1197.6
14	14.7	44.0	38.4	0.0	0.0	0.0	51.6	5.2	146.1	9.2	0.3	0.0	0.0	167.3	0.0	13.6	2.4	23.2	0.3	0.0	419.3
15	16.1	49.6	36.4	0.0	0.0	0.0	76.2	7.3	197.1	12.4	0.4	0.0	0.0	240.2	0.0	20.7	3.6	35.2	0.5	0.0	593.7
16	15.1	50.7	23.1	0.0	0.0	0.0	60.9	6.2	172.5	10.8	0.3	0.0	0.0	197.6	0.0	16.1	2.9	27.4	0.4	0.0	495.1
17	12.1	59.4	69.7	0.0	0.0	0.0	11.6	1.2	33.0	2.1	0.1	0.0	0.0	37.7	0.0	3.1	0.5	5.2	0.1	0.0	94.6
18	9.2	68.9	101.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	5.2	40.9	230.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	4.0	8.0	72.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	2.9	37.2	79.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	3.0	35.3	42.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	3.8	111.6	232.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	4.7	9.3	127.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average			168.3	0.0	0.0	0.0	50.6	4.9	132.3	8.3	0.3	0.0	0.0	160.1	0.0	13.7	2.4	23.3	0.3	0.0	396.3
Percentage Contribution				0.0%	0.0%	0.0%	12.8%	1.2%	33.4%	2.1%	0.1%	0.0%	0.0%	40.4%	0.0%	3.5%	0.6%	5.9%	0.1%	0.0%	100.0%

Shaded Area = High Wind Hours

Table 4-5C
Emissions Inventory (lbs/hour) for the High Wind Day Modeling (Low Wind Hours) Domain at Cowtown on 04/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Rail Road	Permitt-ed Point Sources	Paved Road	Con-struction	Cleared Area	Desert Shrub-land	Develop-ed Rural Lands	Develop-ed Urban Lands	Un-known	CAFOs	Agriculture		Unpaved Road					Total
														County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	6.1	332.4	68.3	1.2	10.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	37.1	3.5	1.5	0.0	19.6	3.0	0.0	2.3	79.0
2	0.7	320.5	73.0	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	37.1	3.5	1.5	0.0	22.2	14.8	0.0	4.8	96.0
3	5.9	314.7	88.1	1.2	10.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	74.2	3.5	1.5	0.0	18.1	7.4	0.0	2.8	119.5
4	3.9	84.4	59.7	1.2	10.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	148.4	3.5	1.5	0.0	18.3	0.0	0.0	1.5	185.3
5	2.2	25.7	92.3	1.2	10.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	39.7	8.9	0.0	5.1	442.8
6	2.4	156.6	492.9	1.2	10.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	84.1	31.2	0.0	13.7	522.5
7	1.6	229.1	326.4	1.2	10.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	185.9	62.3	2.2	39.8	1045.0
8	2.1	11.6	222.0	1.2	10.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	268.9	38.6	2.2	42.0	1105.3
9	10.9	33.2	372.4	1.2	10.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	249.1	51.9	2.2	43.2	1098.5
10	20.0	52.9	886.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	271.6	98.0	2.2	53.3	1158.2
11	17.6	44.4	107.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	296.7	63.5	52.1	246.7	248.8	65.3	2.2	45.8	1021.2
12	15.7	43.0	122.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	296.7	63.5	52.1	246.7	288.2	100.9	2.2	55.9	1106.2
13	17.7	37.0	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	222.5	63.5	52.1	246.7	254.3	72.7	2.2	49.4	963.5
14	14.7	44.0	38.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	222.5	63.5	52.1	246.7	283.3	115.8	2.2	59.1	1045.2
15	16.1	49.6	36.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	222.5	63.5	52.1	246.7	311.9	92.0	2.2	56.1	1047.1
16	15.1	50.7	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	296.7	63.5	52.1	246.7	327.6	98.0	2.2	58.2	1145.0
17	12.1	59.4	69.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	63.5	52.1	246.7	313.4	71.2	2.2	50.9	1171.0
18	9.2	68.9	101.2	1.2	10.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	519.2	63.5	52.1	246.7	272.8	59.4	2.2	45.4	1279.8
19	5.2	40.9	230.1	1.2	10.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	667.6	3.5	1.5	0.0	152.8	62.3	0.0	24.8	927.8
20	4.0	8.0	72.9	1.2	10.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	667.6	3.5	1.5	0.0	88.7	47.5	0.0	16.3	839.6
21	2.9	37.2	79.7	1.2	10.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	519.2	3.5	1.5	0.0	94.2	53.4	0.0	17.8	703.6
22	3.0	35.3	42.6	1.2	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	370.9	3.5	1.5	0.0	76.2	14.8	0.0	9.0	489.2
23	3.8	111.6	232.5	1.2	10.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	111.3	3.5	1.5	0.0	50.7	13.4	0.0	6.5	199.5
24	4.7	9.3	127.5	1.2	10.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	111.3	3.5	1.5	0.0	36.6	4.5	0.0	3.6	173.3
Average			168.3	0.8	6.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	309.1	33.5	26.8	123.4	165.7	49.5	1.1	29.5	748.5
Percentage Contribution				0.1%	0.9%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	41.3%	4.5%	3.6%	16.5%	22.1%	6.6%	0.1%	3.9%	100.0%

Shaded Area = High Wind Hours

Table 4-6A
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at Maricopa on 10/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Rail Road	Paved Road	Construc -tion	CAFOs	Cleared Area	Desert Shrub-land	Develop-ed Rural Lands	Develop-ed Urban Lands	Un-known	Agriculture		Unpaved Road					Total
													County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	3.8	160.0	239.9	1.0	3.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.8	0.0	1.0	18.9
2	2.0	106.0	143.5	1.0	2.8	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	8.9	0.0	2.2	25.2
3	1.3	6.0	70.3	1.0	2.8	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.4	0.0	1.3	30.6
4	1.3	348.0	73.8	1.0	3.4	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.7	43.4
5	2.5	290.0	98.7	1.0	6.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	5.3	0.0	2.3	111.1
6	2.0	241.0	91.8	1.0	21.3	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	18.7	0.0	6.3	153.3
7	1.3	215.0	129.8	1.0	32.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	28.9	37.4	1.0	18.2	384.9
8	5.6	82.0	160.4	1.0	28.8	256.5	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	43.9	23.1	1.0	19.2	639.5
9	13.0	84.0	326.2	0.0	0.0	631.0	89.2	108.5	52.4	59.9	30.2	8.8	247.3	7.2	175.9	41.6	36.4	1.6	19.7	1509.8
10	16.1	85.0	852.9	0.0	0.0	2657.9	89.2	663.4	305.9	349.2	200.6	53.0	1428.2	7.2	270.5	63.4	94.0	5.0	24.3	6211.9
11	18.3	81.0	496.5	0.0	0.0	2401.5	71.3	592.5	273.3	311.9	179.2	47.3	1276.8	7.2	258.6	55.7	70.7	4.6	20.9	5571.4
12	16.3	82.0	293.2	0.0	0.0	1193.1	71.3	425.3	119.3	136.2	78.3	20.7	563.3	7.2	202.6	56.8	74.2	2.6	25.5	2976.4
13	17.0	79.0	176.0	0.0	0.0	1055.9	53.5	220.8	101.8	116.3	66.8	17.6	482.4	7.2	196.2	47.9	55.3	2.3	22.6	2446.6
14	16.8	74.0	141.9	0.0	0.0	878.3	53.5	171.8	79.2	90.4	51.9	13.7	377.5	7.2	188.0	52.1	78.5	2.0	27.0	2071.0
15	15.4	72.0	84.8	0.0	0.0	514.8	53.5	71.5	36.2	41.3	20.8	6.1	173.8	7.2	170.7	52.6	58.8	1.4	25.6	1234.4
16	13.6	71.0	76.6	0.0	0.0	350.1	71.3	27.1	13.1	15.0	7.6	2.2	69.6	7.2	163.3	50.3	60.0	1.2	26.6	864.7
17	13.0	72.0	68.6	0.0	0.0	318.9	89.2	18.1	8.7	10.0	5.0	1.5	49.9	7.2	161.9	42.3	43.6	1.1	23.3	780.6
18	8.7	62.0	60.4	1.0	23.1	0.0	124.8	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	36.7	35.6	1.0	20.7	419.7
19	7.2	61.0	56.2	1.0	13.5	0.0	160.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.6	37.4	0.0	11.3	243.3
20	7.4	68.0	45.1	1.0	10.7	0.0	160.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	28.5	0.0	7.5	217.7
21	9.6	70.0	36.1	1.0	9.2	0.0	124.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	32.0	0.0	8.1	184.6
22	9.8	80.0	30.8	1.0	6.8	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	8.9	0.0	4.1	117.5
23	9.2	82.0	33.2	1.0	5.0	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	8.0	0.0	3.0	49.6
24	8.9	78.0	38.7	1.0	3.8	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.7	0.0	1.7	40.9
Average			159.4	0.6	7.2	427.4	74.3	95.8	41.2	47.1	26.7	7.1	195.8	3.6	94.4	27.6	34.3	1.0	13.5	1097.8
Percentage Contribution				0.1%	0.7%	38.9%	6.8%	8.7%	3.8%	4.3%	2.4%	0.6%	17.8%	0.3%	8.6%	2.5%	3.1%	0.1%	1.2%	100.0%

Shaded Area = High Wind Hours

Table 4-6B
Emissions Inventory (lbs/hour) for the High Wind Day (High Wind Hour) Modeling Domain at Maricopa on 10/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Rail Road	Paved Road	Con-struction	CAFOs	Cleared Area	Desert Shrub-land	Develop-ed Rural Lands	Develop-ed Urban Lands	Un-known	Agriculture		Unpaved Road					Total
													County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	3.8	160.0	239.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0	106.0	143.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	1.3	6.0	70.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.3	348.0	73.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	2.5	290.0	98.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	2.0	241.0	91.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.3	215.0	129.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	5.6	82.0	160.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	13.0	84.0	326.2	0.0	0.0	374.5	0.0	108.5	52.4	59.9	30.2	8.8	236.9	0.0	16.8	2.2	5.3	0.6	0.0	896.2
10	16.1	85.0	852.9	0.0	0.0	2401.4	0.0	663.4	305.9	349.2	200.6	53.0	1417.8	0.0	111.3	14.8	35.3	4.0	0.0	5556.8
11	18.3	81.0	496.5	0.0	0.0	2145.0	0.0	592.5	273.3	311.9	179.2	47.3	1266.4	0.0	99.4	13.2	31.5	3.5	0.0	4963.3
12	16.3	82.0	293.2	0.0	0.0	936.6	0.0	425.3	119.3	136.2	78.3	20.7	552.9	0.0	43.4	5.8	13.8	1.5	0.0	2333.8
13	17.0	79.0	176.0	0.0	0.0	799.4	0.0	220.8	101.8	116.3	66.8	17.6	472.0	0.0	37.1	4.9	11.7	1.3	0.0	1849.8
14	16.8	74.0	141.9	0.0	0.0	621.8	0.0	171.8	79.2	90.4	51.9	13.7	367.1	0.0	28.8	3.8	9.1	1.0	0.0	1438.7
15	15.4	72.0	84.8	0.0	0.0	258.3	0.0	71.5	36.2	41.3	20.8	6.1	163.4	0.0	11.6	1.5	3.7	0.4	0.0	614.9
16	13.6	71.0	76.6	0.0	0.0	93.6	0.0	27.1	13.1	15.0	7.6	2.2	59.2	0.0	4.2	0.6	1.3	0.1	0.0	224.0
17	13.0	72.0	68.6	0.0	0.0	62.4	0.0	18.1	8.7	10.0	5.0	1.5	39.5	0.0	2.8	0.4	0.9	0.1	0.0	149.4
18	8.7	62.0	60.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	7.2	61.0	56.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	7.4	68.0	45.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	9.6	70.0	36.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	9.8	80.0	30.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	9.2	82.0	33.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	8.9	78.0	38.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average			159.4	0.0	0.0	320.5	0.0	95.8	41.2	47.1	26.7	7.1	190.6	0.0	14.8	2.0	4.7	0.5	0.0	751.1
Percentage Contribution				0.0%	0.0%	42.7%	0.0%	12.8%	5.5%	6.3%	3.6%	0.9%	25.4%	0.0%	2.0%	0.3%	0.6%	0.1%	0.0%	100.0 %

Shaded Area = High Wind Hours

Table 4-6C
Emissions Inventory (lbs/hour) for the High Wind Day (Low Wind Hour) Modeling Domain at Maricopa on 10/27/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Rail Road	Paved Road	Con-struction	CAFOs	Cleared Area	Desert Shrub-land	Develop-ed Rural Lands	Develop-ed Urban Lands	Un-known	Agriculture		Unpaved Road					Total
													County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal road	
1	3.8	160.0	239.9	1.0	3.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.8	0.0	1.0	18.9
2	2.0	106.0	143.5	1.0	2.8	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	8.9	0.0	2.2	25.2
3	1.3	6.0	70.3	1.0	2.8	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.4	0.0	1.3	30.6
4	1.3	348.0	73.8	1.0	3.4	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.7	43.4
5	2.5	290.0	98.7	1.0	6.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	5.3	0.0	2.3	111.1
6	2.0	241.0	91.8	1.0	21.3	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	18.7	0.0	6.3	153.3
7	1.3	215.0	129.8	1.0	32.5	0.0	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	28.9	37.4	1.0	18.2	384.9
8	5.6	82.0	160.4	1.0	28.8	256.5	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	43.9	23.1	1.0	19.2	639.5
9	13.0	84.0	326.2	0.0	0.0	256.5	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	39.3	31.1	1.0	19.7	613.6
10	16.1	85.0	852.9	0.0	0.0	256.5	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	48.7	58.7	1.0	24.3	655.1
11	18.3	81.0	496.5	0.0	0.0	256.5	71.3	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	42.5	39.1	1.0	20.9	608.2
12	16.3	82.0	293.2	0.0	0.0	256.5	71.3	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	51.1	60.5	1.0	25.5	642.6
13	17.0	79.0	176.0	0.0	0.0	256.5	53.5	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	43.0	43.6	1.0	22.6	596.9
14	16.8	74.0	141.9	0.0	0.0	256.5	53.5	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	48.2	69.4	1.0	27.0	632.3
15	15.4	72.0	84.8	0.0	0.0	256.5	53.5	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	51.1	55.1	1.0	25.6	619.6
16	13.6	71.0	76.6	0.0	0.0	256.5	71.3	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	49.8	58.7	1.0	26.6	640.6
17	13.0	72.0	68.6	0.0	0.0	256.5	89.2	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	41.9	42.7	1.0	23.3	631.3
18	8.7	62.0	60.4	1.0	23.1	0.0	124.8	0.0	0.0	0.0	0.0	0.0	10.4	7.2	159.1	36.7	35.6	1.0	20.7	419.7
19	7.2	61.0	56.2	1.0	13.5	0.0	160.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.6	37.4	0.0	11.3	243.3
20	7.4	68.0	45.1	1.0	10.7	0.0	160.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	28.5	0.0	7.5	217.7
21	9.6	70.0	36.1	1.0	9.2	0.0	124.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	32.0	0.0	8.1	184.6
22	9.8	80.0	30.8	1.0	6.8	0.0	89.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	8.9	0.0	4.1	117.5
23	9.2	82.0	33.2	1.0	5.0	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	8.0	0.0	3.0	49.6
24	8.9	78.0	38.7	1.0	3.8	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.7	0.0	1.7	40.9
Average			159.4	0.6	7.2	106.9	74.3	0.0	0.0	0.0	0.0	0.0	5.2	3.6	79.6	25.7	29.6	0.5	13.5	346.7
Percentage Contribution				0.1%	0.7%	30.8%	21.4%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	1.0%	23.0%	7.4%	8.6%	0.1%	3.9%	100.0 %

Shaded Area = High Wind Hours

Table 4-7A
Emissions Inventory (lbs/hour) for the High Wind Day Modeling Domain at STF on 11/21/2008

Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	Paved Road	Construc-tion	CAFOs	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	4.1	119.2	112.4	0.2	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	18.0	2.2	0.0	33.9
2	3.5	161.6	59.4	0.2	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	22.4	10.9	0.0	47.0
3	3.9	117.3	157.4	0.2	0.0	26.9	0.0	0.0	0.0	0.0	0.0	0.0	16.7	5.5	0.0	49.3
4	4.3	125.4	158.4	0.3	0.0	53.8	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	70.8
5	3.7	274.2	102.3	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	33.6	6.6	0.0	175.2
6	4.0	240.9	234.2	1.7	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	72.2	23.0	0.0	231.5
7	15.9	85.5	357.4	0.0	0.0	215.9	2.1	112.8	9.5	0.1	697.8	668.3	181.7	49.3	2.5	1939.9
8	18.3	81.9	326.6	0.0	1.3	267.8	3.4	185.0	15.5	0.2	1112.4	692.6	261.2	33.9	2.9	2576.2
9	20.4	82.2	584.6	0.0	1.3	720.1	14.8	812.6	68.2	0.8	4719.2	904.2	304.6	62.4	5.7	7613.9
10	19.9	81.1	429.2	0.0	1.3	351.8	5.5	301.5	25.3	0.3	1782.0	731.9	269.3	81.1	3.4	3553.4
11	20.0	80.2	334.3	0.0	1.3	255.4	3.7	205.0	17.2	0.2	1227.5	699.3	238.5	54.2	3.0	2705.4
12	18.2	80.4	186.1	0.0	1.3	175.8	1.7	94.5	7.9	0.1	592.7	662.1	262.9	77.2	2.5	1878.7
13	14.7	79.2	93.9	0.0	1.3	104.3	0.6	36.0	3.0	0.0	239.1	641.0	228.7	54.5	2.2	1310.8
14	13.4	78.5	65.1	0.0	1.3	90.7	0.3	15.2	1.3	0.0	129.7	634.8	254.4	85.7	2.1	1215.5
15	12.3	75.3	64.8	0.0	1.3	84.8	0.1	6.2	0.5	0.0	90.3	632.1	282.0	68.0	2.1	1167.4
16	9.9	77.2	65.2	3.9	1.3	107.6	0.0	0.0	0.0	0.0	49.4	630.2	302.0	72.2	2.0	1168.7
17	7.1	74.7	87.1	3.7	1.3	134.5	0.0	0.0	0.0	0.0	49.4	630.2	289.0	52.5	2.0	1162.7
18	4.7	73.8	104.6	2.0	0.0	188.4	0.0	0.0	0.0	0.0	49.4	630.2	254.2	43.8	2.0	1170.0
19	6.3	75.1	88.3	1.1	0.0	242.2	0.0	0.0	0.0	0.0	0.0	0.0	143.5	45.9	0.0	432.7
20	5.6	86.2	56.1	0.9	0.0	242.2	0.0	0.0	0.0	0.0	0.0	0.0	85.0	35.0	0.0	363.0
21	2.6	158.4	98.3	0.7	0.0	188.4	0.0	0.0	0.0	0.0	0.0	0.0	90.5	39.4	0.0	319.0
22	2.2	230.2	249.6	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	74.5	10.9	0.0	220.5
23	2.9	270.1	171.6	0.4	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	49.1	9.8	0.0	99.8
24	2.4	291.4	99.5	0.3	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	33.4	3.3	0.0	77.4
Average			178.6	0.7	0.5	165.1	1.3	73.7	6.2	0.1	447.5	339.9	157.7	38.6	1.4	1232.6
Percentage Contribution				0.1%	0.0%	13.4%	0.1%	6.0%	0.5%	0.0%	36.3%	27.6%	12.8%	3.1%	0.1%	100.0%

Shaded Area = High Wind Hours

Table 4-7B
Emissions Inventory (lbs/hour) for the High Wind Day (High Wind Hour) Modeling Domain at STF on 11/21/2008

Hour	WSPD (mph)	WD (degree)	PM10 Observation (µg/m3)	Paved Road	Construc-tion	CAFOs	Cleared Area	Desert Shrubland	Develop-ed Rural Lands	Develop-ed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	4.1	119.2	112.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	3.5	161.6	59.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	3.9	117.3	157.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	4.3	125.4	158.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	3.7	274.2	102.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	4.0	240.9	234.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	15.9	85.5	357.4	0.0	0.0	81.3	2.1	112.8	9.5	0.1	648.4	38.0	11.6	3.3	0.5	907.6
8	18.3	81.9	326.6	0.0	0.0	133.3	3.4	185.0	15.5	0.2	1063.0	62.4	19.0	5.5	0.8	1488.1
9	20.4	82.2	584.6	0.0	0.0	585.6	14.8	812.6	68.2	0.8	4669.8	273.9	83.6	24.1	3.7	6537.0
10	19.9	81.1	429.2	0.0	0.0	217.3	5.5	301.5	25.3	0.3	1732.6	101.6	31.0	8.9	1.4	2425.4
11	20.0	80.2	334.3	0.0	0.0	147.7	3.7	205.0	17.2	0.2	1178.1	69.1	21.1	6.1	0.9	1649.2
12	18.2	80.4	186.1	0.0	0.0	68.1	1.7	94.5	7.9	0.1	543.3	31.9	9.7	2.8	0.4	760.6
13	14.7	79.2	93.9	0.0	0.0	23.6	0.6	36.0	3.0	0.0	189.7	10.8	3.3	0.9	0.1	268.1
14	13.4	78.5	65.1	0.0	0.0	10.0	0.3	15.2	1.3	0.0	80.3	4.6	1.4	0.4	0.1	113.4
15	12.3	75.3	64.8	0.0	0.0	4.1	0.1	6.2	0.5	0.0	40.9	1.9	0.6	0.2	0.0	54.4
16	9.9	77.2	65.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	7.1	74.7	87.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	4.7	73.8	104.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	6.3	75.1	88.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	5.6	86.2	56.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	2.6	158.4	98.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	2.2	230.2	249.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	2.9	270.1	171.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	2.4	291.4	99.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average			178.6	0.0	0.0	53.0	1.3	73.7	6.2	0.1	422.8	24.8	7.6	2.2	0.3	591.8
Percentage Contribution				0.0%	0.0%	8.9%	0.2%	12.5%	1.0%	0.0%	71.4%	4.2%	1.3%	0.4%	0.1%	100.0%

Shaded Area = High Wind Hours

Table 4-7C
Emissions Inventory (lbs/hour) for the High Wind Day (Low Wind Hour) Modeling Domain at STF on 11/21/2008

Hour	WSPD (mph)	WD (degree)	PM10 Obser-vation (µg/m3)	Paved Road	Con-struction	CAFOs	Cleared Area	Desert Shrub-land	Developed Rural Lands	Developed Urban Lands	Agri-culture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	4.1	119.2	112.4	0.2	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	18.0	2.2	0.0	33.9
2	3.5	161.6	59.4	0.2	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	22.4	10.9	0.0	47.0
3	3.9	117.3	157.4	0.2	0.0	26.9	0.0	0.0	0.0	0.0	0.0	0.0	16.7	5.5	0.0	49.3
4	4.3	125.4	158.4	0.3	0.0	53.8	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	70.8
5	3.7	274.2	102.3	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	33.6	6.6	0.0	175.2
6	4.0	240.9	234.2	1.7	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	72.2	23.0	0.0	231.5
7	15.9	85.5	357.4	0.0	0.0	134.5	0.0	0.0	0.0	0.0	49.4	630.2	170.1	45.9	2.0	1032.3
8	18.3	81.9	326.6	0.0	1.3	134.5	0.0	0.0	0.0	0.0	49.4	630.2	242.2	28.4	2.0	1088.1
9	20.4	82.2	584.6	0.0	1.3	134.5	0.0	0.0	0.0	0.0	49.4	630.2	221.0	38.3	2.0	1076.8
10	19.9	81.1	429.2	0.0	1.3	134.5	0.0	0.0	0.0	0.0	49.4	630.2	238.3	72.2	2.0	1128.0
11	20.0	80.2	334.3	0.0	1.3	107.6	0.0	0.0	0.0	0.0	49.4	630.2	217.4	48.1	2.0	1056.1
12	18.2	80.4	186.1	0.0	1.3	107.6	0.0	0.0	0.0	0.0	49.4	630.2	253.2	74.4	2.0	1118.1
13	14.7	79.2	93.9	0.0	1.3	80.7	0.0	0.0	0.0	0.0	49.4	630.2	225.4	53.6	2.0	1042.7
14	13.4	78.5	65.1	0.0	1.3	80.7	0.0	0.0	0.0	0.0	49.4	630.2	253.0	85.3	2.0	1102.0
15	12.3	75.3	64.8	0.0	1.3	80.7	0.0	0.0	0.0	0.0	49.4	630.2	281.4	67.8	2.0	1113.0
16	9.9	77.2	65.2	3.9	1.3	107.6	0.0	0.0	0.0	0.0	49.4	630.2	302.0	72.2	2.0	1168.7
17	7.1	74.7	87.1	3.7	1.3	134.5	0.0	0.0	0.0	0.0	49.4	630.2	289.0	52.5	2.0	1162.7
18	4.7	73.8	104.6	2.0	0.0	188.4	0.0	0.0	0.0	0.0	49.4	630.2	254.2	43.8	2.0	1170.0
19	6.3	75.1	88.3	1.1	0.0	242.2	0.0	0.0	0.0	0.0	0.0	0.0	143.5	45.9	0.0	432.7
20	5.6	86.2	56.1	0.9	0.0	242.2	0.0	0.0	0.0	0.0	0.0	0.0	85.0	35.0	0.0	363.0
21	2.6	158.4	98.3	0.7	0.0	188.4	0.0	0.0	0.0	0.0	0.0	0.0	90.5	39.4	0.0	319.0
22	2.2	230.2	249.6	0.5	0.0	134.5	0.0	0.0	0.0	0.0	0.0	0.0	74.5	10.9	0.0	220.5
23	2.9	270.1	171.6	0.4	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	49.1	9.8	0.0	99.8
24	2.4	291.4	99.5	0.3	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	33.4	3.3	0.0	77.4
Average			178.6	0.7	0.5	112.1	0.0	0.0	0.0	0.0	24.7	315.1	150.1	36.5	1.0	640.8
Percentage Contribution				0.1%	0.1%	17.5%	0.0%	0.0%	0.0%	0.0%	3.9%	49.2%	23.4%	5.7%	0.2%	100.0%

Shaded Area = High Wind Hours

Appendix 11

Pinal County Land Use Descriptions

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Twelve Pinal County Land Use Descriptions

5/28/2013

The twelve land uses listed in the Table below include nine land uses which were previously agreed upon by the Arizona Department of Environmental Quality (ADEQ), Pinal County Air Quality Department (PCAQD), and Sierra Research as land use classifications for purposes of calculating the Pinal County Nonattainment Area Emission Inventory, as well as three additional land uses for subclassification of construction areas. A GIS layer has been created categorizing areas of the Pinal County Nonattainment Area into the twelve land use categories listed below:

ADEQID	Description
A	Developed Urban Lands
B	Developed Rural Lands (low density residential)
C	Paved Roads
D	Unpaved Roads
E	Cleared Areas
F	Residential Construction
G	CAFOs and Dairies
H	Desert Shrubland
I	Agricultural Croplands
J	Commercial Construction
K	Other
L	Site Development

Below are descriptions of each of the land uses listed in the above table.

A. Developed Urban Lands – A land parcel which had been significantly cleared of natural desert vegetation, contains a man-made structure, and has a total area of land which is greater than ~50% covered by non-native vegetation (e.g. lawn grass), buildings, or pavement.
B. Developed Rural Lands – A land parcel which had been significantly cleared of natural desert vegetation, contains a man-made structure, but has a total area of land which is less than ~50% covered by non-native vegetation (e.g. lawn grass), buildings, or pavement.
C. Paved Roads – Any roadway which has been covered by concrete or asphalt pavement.
D. Unpaved Roads – Any roadway which has not been covered by concrete or asphalt pavement including County Maintained Dirt, Trail, Asphalt Rock Dust Pallative (ARDP), Private Dirt, Railroad, Agricultural, and Construction roadways.
E. Cleared Areas – A land parcel which had been significantly cleared of natural desert vegetation, but does not contain a man-made structure or significant vegetation.

F. Residential Construction – A land parcel which was permitted for residential construction for the year of 2008 by PCAQD or which contained visible evidence of residential construction from 2008 aerial photography (e.g. unfinished residential structures and construction equipment).
G. CAFOs and Dairies – A land parcel which was identified as a CAFO or dairy by PCAQD.
H. Desert Shrublands – A land parcel which had no significant clearing of natural vegetation and contained no man-made structures.
I. Agricultural Croplands – A land parcel which was identified by PCAQD or ADEQ through aerial photography as actively growing or showing signs of previously growing cultivated crops for agricultural purposes. This land use was QA/QC'ed by an external source from the Agricultural community and further subdivided into the types of crops grown in each fields surrounding the Maricopa, Cowtown, Pinal County Housing, and Stanfield air monitors for the year of 2008 (crop types are not included in provided maps).
J. Commercial Construction - A land parcel which was permitted for commercial construction for the year of 2008 by PCAQD.
K. Other – Any land use not identified by the eleven other land uses characterized in this list.
L. Site Development - A land parcel which had been significantly cleared of natural desert vegetation and is undergoing grading, filling, cutting, or trenching for infrastructure.

ADEQ created detailed GIS land use maps for a 6 km boundary surrounding the Maricopa, Cowtown, Pinal County Housing, and Stanfield monitors utilizing the land use classifications listed above (paved and unpaved roads were not characterized by ADEQ since these were contained within a detailed GIS layer created by PCAQD). This GIS layer was later merged with a land use map created by PCAQD to supplement those areas outside of the 6 km map but within the nonattainment area. The reason for recreating the land use map within a 6 km boundary of the 4 previously mentioned monitors in place of using the PCAQD land use map was to increase land use resolution for those areas near each of the 4 modeled monitors. Creation of the 6 km map depended on the previously created PCAQD land use map as well as analysis of 2008 aerial photography. ADEQ then merged this map with PCAQD's 2008 construction permit map and PCAQD's roadway map for Pinal County. The final map is titled "Land_Use_5_28_13_w_rds.shp" and is available on the ADEQ ftp site. ADEQ also provided a land use map for all land uses except roadways ("Land_Use_5_28_13.shp"). It should be noted that the "Land_Use_5_28_13_w_rds.shp" file was created by the combination of the "Land_Use_5_28_13.shp" and the ftp://ftp.azdeq.gov/OLD_Materials/GIS_data/PM10%20Roads/PM10_Roads_Shapefile.shp where the later shapefile was converted to polygon features and then merged with the Land_Use_5_28_13.shp file. It is not guaranteed that all roads line up in there exact locations between the two layers and thus, some roadways may be offset slightly when compared to the other land uses. Within the Land_Use_5_28_13.shp and Land_Use_5_28_13_w_rds.shp files, shape lengths correspond to perimeter lengths (ft) for all land use types except roadways, for which shape lengths represent the length (ft) of the roadway segment. For all land use types the

shape area represents the area of each polygon (ft^2). Conversion of the road lines feature class to a polygon feature class required road widths for each roadway. For most roadways within the shapefile a road width was reported; however, for those roadways which did not have reported widths a width was assumed. Average road widths (from those roads which had reported road widths) for each road surface type were calculated and were assumed for those roads of a given surface type which did not did not have reported widths. Average railroad width was assumed to be three times as wide as a normal railroad track width (~5 ft). Assumed road widths are given in the Table below.

Surface	Description	Average Width (ft)
1	Paved	30
2	County Maintained Dirt	28
3	ARDP	28
4	Trail	10
5	Private Dirt	15
7	Railroad	15
8	Agriculture	10
9	Construction	26

While these road types are compiled into one of two ADEQIDs, the "Surface" type is still available in the land use shapefile for further discretization if necessary.

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APPENDIX C

Air Quality Modeling for Pinal County PM_{10} Nonattainment Area

Preliminary Source Apportionment for Selected Design Days and Modeling Domains

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FINAL

Air Quality Modeling for Pinal County PM10 Nonattainment Area – 2008 Source Apportionment for Selected Design Days and Modeling Domains

prepared for:

Arizona Dept. of Environmental Quality

November 2013

prepared by:

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FINAL REPORT

Air Quality Modeling for Pinal County PM10 Nonattainment Area – 2008 Source Apportionment for Selected Design Days and Modeling Domains

prepared for:

Arizona Dept. of Environmental Quality

November 2013

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Air Quality Modeling for Pinal County PM10 Nonattainment Area – 2008 Source Apportionment for Selected Design Days and Modeling Domains

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1. INTRODUCTION

The goal of this effort was to structure a U.S. Environmental Protection Agency (EPA) approved plume dispersion model to compute PM_{10} air quality impacts from arrays of significant emissions sources near existing permanent monitoring stations for use in improving base-year emission inventories and assessing the benefits of alternative control strategies in the Western Pinal County PM_{10} Nonattainment Area (Pinal County). From previous review of U.S. EPA guidance and discussions with EPA Region 9 staff, the Arizona Department of Environmental Quality (ADEQ) team preparing the Pinal County attainment plan (State Implementation Plan or SIP) chose 2008 as the base-year for planning purposes.[1]

The dual goals of this modeling effort were critical to the integrity of the completed plan. Separate emission inventories had been prepared for the areas surrounding and impacting four Pinal County Air Quality Control District (PCAQCD) monitoring stations in nonattainment status, and the predominance of area source emissions in these inventories required the use of dispersion modeling for stagnation meteorological conditions and distance-weighted approach for high wind conditions, to overcome the significant uncertainties in inventory accuracy that are inherent to these highly variable source categories. Also, because of the spatial distribution patterns of area sources surrounding the monitors, dispersion modeling was critical to the assessment of benefits of emission control measures that will differentially reduce emissions impacts at different monitors.

The need for a comprehensive modeling effort in support of attainment planning was further underscored by a prior determination that PM_{10} exceedances were caused at three of the four monitoring sites by two different sets of meteorological conditions. In late fall and winter months, the presence of regional high pressure cells combined with the absence of storm fronts passing through central Arizona produces stagnation (or low wind) conditions that reduce nocturnal mixing heights to tens of meters above the ground and concentrate emitted pollutants at ground-level. In the spring and summer, high wind conditions are periodically generated by monsoonal thunderstorms or strong eddy currents associated with the retreating circumpolar vortex. Because these two types of events are not typically accompanied by precipitation over Pinal County, both cause significant increases in windblown emissions sufficient to produce exceedances of PM_{10} standards.

[1] Pinal County PM Inventory Preparation Plan, prepared for the Arizona Department of Environmental Quality by Sierra Research, December 2012.

Air quality modeling combines information on meteorological conditions (e.g., wind speed, wind direction, mixing height, etc.) with emission estimates to calculate downwind pollutant concentrations at selected locations. For this planning process, AERMOD—an EPA-preferred Gaussian dispersion model for non-reactive pollutants for stagnation conditions, and an EPA-approved modified weighted rollback approach for high wind conditions—were selected to estimate hourly PM_{10} concentrations at monitoring stations produced by emissions of area sources located within specified modeling domains surrounding the monitoring stations. Because the PM_{10} ambient air quality standard exceeded in Pinal County is designed to limit short-term acute exposures and is measured over 24-hour averaging periods, the attainment demonstrations are required by EPA policy to show how PM_{10} concentrations would be reduced from levels recorded on exceedance days in the base year experiencing the strongest stagnation or high wind meteorological conditions. The selection of these "design days" is discussed in an accompanying report.

Different approaches were used to estimate emission impacts at monitors on low wind and high wind design days. On low wind days, AERMOD was run with meteorological data recorded at the subject monitor and emissions rates for each source within the modeling domain were calculated from reported activity data and best-representative emissions factors. For both high wind hours (>12 mph) and low wind hours (≤12 mph) on high wind days, a weighted rollback method was used to assess the relative contribution of each upwind source area to the hourly monitored PM_{10} contribution under assumptions of (1) emission factor uniformity within "disturbed" and "undisturbed" states of surface soil conditions and (2) an inverse relationship between the source's distance from the monitor and the emission impact at that monitor.

The weighted rollback method for high wind day analysis is based on modeling experiences related to development of the Maricopa Association of Government's (MAG) Five Percent Plan. Through experience gained in the preparation of PM_{10} SIPs, and in consultation with EPA, MAG determined that neither AERMOD nor photochemical grid models performed well in quantifying discrete area source contributions at downwind monitors under high wind conditions, and that attainment demonstrations relying on use of these models were not reliable. For this reason, MAG developed an alternate but more reliable approach that weights the contribution of each upwind source's emissions by the reciprocal of its distance to the monitor and assumes that each source's fractional contribution to the sum of weighted emissions is equal to that source's fractional contribution to the hourly PM_{10} concentration measured at the downwind monitor (i.e., that the impacts of emissions from nearby sources are proportionally greater than the impacts from remote sources, assuming equivalent emissions rates among sources). Individual source contributions, using this approach, can be determined through review of hourly and daily estimates of weighted emissions rates.

Under each of these methodologies, the degree of emissions reductions needed to achieve attainment of the 24-hour PM_{10} standard at designated monitors on respective stagnation and high wind design days—both in overall terms or by individual area source—can be quantified. Evaluation and selection of suites of control measures capable of

demonstrating attainment at all monitors on all design days involve many different factors and are the subject of another accompanying report.

The remainder of this report discusses the data sources, analyses, and final design of air quality assessment methodologies used in the Pinal County PM_{10} plan for control strategy evaluation and attainment demonstration. Section 2 summarizes the development of an assessment methodology addressing stagnation design days, and Section 3 reviews the methodology developed to evaluate solutions for high wind design days. At the conclusion of development discussions, the methodologies are used to calculate design day impacts at each monitor, on the basis of emission inventories available at the time of this report's drafting, for comparison to hourly PM_{10} concentrations recorded at the stations on these design days.

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2. STAGNATION DAY MODELING

A review of EPA guidelines and related fugitive dust modeling employed in attainment demonstrations prepared for Maricopa County determined that AERMOD is the most suitable model for evaluating hourly source contributions to PM_{10} exceedances recorded at Pinal County monitors on stagnation design days. AERMOD is a steady-state Gaussian plume dispersion model that assesses pollutant concentrations from a variety of source types. Adopted by EPA as a regulatory model on December 9, 2005, AERMOD contains improved algorithms for addressing low wind speed (near-calm conditions) and can provide estimates for conditions when wind speeds are less than 1 m/sec,[2,3] which are common on the selected stagnation design days.

AERMOD Inputs

Key inputs required for the successful use of AERMOD are summarized below.

- Emission Inventory – Hourly estimates of emissions were prepared using land parcel data provided by ADEQ and PCAQCD, activity data collected through field surveys, contacts with stakeholders, etc., and cited fugitive dust emission factors.

- AERMET-formatted Meteorological Data – AERMET is a preprocessor that converts raw meteorological measurements into formatted meteorological input files for AERMOD. The following data sources were used to configure AERMET to produce these input files:

  - The on-site meteorological data collected at the Cowtown, Pinal County Housing, and Stanfield monitoring stations, with parameters of wind direction, wind speed, and temperature. A wind speed threshold of 0.5 meters/second was specified for the upper limit of calm conditions.

  - Upper air meteorological data were derived from Tucson 2008 twice-daily soundings by the National Weather Service (NWS).

[2] "Revisions to the Guideline on Air Quality Models: Adoption of Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions," U.S. Environmental Protection Agency, Federal Register, Vol. 70, No. 216, p. 68218, November 9, 2005 (Attachment IV)
[3] User's Guide for AERMET, EPA-454/B-03-002, November 2004

- Cloud cover meteorological data were obtained from the records of the Phoenix NWS meteorological station at Sky Harbor Airport.

- The surface characteristics of albedo, Bowen Ratio and surface roughness appropriate to the areas surrounding the Cowtown, Pinal County Housing, and Stanfield monitoring stations were obtained from AERSURFACE.[4] Albedo is the portion of sunlight that is reflected from the surface of the ground, Bowen ratio is a measure of moisture available for evaporation, and surface roughness is a measure of the depth of the thin boundary layer at the ground surface that is protected from influences of wind-generated frictional drag by the small variability in ground surface elevation.[5,6] These parameters are functions of ground cover (land use) and affect the concentration calculations. Values of these parameters were calculated by monthly average by AERSURFACE for each of the Cowtown, Pinal County Housing, and Stanfield monitoring sites and are listed below in Tables 2-1, 2-2 and 2-3, respectively. Only data from October were used to represent the stagnation design day conditions.

Table 2-1
AERMET Stage 3 Meteorological Processing Parameters
Cowtown Monitoring Site

Sector Definition

Sector	Starting Angle (degree)	Ending Angle (degree)
1	0	360

Seasonal Parameters

Month	Sector	Albedo	Bowen Ratio	Roughness Length (m)
1	1	0.18	0.81	0.029
2	1	0.18	0.81	0.029
3	1	0.15	0.38	0.042
4	1	0.15	0.38	0.042
5	1	0.15	0.38	0.042
6	1	0.2	0.57	0.203
7	1	0.2	0.57	0.203
8	1	0.2	0.57	0.203
9	1	0.2	0.81	0.203
10	1	0.2	0.81	0.203
11	1	0.2	0.81	0.203
12	1	0.18	0.81	0.029

[4] U.S. EPA, AERSURFACE User's Guide, *http://www.epa.gov/scram001/7thconf/aermod/aersurface_userguide.pdf*
[5] Appendix W to Part 51—Guideline on air Quality Models, §8.3.c
[6] U.S. EPA. AERMOD Implementation Guide, March 19, 2009.

Table 2-2
AERMET Stage 3 Meteorological Processing Parameters
Pinal County Housing Monitoring Site

Sector Definition		
Sector	**Starting Angle (degree)**	**Ending Angle (degree)**
1	0	360

Seasonal Parameters				
Month	**Sector**	**Albedo**	**Bowen Ratio**	**Roughness Length (m)**
1	1	0.18	0.88	0.113
2	1	0.18	0.88	0.113
3	1	0.15	0.43	0.131
4	1	0.15	0.43	0.131
5	1	0.15	0.43	0.131
6	1	0.19	0.61	0.254
7	1	0.19	0.61	0.254
8	1	0.19	0.61	0.254
9	1	0.19	0.88	0.254
10	1	0.19	0.88	0.254
11	1	0.19	0.88	0.254
12	1	0.18	0.88	0.113

Table 2-3
AERMET Stage 3 Meteorological Processing Parameters
Stanfield Monitoring Site

Sector Definition		
Sector	**Starting Angle (degree)**	**Ending Angle (degree)**
1	0	360

Seasonal Parameters				
Month	**Sector**	**Albedo**	**Bowen Ratio**	**Roughness Length (m)**
1	1	0.18	0.8	0.069
2	1	0.18	0.8	0.069
3	1	0.15	0.37	0.086
4	1	0.15	0.37	0.086
5	1	0.15	0.37	0.086
6	1	0.2	0.57	0.238
7	1	0.2	0.57	0.238
8	1	0.2	0.57	0.238
9	1	0.2	0.8	0.237
10	1	0.2	0.8	0.237
11	1	0.2	0.8	0.237
12	1	0.18	0.8	0.069

- The wind measurement height[7] for each monitor was input as the onsite instrument height parameter to AERMET. AERMOD adjusts the wind speed at these measurement heights to other heights based on the AERMOD profile equation for wind speed.[8]

- AERMOD Particle Deposition Algorithm was activated to simulate the impacts of particle deposition on calculated PM_{10} concentrations.

  - Table 2-4 summarizes the particle parameters for modeling the Concentrated Animal Feeding Operations (CAFOs).[9]

Table 2-4
Particle Parameters for Modeling Concentrated Animal Feeding Operations (CAFO)

Particle size (µm)	0 - 1.8	1.8 - 3.1	3.1 - 6.2	6.2 - 9.9
Mass Fraction	0.14	0.07	0.27	0.52
Particle Density (mg/m^3)	2.5	2.5	2.5	2.5

  - For all other source categories, two sources of particle size data were available, as described below.

    1. The particle size data collected by dust jar[10] at Durango Complex and West 43rd Avenue monitors in 2008 detailed in the MAG Five Percent Plan, as listed in Table 2-5.

[7] Reported by PCAQCD to be 3 meters, 3.5 meters, and 9.2 meters at the PCH, Cowtown, and Stanfield monitoring stations, respectively.

[8] AERMOD Description of Model Formulation, Page 24, 4.1.1 Wind Speed Profiling. *http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_mfd.pdf.*

[9] "Particulate matter emission rates from beef cattle feedlots in Kansas - Reverse dispersion modeling," H.F. Bonifacio et al, Journal of the Air & Waste Management Association (JAWMA) Vol. 63, No. 3, p. 350-361.

[10] Particulate matter deposition was monitored using dust fall jars over one-week periods at four locations surrounding each monitor. Particle Measurement Technology in Ventura, California, was retained to conduct particle counts using a laser counting technology. Only a portion of each solution was used in each count, allowing for the use of duplicate counts to quantify instrumental precision. The particle counts were converted to particle mass using standard conversion methods. See page 8-20 of the 2007 MAG Five Percent Plan for more details on the collection and quantification of particle size distribution.

Table 2-5 Particle Size Distributions Collected from Dust Jars for 2007 MAG Five Percent Plan				
Particle size (μm)	0 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 – 10.0
Mass Fraction	0.14	0.18	0.28	0.4

2. The particle size data collected by the Aerodynamic Particle Sizer (APS) Spectrometer[11] at Casa Grande Airport in July 2008, as listed in Table 2-6.

Table 2-6 Particle Size Distributions Collected by Aerodynamic Particle Sizer Spectrometer at Casa Grande Airport in July 2008				
Particle size (μm)	0 - 1.84	1.84 - 3.28	3.28 - 6.26	6.26 – 9.65
Mass Fraction	0.027	0.134	0.281	0.558

– While the results from both of these studies are similar, the land use surrounding the Durango Complex and West 43rd Avenue monitors more closely represents areas adjacent to the Cowtown, Pinal County Housing, and Stanfield monitors. Therefore, the particle parameters used in the MAG Five Percent Plan, as shown in Table 2-7, were used in Pinal modeling.

Table 2-7 Particle Parameters Used for Modeling Source Categories Other Than CAFO				
Particle size (μm)	0 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 – 10.0
Mass Fraction	0.14	0.18	0.28	0.40
Particle Density (mg/m^3)	2.5	2.5	2.5	2.5

- Flag pole receptor heights of 3 meters, 3.5 meters, and 4.8 meters for Pinal County Housing, Cowtown, and Stanfield sites, respectively, were used to represent the measurement height for each PM_{10} monitor. The following UTM Coordinates, (in NAD 83, zone 12) were assigned to receptor points representing these three PM_{10} monitors:

  Pinal County Housing: 446631.83(East), 3639334.80 (North);
  Cowtown: 409201.93 (East), 3652874.86 (North);
  Stanfield: 409999.82 (East), 3638528.80 (North).

[11] PCAQCD staff followed directions in the "Aerosol Instrument Manager Software for APS Spectrometers" Users Manual to quantify the particle size distribution for measurements collected by the APS Spectrometer. *http://www.yumpu.com/en/document/view/15444179/aerosol-instrument-manager-software-for-aps-spectrometers-tsi*

- Source parameters for significant source categories:
    - Unpaved Roads: Road links were modeled as area sources with release heights of 2 meters. The widths of these links were extracted from an ARCGIS shape file provided by PCAQCD and expanded by 10 foot mixing zones on each side,[12,13] and the lengths of these links were also extracted from the ARCGIS shape file provided by ADEQ.
    - Agriculture: Agricultural parcels were modeled as area sources with release heights of 2 meters. The horizontal dimensions of these area sources were extracted from the ARCGIS shape file provided by ADEQ.
    - Construction: Construction sites were modeled as area sources with release heights of 2 meters. The horizontal dimensions of these area sources were extracted from the ARCGIS shape file provided by PCAQCD. The method for determining the activity status of construction sites is discussed in an accompanying emission inventory report.[14]
    - CAFOs: Feedlots were modeled as area sources with release heights of 2.3 meters, based on recommendations contained in a feedlot emission and modeling study conducted in Kansas by Bonifacio et al.[15] The horizontal dimensions of these facilities were extracted from an ARCGIS shape file provided by ADEQ.
    - Industrial facilities: Stack and exhaust parameters for stationary equipment were derived from data contained in PCAQCD permit files. Facility-specific data are presented and discussed in an accompanying emission inventory report[14].
    - Railroads: Railroad links were modeled as area sources with release heights of 3.0 meters. The horizontal dimensions of these links were extracted from the ARCGIS shape file provided by ADEQ.

Post-Processing Methodology

Once AERMOD runs were completed, PM_{10} concentrations reported by the model as impacts at monitoring stations from modeling domain area source emissions were

[12] Ten foot wide mixing zones extending beyond the roadway outer edges have been found through research studies to be impacted by the bow wakes of trucks and cars in a manner that mixes vehicle exhaust pollutants and entrained road dust into these near-road areas, producing well mixed, uniform concentrations across the mixing zones and roadway surface prior to upward and downwind dispersion.

[13] *http://www.epa.gov/scram001/userg/regmod/caline3.pdf*. CALINE3 treats the region directly over the highway as a zone of uniform emissions and turbulence. This is designated as the mixing zone, and is defined as the region over the traveled way (traffic lanes, not including shoulders) plus three meters on either side.

[14] Chapter 3, *Pinal County PM_{10} Nonattainment Area 2008 Base Year Emissions for Selected Design Days and Modeling Domains.*

[15] Bonifacio, H.F, et al., ibid.

adjusted to account for the contributions of sources located outside of modeling domains as follows:

- Background – Although wind speeds during stagnant periods were extremely low, they are sufficient to allow for the transport of non-anthropogenic emissions from outside of the nonattainment area to the three low wind modeling domains. To account for the contribution of transported PM_{10}, non-anthropogenic background PM_{10} concentrations recorded at Organ Pipe Cactus National Monument were evaluated. This monitor, located 68 miles southwest of Tucson, is impacted by very little anthropogenic activity. The monitor is part of the IMPROVE monitoring network[16]. Filter-based measurements are collected every 3 days and 24-hour average concentrations of both PM_{10} and PM2.5 are stored online. PM_{10} data were downloaded from the IMPROVE network for October and November 2008, representing twenty (20) 24-hour averages. Using meteorological data collected on the same dates in Tucson (the closest representative monitoring site), the 20 Organ Pipe measurements were screened to eliminate days with high wind conditions. Analysis of the meteorological data identified one day with 10 hours of winds exceeding the 12 mph high wind threshold velocity, and a second day had one hour of winds exceeding the 12 mph threshold. On the basis of this analysis, the one day with 10 hours of high winds was excluded from the calculation of background conditions. The average of 24-hour concentrations for the remaining 19 days was 11.5 $\mu g/m^3$. This average concentration was added to the AERMOD-modeled hourly PM_{10} concentrations at each of the stagnation monitors representative of modeling domain emissions plus regional background contributions.

- Carryover – A comparison between the modeled concentrations (including background) and the monitored concentrations found significant shortfalls in the modeled estimates. This was thought to be the result of extremely low wind speeds which promote carryover (i.e., locally-emitted particulate matter remaining in the atmosphere for multiple hours and continuing to contribute to monitored concentrations before being removed by particle deposition). AERMOD does not account for carryover; concentrations are estimated for each hour based on particulate mass emitted within the modeling domain in that hour. To address the effect of carryover, modeled concentrations from the previous hour were added to the succeeding hour. The carryover concentrations, however, were adjusted to account for particle deposition that would occur over the second hour of suspension. Information on particle size distribution, mixing height, and particle deposition velocity was used to estimate the amount of deposition that would occur in the second hour. As noted above, two estimates of particle size distribution were used to configure AERMOD—values from feedlot emission studies[17] were used to represent CAFOs emissions, and values reported in the MAG Five Percent Plan based on sampling conducted with a dust jar in 2008 at Durango and West 43rd Avenue were used to represent emissions from all other

[16] *http://vista.cira.colostate.edu/improve/default.htm*
[17] Bonifacio, H.F, et al., ibid.

sources. Mixing height estimates for each of the design days were computed using AERMET. Estimates of settling velocities by particle size range were calculated using an online deposition velocity model.[18] The results of the analysis showed that PM_9 (i.e., particles 0 – 9 μm) would remain suspended in the second hour and that only PM9-10 would settle out during this period. Because the fraction of an area source's PM_{10} emissions that settles out by the second hour is dependent on the emission's particle size distribution, separate second-hour deposition fractions were calculated for CAFO and non-CAFO source emissions. These analyses reported that 87% of CAFO PM_{10} emissions would remain suspended during the second hour following release, and 84% of PM_{10} emissions from all other sources would remain suspended.

- Normalize – A comparison between the diurnal profiles of the modeled and monitored PM_{10} concentrations, after adjusting for background and carryover contributions, showed that modeled estimates were higher in some hours, and lower in other hours, than monitored concentrations at each of the monitoring stations. To reconcile these differences and to match the overall estimated concentrations with the 24-hour average design day PM_{10} measured concentration, the modeled values were normalized to the 24-hour monitored values. This was accomplished by calculating the % difference between the average 24-hour modeled and monitored concentrations (after subtracting out background) and using the % difference to adjust each estimated hourly concentration.

Tabular summaries of estimated hourly concentrations are presented in Tables 2-8 through 2-10 for Cowtown, Pinal County Housing, and Stanfield, respectively. These tables provide information on monitored wind speed, wind direction, PM_{10} concentration, modeled mixing height, and source-specific concentrations. Also included are the total hourly estimated concentrations, total daily source concentration, overall source apportionment, and R^2 value assessing the hourly correlation between modeled and monitored concentrations. Visual displays of monitored and modeled concentrations and mixing height are provided in Figures 2-1, 2-2, and 2-3. Figure 2-4 depicts the average daily source-specific contributions for each site.

[18] *http://www.filtration-and-separation.com/settling/settling.htm*, accessed in August, 2013.

Table 2-8
Stagnation Day Modeling Performance at Cowtown on 10/29/2008, AERMOD Simulation of Monitored Concentrations (µg/m^3)

										Agriculture		Unpaved Road						
Hour	WSPD (m/s)	WD	Mixing Height	PM_{10} Observation	Railroad	Point	Background	Construction	CAFOs	Non-Tribal	Tribal	AG Road	Public Dirt	Private Dirt	Trail	Tribal Road	Paved Road	Total
1	1.0	153.0	45.0	402.3	1.7	0.1	11.5	0.0	44.5	0.0	0.0	0.0	8.0	0.1	0.0	0.0	1.2	67.1
2	1.3	178.0	102.0	343.0	2.0	0.1	11.5	0.0	40.6	0.0	0.0	0.0	8.6	0.1	0.0	0.5	1.6	65.0
3	1.5	133.0	145.0	417.8	1.4	0.1	11.5	0.0	7.3	0.0	0.0	0.0	3.5	0.1	0.0	0.7	1.4	26.0
4	1.7	153.0	210.0	125.4	1.2	0.1	11.5	0.0	48.6	0.0	0.0	0.0	3.3	0.1	0.0	0.2	1.1	66.2
5	0.9	152.0	56.0	248.4	2.3	0.2	11.5	0.0	541.1	0.0	0.0	0.0	19.9	0.2	0.0	0.0	3.6	578.8
6	0.5	198.0	12.0	156.5	3.7	0.7	11.5	0.0	522.6	0.0	0.0	0.0	58.5	0.1	0.0	3.5	11.0	611.8
7	1.3	198.0	105.0	294.2	2.4	0.6	11.5	0.0	101.0	10.7	0.1	28.9	64.6	0.0	0.0	18.0	13.3	251.0
8	1.3	182.0	159.0	171.8	0.9	0.1	11.5	0.0	29.1	13.0	0.1	44.2	46.5	0.0	0.0	19.1	9.0	173.6
9	1.1	184.0	190.0	136.3	0.4	0.1	11.5	0.0	5.8	4.5	0.0	26.3	24.8	0.1	0.0	9.4	4.3	87.2
10	0.5	252.0	251.0	219.5	0.2	0.3	11.5	0.1	40.8	1.6	0.0	20.0	12.4	1.1	0.0	4.6	1.7	94.4
11	0.7	327.0	541.0	165.8	0.1	2.9	11.5	3.4	35.3	0.5	0.0	15.0	7.0	1.5	0.0	1.1	0.8	79.2
12	1.1	348.0	891.0	103.2	0.0	3.4	11.5	3.3	0.5	0.0	0.0	6.4	0.7	0.7	0.0	0.0	0.2	26.7
13	1.2	13.0	1180.0	76.3	0.0	1.0	11.5	1.1	0.0	0.0	0.0	3.6	0.1	0.3	0.0	0.0	0.0	17.7
14	1.8	326.0	1391.0	61.7	0.0	2.0	11.5	1.0	0.0	0.0	0.0	3.7	1.1	0.3	0.0	0.0	0.1	19.8
15	1.4	328.0	1545.0	38.5	0.0	3.9	11.5	0.9	0.2	0.0	0.0	4.4	4.8	0.3	0.0	0.0	0.2	26.2
16	1.1	336.0	1636.0	41.5	0.0	2.0	11.5	0.8	0.2	0.0	0.0	4.8	5.0	0.4	0.0	0.0	0.2	24.9
17	0.8	4.0	1656.0	103.2	0.0	0.1	11.5	1.1	0.1	0.0	0.0	5.3	1.5	0.4	0.0	0.0	0.1	20.2
18	1.5	327.0	167.0	60.6	0.0	0.1	11.5	0.7	0.0	0.0	0.0	28.4	1.2	2.7	0.0	0.0	0.2	44.7
19	0.5	347.0	49.0	67.2	0.0	0.7	11.5	0.0	0.0	0.0	0.0	21.6	0.9	8.3	0.0	0.0	0.3	43.3
20	0.8	286.0	30.0	300.9	2.3	1.1	11.5	0.0	547.8	0.0	0.0	0.0	14.7	7.2	0.0	0.0	7.8	592.4
21	1.2	131.0	56.0	383.6	4.1	0.5	11.5	0.0	492.2	0.0	0.0	0.0	19.6	3.3	0.0	4.5	13.5	549.3
22	0.7	158.0	28.0	194.8	3.9	0.3	11.5	0.0	451.3	0.0	0.0	0.0	29.8	1.4	0.0	4.1	8.8	511.1
23	1.5	149.0	168.0	228.4	2.4	0.2	11.5	0.0	425.4	0.0	0.0	0.0	24.9	0.1	0.0	0.2	3.4	468.1
24	1.8	149.0	245.0	189.2	0.9	0.1	11.5	0.0	66.0	0.0	0.0	0.0	6.8	0.1	0.0	0.0	1.2	86.6
R-Square[a]					0.4	0.2		0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.3	0.0	0.2	0.1
Average			461.4	188.8	1.2	0.9	11.5	0.5	141.7	1.3	0.0	8.9	15.3	1.2	0.0	2.7	3.6	188.8
Percentage Contribution					0.7%	0.5%	6.1%	0.3%	75.0%	0.7%	0.0%	4.7%	8.1%	0.6%	0.0%	1.5%	1.9%	100.0%

a. R^2 between hourly modeled and monitored concentrations

Figure 2-1
Modeled vs Monitored Stagnation Day PM_{10} Concentrations ($\mu g/m^3$) at Cowtown (CTW)
10/29/2008

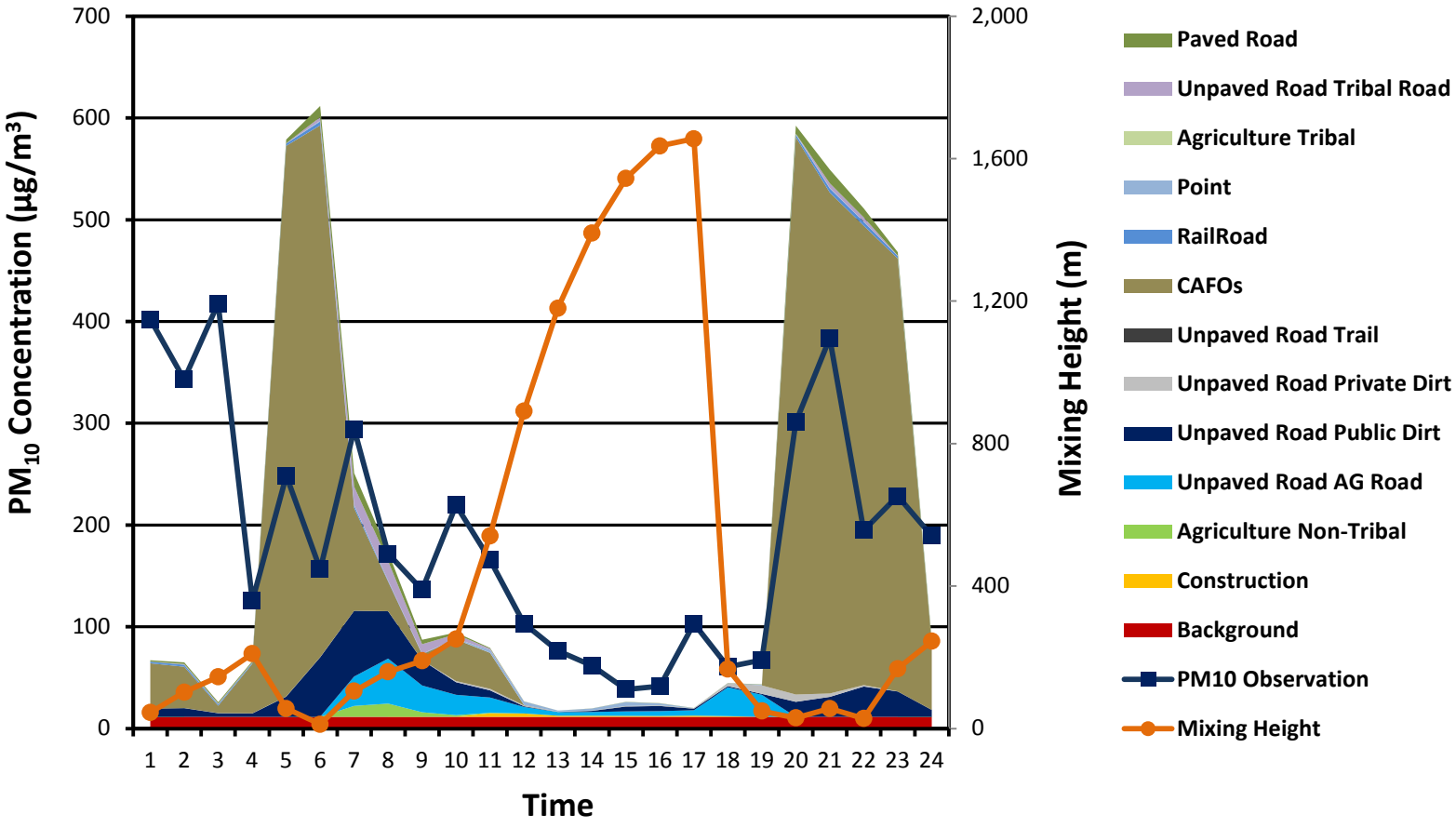


Table 2-9
Stagnation Day Modeling Performance at PCH on 10/29/2008, AERMOD Simulation of Monitored Concentrations (µg/m^3)

Hour	WSPD	WD	Mixing Height	PM_{10}	Background	Neighborhood Unpaved Road	Neighborhood Paved Road	Point	Construction	Nonroad	Dairy	Agriculture	Unpaved Road				Paved Road	Total
													AG Road	Public Dirt	Private Dirt	Trail		
1	1.0	100.2	49.0	91.4	11.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	1.6	0.0	0.2	19.6
2	0.6	122.1	24.0	86.1	11.5	5.4	0.1	0.0	0.0	0.1	0.0	0.0	0.0	14.0	21.0	0.0	0.4	52.4
3	0.5	73.5	19.0	72.5	11.5	5.7	0.2	0.0	0.0	0.1	0.0	0.0	0.0	48.7	16.5	0.0	0.6	83.3
4	0.5	144.0	19.0	67.8	11.5	1.4	0.3	0.0	0.0	0.1	0.0	0.0	0.0	34.3	0.0	0.0	0.8	48.5
5	0.5	246.0	19.0	76.6	11.5	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	15.1	24.9	0.0	1.4	54.3
6	0.5	142.8	19.0	60.1	11.5	4.4	1.4	0.0	0.0	0.1	0.0	0.0	0.0	12.7	57.8	0.0	3.6	91.5
7	0.5	189.5	19.0	145.8	11.5	14.2	1.2	0.0	0.0	0.1	0.0	5.8	0.0	0.0	124.4	11.1	12.9	181.1
8	0.5	276.0	36.0	287.0	11.5	13.8	0.0	0.3	0.0	0.1	0.0	28.2	36.4	130.2	110.4	14.5	10.9	356.2
9	0.7	133.5	146.0	179.2	11.5	5.2	0.1	1.9	0.0	0.0	0.0	27.3	59.6	116.9	32.0	4.4	2.0	260.8
10	0.5	300.9	273.0	455.2	11.5	6.8	0.1	6.5	0.0	0.0	0.0	16.9	49.7	46.9	9.8	0.2	0.3	148.8
11	0.6	18.9	601.0	234.8	11.5	9.9	0.0	6.1	0.0	0.0	0.0	10.7	35.6	40.6	5.6	0.2	0.2	120.3
12	0.7	259.9	956.0	85.6	11.5	6.2	0.0	2.4	0.0	0.1	0.1	2.4	15.5	9.3	5.5	0.1	0.1	53.3
13	0.6	308.7	1245.0	71.4	11.5	4.4	0.0	1.7	0.0	0.1	0.0	2.4	7.7	11.8	5.3	0.2	0.1	45.2
14	1.2	263.9	1458.0	62.7	11.5	4.0	0.0	1.1	0.0	0.0	0.0	1.8	5.4	9.7	5.2	0.2	0.1	39.0
15	1.0	292.9	1613.0	65.6	11.5	4.8	0.0	0.8	0.0	0.0	0.0	1.3	4.3	10.0	4.8	0.2	0.1	37.9
16	0.7	244.0	1705.0	54.5	11.5	4.1	0.0	1.2	0.0	0.0	0.2	1.2	5.3	8.4	6.2	0.3	0.2	38.8
17	0.7	294.0	1724.0	40.8	11.5	5.9	0.0	1.3	0.0	0.0	0.2	2.1	8.1	14.0	7.0	0.4	0.3	50.9
18	0.5	300.1	26.0	368.4	11.5	19.9	0.0	0.6	0.0	0.1	0.0	57.8	274.1	393.4	49.0	3.0	1.6	811.1
19	0.5	53.0	19.0	588.4	11.5	21.9	0.3	0.0	0.0	0.3	0.0	47.3	226.2	535.1	48.6	2.4	3.0	896.6
20	0.5	57.4	19.0	453.5	11.5	14.6	0.4	0.0	0.0	0.4	0.0	0.0	0.0	283.8	14.7	0.0	2.8	328.3
21	0.5	91.7	19.0	281.6	11.5	25.4	0.3	0.0	0.0	0.3	0.0	0.0	0.0	133.5	25.2	0.0	2.1	198.2
22	0.5	82.1	19.0	199.3	11.5	20.2	0.4	0.0	0.0	0.2	0.0	0.0	0.0	118.5	16.4	0.0	1.6	168.8
23	0.5	128.4	19.0	128.6	11.5	6.4	0.6	0.0	0.0	0.2	0.0	0.0	0.0	88.1	20.7	0.0	1.2	128.6
24	0.5	187.8	19.0	114.4	11.5	3.3	0.3	0.0	0.0	0.1	0.0	0.0	0.0	17.5	24.1	0.0	1.6	58.4
R-Square[a]					N/A	0.5	0.0	0.0	0.2	0.3	0.1	0.4	0.4	0.7	0.1	0.0	0.0	0.6
Average			419.4	178.0	11.5	8.7	0.2	1.0	0.0	0.1	0.0	8.6	30.3	87.4	26.5	1.6	2.0	178.0
Percentage Contribution					6.5%	4.9%	0.1%	0.6%	0.0%	0.1%	0.0%	4.8%	17.0%	49.1%	14.9%	0.9%	1.1%	100.0%

a. R^2 between hourly modeled and monitored concentrations

Figure 2-2
Modeled vs Monitored Stagnation Day PM_{10} Concentrations ($\mu g/m^3$) at Pinal County Housing (PCH)
10/29/2008

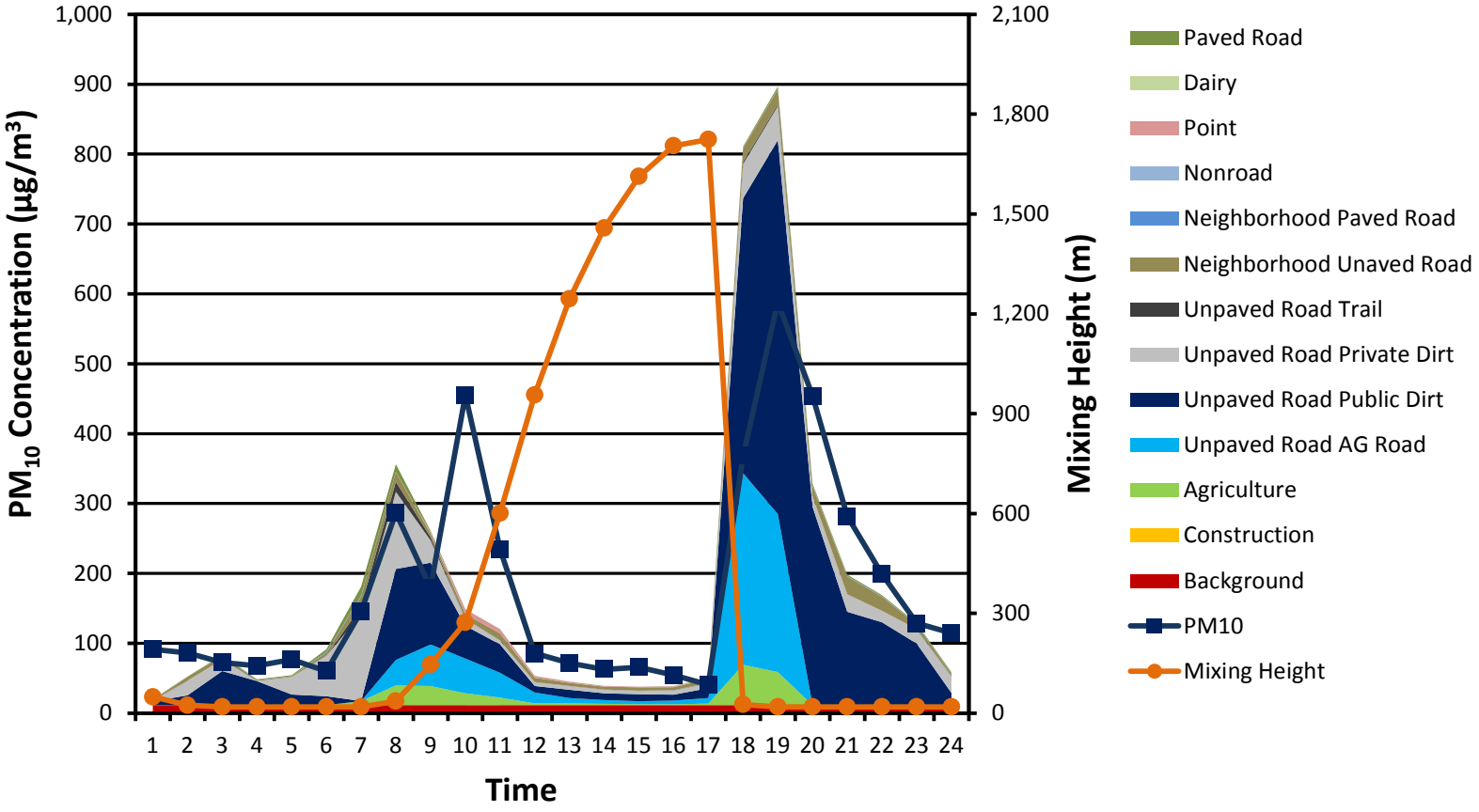


Table 2-10
Stagnation Day Modeling Performance at STF on 10/29/2008, AERMOD Simulation of Monitored Concentrations (μg/m^3)

Hour	WSPD (m/s)	WD	Mixing Height	PM_{10}	Background	Neighborhood Paved Road	Neighborhood UnPaved Road	Construction	Non road	CAFOs	Agriculture	Unpaved Road				Paved Road	Total
												AG Road	Public Dirt	Private Dirt	Trail		
1	1.0	251.9	27.0	46.0	11.5	0.1	0.2	0.0	0.0	0.0	0.0	0.0	1.1	0.7	0.0	1.4	15.0
2	1.0	159.9	31.0	79.0	11.5	0.2	1.7	0.0	0.0	0.0	0.0	0.0	5.9	17.6	0.0	1.5	38.3
3	1.6	139.5	57.0	76.8	11.5	0.2	1.9	0.0	0.0	0.0	0.0	0.0	6.4	20.8	0.0	0.4	41.2
4	1.3	155.2	42.0	63.0	11.5	0.2	0.5	0.0	0.0	0.0	0.0	0.0	4.8	5.5	0.0	0.5	23.0
5	1.2	99.4	41.0	144.0	11.5	0.4	0.1	0.0	0.0	178.1	0.0	0.0	13.1	1.7	0.0	3.3	208.3
6	0.9	108.0	24.0	183.5	11.5	3.0	2.9	0.0	0.0	276.3	0.0	0.0	64.5	34.8	0.0	7.2	400.2
7	0.8	179.6	21.0	187.7	11.5	6.2	10.0	0.0	0.0	105.6	3.2	165.2	81.1	102.2	0.9	8.3	494.2
8	0.8	171.9	21.0	307.2	11.5	5.8	10.9	0.0	0.0	0.0	17.6	287.3	77.4	106.2	2.2	7.3	526.2
9	0.7	183.8	98.0	226.0	11.5	2.7	4.3	2.4	0.0	0.0	13.1	243.1	61.6	43.9	2.0	3.2	387.9
10	1.6	82.4	266.0	133.2	11.5	0.6	0.8	2.0	0.0	0.4	4.0	114.2	22.3	5.9	1.4	0.3	163.5
11	1.4	121.4	539.0	126.2	11.5	0.2	0.6	0.0	0.0	1.4	4.8	29.1	10.4	3.6	0.7	0.1	62.6
12	1.3	129.8	888.0	116.1	11.5	0.2	0.7	0.0	0.0	1.2	2.6	25.3	10.4	8.4	0.2	0.2	60.8
13	1.3	165.8	1177.0	101.7	11.5	0.3	0.8	0.4	0.0	0.3	1.3	13.9	5.7	8.1	0.1	0.2	42.5
14	0.9	112.1	1387.0	69.7	11.5	0.4	1.0	0.3	0.0	1.6	1.5	12.8	5.4	7.7	0.3	0.2	42.6
15	1.0	67.2	1541.0	65.5	11.5	0.4	1.6	0.0	0.0	1.6	2.0	14.9	6.4	4.7	0.7	0.2	44.0
16	1.1	94.3	1632.0	43.8	11.5	0.7	1.6	0.0	0.0	1.9	1.9	13.3	6.5	3.5	0.9	0.3	42.1
17	1.3	59.4	1652.0	43.8	11.5	1.2	1.8	0.0	0.0	1.6	2.1	15.9	5.2	2.4	1.5	0.3	43.5
18	1.2	5.3	45.0	509.1	11.5	4.3	10.9	0.0	0.0	0.0	19.5	229.2	279.4	0.2	1.0	0.3	556.4
19	1.1	297.8	35.0	341.7	11.5	4.0	17.4	0.0	0.0	0.0	15.5	185.6	233.4	11.6	0.1	0.8	480.0
20	0.8	296.4	21.0	628.5	11.5	1.8	16.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	1.1	50.4
21	1.3	260.5	44.0	124.8	11.5	0.8	9.3	0.0	0.0	2.2	0.0	0.0	6.3	13.7	0.0	3.4	47.2
22	1.0	253.8	28.0	72.7	11.5	0.1	2.8	0.0	0.0	1.9	0.0	0.0	10.3	7.5	0.0	5.7	39.8
23	1.3	169.3	43.0	93.1	11.5	0.3	1.8	0.0	0.0	0.0	0.0	0.0	12.2	13.3	0.0	3.1	42.3
24	1.6	163.9	58.0	106.6	11.5	0.3	1.2	0.0	0.0	0.0	0.0	0.0	12.8	12.1	0.0	0.6	38.4
R-Square[a]						0.4	0.7	0.0	0.0	0.0	0.3	0.3	0.4	0.1	0.0	0.0	0.3
Average			404.9	162.1	11.5	1.4	4.2	0.2	0.0	23.9	3.7	56.2	39.3	19.0	0.5	2.1	162.1
Percentage Contribution					7.1%	0.9%	2.6%	0.1%	0.0%	14.8%	2.3%	34.7%	24.2%	11.7%	0.3%	1.3%	100.0%

a. R^2 between hourly modeled and monitored concentrations

Figure 2-3
Modeled vs Monitored Stagnation Day PM_{10} Concentrations ($\mu g/m^3$) at Stanfield (STF)
10/29/2008

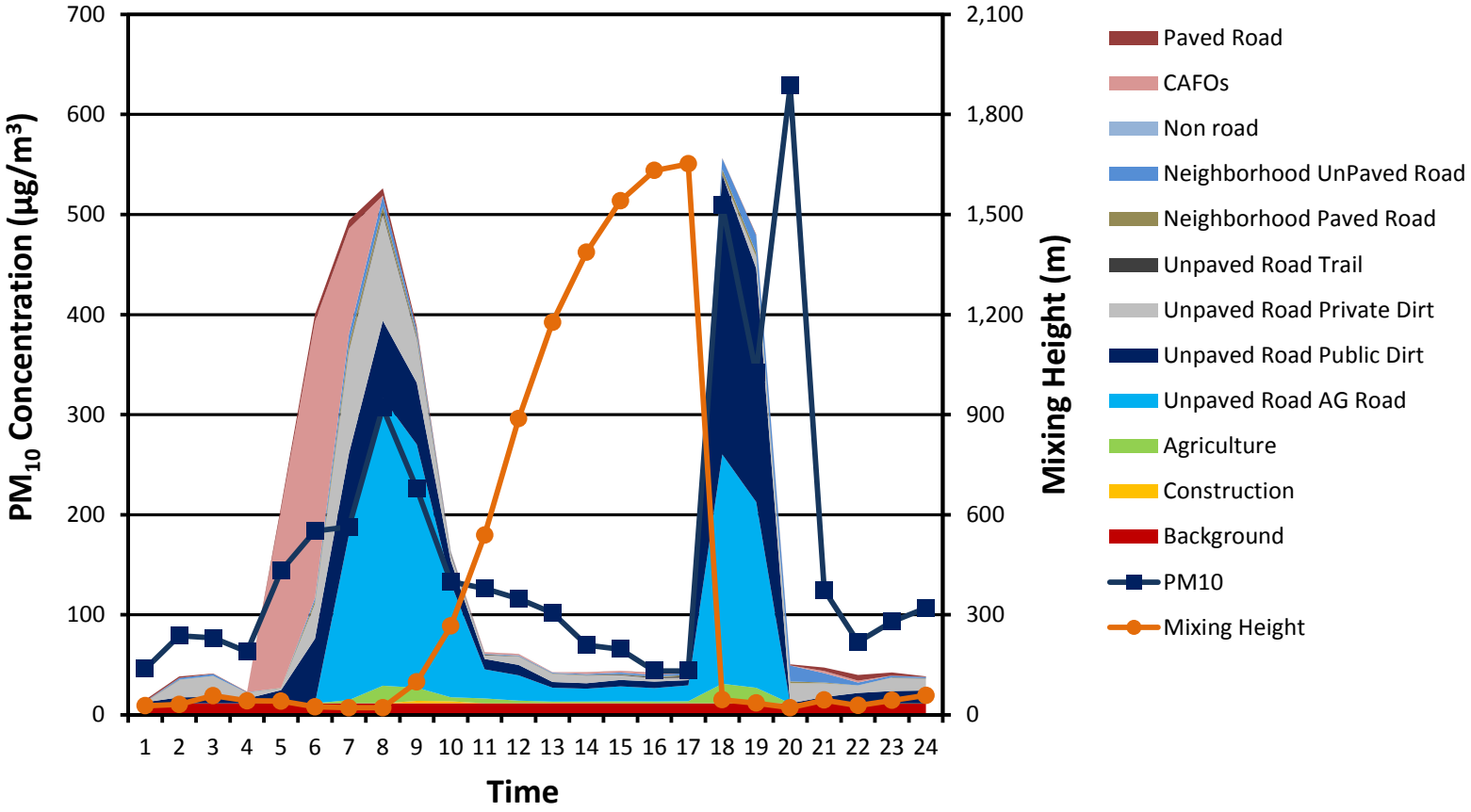
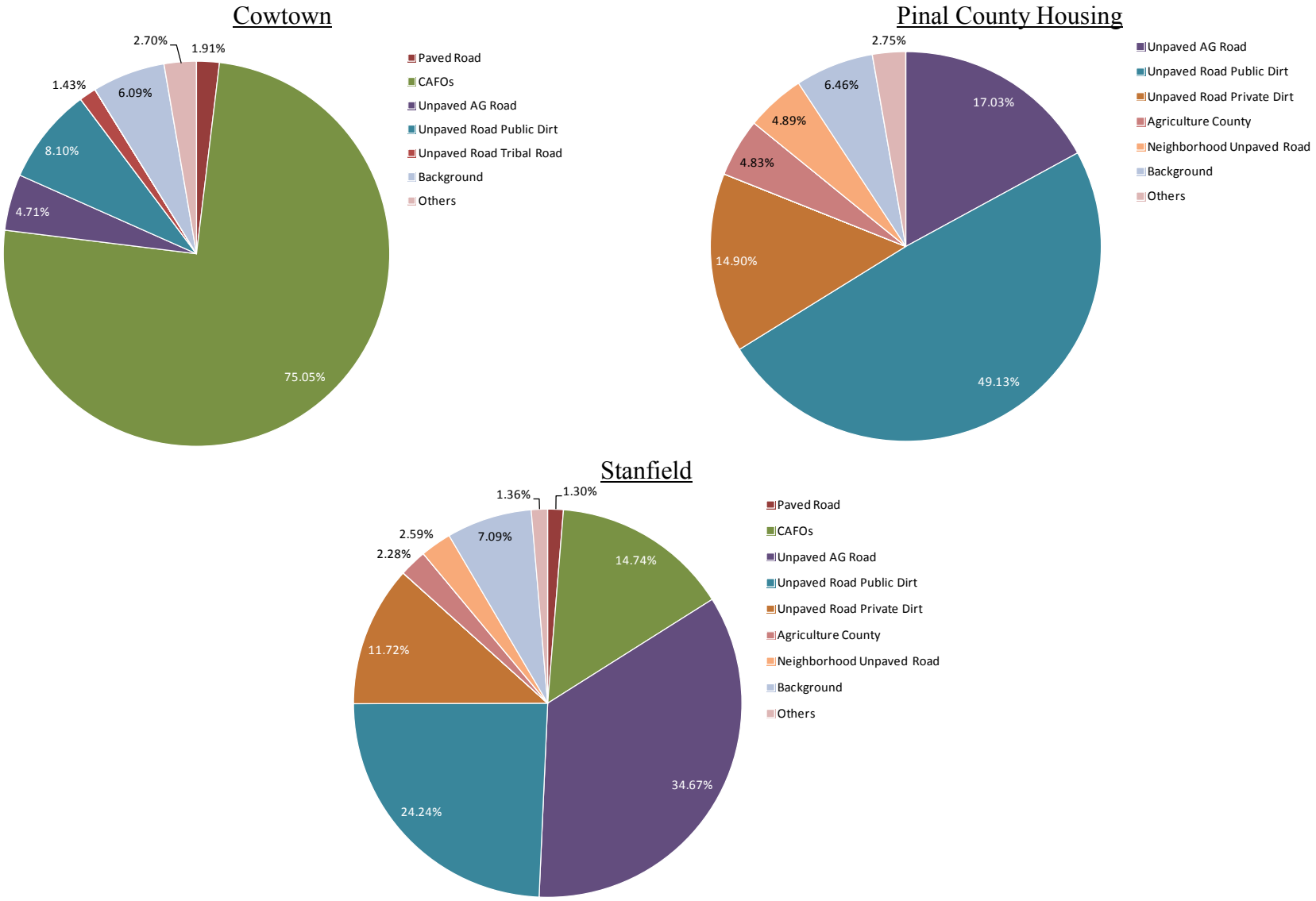


Figure 2-4
Stagnation Design Day Source Contributions



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3. HIGH WIND DAY MODELING

High wind design days selected for Pinal County PM_{10} monitoring sites included both high wind hours (when hourly average wind speeds exceeded 12 mph) and low wind hours. During high wind hours, windblown PM_{10} emissions are generally much greater than those generated by mechanical sources. However, as discussed in the emission inventory report, emission from sources of mechanically generated PM_{10} were included in the modeling of windblown PM_{10} emissions in order to fully account for all source contributions during high wind hours. On low wind hours, the assumption that all PM_{10} emissions are generated by mechanical sources and none are produced by wind entrainment was utilized. The remainder of this section describes how high wind hour emissions were treated and how the benefits from high wind control measures were evaluated.

The method used to assess high wind hour source apportionment and to provide a basis for demonstrating attainment is the weighted rollback method, a demonstration approach that was employed in MAG's Five Percent Plan[19] and approved by EPA. As discussed in the Five Percent Plan:

> *The fundamental assumption underlying any rollback method is that pollutant concentrations are directly proportional to total emissions over the area of interest. A weighted rollback approach applies a distance reduction factor to the emissions of each source in the modeling domain to help assess the impact of emissions as distance from the monitor increases. The reduction factor is calculated based upon the distance between each source and the impacting monitor.*

The concept for this approach came from a saturation monitoring study in which Maricopa County placed a string of temporary PM_{10} continuous monitors along the Salt River channel west of the permanent monitors in the Salt River industrial zone (e.g., West 43rd Avenue and Durango Complex stations). Data were collected for an extended period, and differences between sequential monitored concentrations were calculated during high wind hours when winds generally followed a path parallel to the line connecting the temporary and permanent monitors. The results of that analysis and the AERMOD analysis of alternate weighting factors determined that distance weighting (1/distance, where distance is measured from the centroid of the source to the monitor)

[19] Chapter 6, Attainment Demonstration, "MAG Five Percent Plan for PM-10 for Maricopa County Nonattainment Area," May 2012

was an appropriate mechanism to evaluate the impacts of PM_{10} emissions from individual land parcels within back-trajectory modeling domains. MAG used this approach to evaluate all high wind hour emission estimates.

Because MAG had not experienced a low wind/stagnation violation of the PM_{10} standard since 2007, the Five Percent Plan focused on modeling windblown fugitive dust produced during high wind hours. This resulted in the distance-weighted modeling approach cited above to assess impacts at monitors. Low wind monitor impacts were not modeled; instead, emission inventory estimates for the low wind domains were simply quantified[20] to represent the basis for low wind hour concentrations.

In contrast to MAG, Pinal County experienced violations under both low wind/stagnation and high wind conditions. A review of low wind hour concentrations on high wind days found that they exceeded high wind hour concentrations at each of the monitors. Based on this finding, decisions were made (1) to model the effect of low wind hour mechanically generated emissions and (2) to model both mechanically-generated emissions and windblown dust emissions during high wind hours.

As noted in the accompanying base year emission inventory document, mechanically driven emissions were quantified for the low wind domains at each monitor for each hour of the high wind design days. Because the areal extent of these domains encompassed the high wind domains, mechanically driven emissions for sources located within the high wind domains were extracted from the low wind domains for the high wind hours using 45º arcs centered on and opening in the direction opposite to the vector-average wind direction for each high wind hour. The rationale supporting this choice was that the areal extent of the low wind domains should approximate the modeling domains used for high winds. A similar approach was adopted to define the areal boundaries of low wind hour domains to be modeled.[21] Parcel-specific emissions within the low wind and high wind domains were weighted in proportion to their distance from the monitor. This approach ensured that both high and low wind hourly emissions were weighted in the same manner so as to be additive and facilitate control strategy benefit analysis.

Non-Anthropogenic Background

Evaluations of meteorological conditions on high wind design days revealed that winds capable of entraining surface soil particles (i.e., having hourly average speeds $\geq$ 12 mph) were consistently from the northeast direction during high wind hours. One of the closest PM_{10} monitors outside the boundary of the Western Pinal County nonattainment area and generally upwind in a northeasterly direction from the four high wind exceedance monitors is a station located in the small community of Queen Valley. The community of Queen Valley was recorded in the 2010 Census as having a permanent population of 788. The permanent population is augmented in winter by seasonal residents drawn by the relatively moderate climate. Land use in the area is predominately residential, light

[20] 2012 Five Percent Plan TSD, page V-75

[21] Boundaries for both low and high wind hour domains on high wind days are displayed in Chapter 2 of the emission inventory document.

commercial use, and recreation (e.g., the nearby golf course). The topography of the area is generally hilly or mountainous, with the Queen Creek wash running east to west through the community. PM_{10} source emissions near the site are low and limited to contributions from vehicular traffic and residential and commercial activities. In general, roadways in Queen Valley are paved, with the exception of roads outside the populated area. The Queen Valley site was selected to represent PM_{10} concentrations near the upwind boundary of the nonattainment area during high wind hours.

Because the Queen Valley PM_{10} monitoring period included days during which no high wind hours were recorded, the days for which 24-hour average PM_{10} concentrations were available were screened to identify the subset of high wind days. Because the Queen Valley site does not record meteorological conditions, meteorological data were obtained from a monitoring station located in Superior, Arizona, approximately 12 miles to the east. The Queen Valley data were screened to eliminate days with fewer than 6 hours of high winds (> 12 mph), to be consistent with the criteria used to define days eligible for high wind design day designation, and days when high winds were predominantly from directions other than the northeast. This produced a 6-day data set, with an average concentration of 17.5 $\mu g/m^3$. An analysis of high wind days at Organ Pipe Cactus National Monument, the background site used in the MAG Five Percent Plan, produced a 5-day data set with an average concentration of 18.5 $\mu g/m^3$, demonstrating that the Queen Valley high wind day concentrations were in the same range as those collected at Organ Pipe, a rural site with almost no anthropogenic activity or disturbance nearby. The 6-day average of 17.5 $\mu g/m^3$ recorded at Queen Valley was selected to represent the background PM_{10} level in high wind rollback calculations.

A summary of the source contributions to overall weighted emissions is presented by hour for each monitor and design day in Tables 3-1 through 3-4 for Pinal County Housing, Cowtown, Maricopa, and Stanfield monitoring sites, respectively. Also presented is information on hourly wind speed, wind direction, mixing height, and monitored concentration. While these variables employ different units (e.g., degrees, miles/hour, $\mu g/m^3$, etc.), insight into source apportionment can be gained by contrasting the modeled diurnal profiles of individual source categories and the monitored diurnal profiles of the four sites on designated high wind design days. Visual displays of the source-specific hourly weighted emission estimates and monitored concentrations are displayed in Figures 3-1 through 3-4. Figure 3-5 summarizes the average daily source-specific contributions for each site.

The methodology for computing high wind emission factors is presented in an accompanying base year emission inventory document.[22] Independent of the relationships developed between windblown PM_{10} emission factors and hourly-average wind speed, the analysis of emission factors in the accompanying document includes discussions of particle saltation initiation times and soil reservoir depletion that also play a role in the diurnal profile of windblown PM_{10} emissions on high wind days.

[22] Ibid.

Table 3-1
Distance-Weighted Emissions for the High Wind Day at PCH on 1/1/2008

Hour	SPD mph (H=10m)	WD	PM_{10} Observation ($\mu g/m^3$)	Paved Road	Dairies	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agriculture	Unpaved Road				Total
											AG Road	Public Dirt	Private Dirt	Trail	
1	1.6	303.8	28.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.1	0.0	1.4
2	1.5	318.0	21.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.8	0.0	2.9
3	2.0	335.4	22.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.8	0.0	2.0
4	2.5	333.7	24.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	1.3
5	5.9	352.2	16.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.9	0.0	2.6
6	3.2	299.6	19.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.5	0.0	5.1
7	3.9	339.3	16.2	0.9	0.0	0.0	0.0	0.0	0.0	14.1	29.8	12.6	6.8	0.4	64.5
8	5.7	5.0	22.7	1.0	0.0	0.0	0.0	0.0	0.0	14.0	40.2	13.3	3.8	0.0	72.2
9	4.8	53.9	34.7	0.6	0.0	0.0	0.0	0.0	0.0	15.2	39.5	75.7	3.4	0.2	134.7
10	16.3	41.2	871.2	0.0	0.0	43.9	138.5	57.8	6.8	1317.0	144.1	50.5	28.0	4.8	1791.3
11	21.4	46.3	919.3	0.0	0.0	131.0	383.8	160.2	23.0	4185.3	398.3	117.7	69.7	15.6	5484.5
12	25.1	49.6	1136.1	0.0	0.0	236.3	692.5	289.0	41.5	7546.0	685.7	211.5	123.1	28.0	9853.6
13	23.6	48.5	790.7	0.0	0.0	101.5	297.5	124.2	17.8	3248.2	316.0	101.7	56.2	12.1	4275.1
14	22.9	48.3	946.1	0.0	0.0	49.8	146.0	60.9	8.7	1600.5	174.7	63.2	35.2	6.0	2145.1
15	19.2	47.6	320.0	0.0	0.0	24.1	76.2	31.8	3.7	695.0	96.4	43.3	19.1	2.7	992.5
16	22.3	53.6	397.9	0.0	0.0	32.3	94.7	39.5	5.7	1045.0	128.3	125.9	22.1	4.0	1497.4
17	19.9	53.6	281.9	0.0	0.0	29.5	93.1	38.9	4.6	851.2	111.2	104.4	17.3	3.3	1253.5
18	15.0	50.6	65.8	0.0	0.0	7.6	24.8	10.4	1.1	212.9	55.8	28.7	7.9	0.9	350.0
19	15.5	54.6	50.9	0.0	0.0	5.4	17.7	7.4	0.8	142.1	12.1	43.1	6.2	0.5	235.4
20	19.4	58.1	61.5	0.0	0.0	6.7	21.2	8.8	1.0	190.0	16.3	24.2	5.9	0.7	274.8
21	19.3	56.7	70.6	0.0	0.0	8.0	25.4	10.6	1.2	228.0	19.6	24.8	7.0	0.8	325.5
22	19.2	57.4	67.6	0.0	0.0	8.0	25.4	10.6	1.2	228.0	19.6	22.3	4.4	0.8	320.4
23	17.2	55.7	32.7	0.0	0.0	2.4	7.7	3.2	0.4	69.2	5.9	14.3	1.9	0.3	105.4
24	14.9	54.6	139.3	0.0	0.0	4.8	15.8	6.6	0.7	126.4	10.8	13.1	2.2	0.5	180.9
R-Square[a]				0.1	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7
Average			264.9	0.1	0.0	28.8	85.8	35.8	4.9	905.3	96.0	45.8	17.7	3.4	1223.8
Percentage Contribution				0.0%	0.0%	2.4%	7.0%	2.9%	0.4%	74.0%	7.8%	3.7%	1.4%	0.3%	100.0%

a. R^2 between hourly distance-weighted emissions and monitored concentrations

Figure 3-1
Distance-Weighted Emissions for Pinal County Housing (PCH) Monitor on High Wind Day
1/1/2008

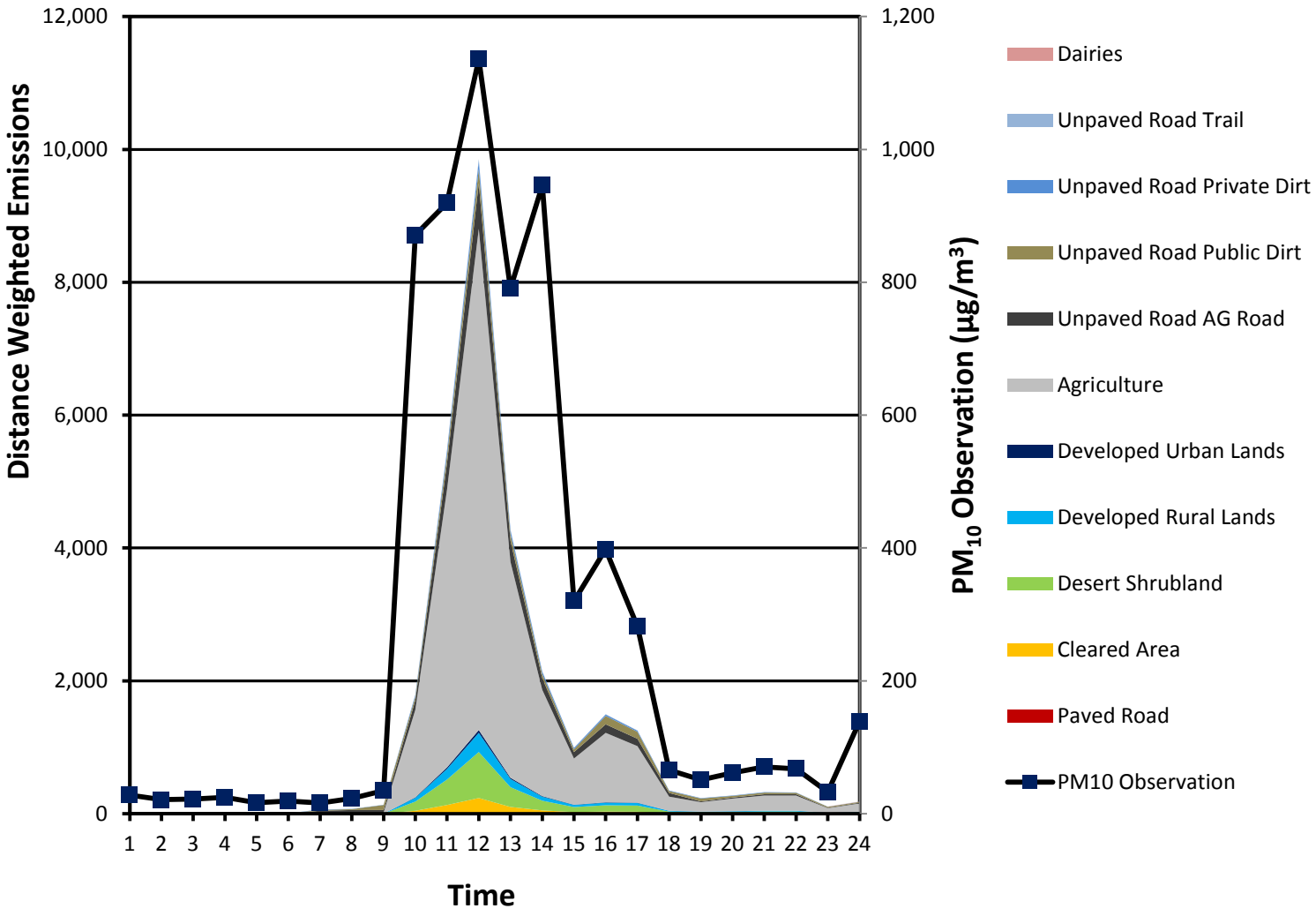

Table 3-2
Distance-Weighted Emissions for the High Wind Day Modeling Domain at Cowtown on 04/27/2008

Hour	SPD mph (H=10m)	WD	PM_{10} Obser-vation ($\mu g/m^3$)	Rail Road	Point Sources	Paved Road	Construc-tion	Cleared Area	Desert Shrubland		Develop-ed Rural Lands	Develop-ed Urban Lands	CAFOs	Agriculture		Unpaved Road					Total
									County	Tribal				County	Tribal	AG Road	Public Dirt	Private Dirt	Trail	Tribal Road	
1	6.1	332.4	68.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.3
2	0.7	320.5	73.0	0.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.9	0.0	0.0	6.2
3	5.9	314.7	88.1	0.9	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	0.2	0.3	0.0	0.0	10.2
4	3.9	84.4	59.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.7	0.0	0.0	0.0	0.8
5	2.2	25.7	92.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.6	0.0	0.0	1.8
6	2.4	156.6	492.9	0.0	9.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	111.2	0.0	0.3	0.0	20.4	0.0	0.0	0.3	142.0
7	1.6	229.1	326.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	300.1	2.0	9.7	9.4	27.6	0.0	0.0	2.9	351.9
8	2.1	11.6	222.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.3	0.1	8.4	0.2	0.0	38.5
9	10.9	33.2	372.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	1.9	28.0	29.0	10.2	0.1	0.2	78.2
10	20.0	52.9	886.8	0.0	0.0	0.0	219.8	22.3	528.0	141.0	63.9	1.3	0.0	1078.9	1.8	42.2	40.7	23.4	0.4	0.6	2164.1
11	17.6	44.4	107.7	0.0	0.0	0.0	58.3	5.9	140.0	37.4	16.9	0.3	0.0	292.8	2.0	32.1	32.7	9.1	0.1	0.4	628.0
12	15.7	43.0	122.3	0.0	0.0	0.0	26.6	2.7	63.9	17.1	7.7	0.2	0.0	138.0	2.0	30.6	39.3	9.7	0.0	0.5	338.3
13	17.7	37.0	72.0	0.0	0.0	0.0	54.4	5.5	130.6	34.9	15.8	0.3	0.0	272.6	2.0	29.6	33.3	18.8	0.0	0.4	598.0
14	14.7	44.0	38.4	0.0	0.0	0.0	18.2	1.9	48.0	12.8	5.8	0.1	0.0	101.3	2.0	29.0	37.0	10.2	0.1	0.5	266.9
15	16.1	49.6	36.4	0.0	0.0	0.0	26.9	2.7	64.7	17.3	7.8	0.2	0.0	139.8	1.8	27.6	39.3	9.6	0.2	0.6	338.7
16	15.1	50.7	23.1	0.0	0.0	0.0	21.5	2.3	56.7	15.1	6.9	0.1	0.0	118.0	1.9	27.7	38.1	9.4	0.2	0.6	298.5
17	12.1	59.4	69.7	0.0	0.0	0.0	4.1	0.4	10.8	2.9	1.3	0.0	0.0	29.4	1.1	25.6	35.1	6.0	0.2	0.6	117.6
18	9.2	68.9	101.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	1.1	20.0	35.7	4.1	0.2	0.9	70.2
19	5.2	40.9	230.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	13.9	4.8	0.0	0.2	19.0
20	4.0	8.0	72.9	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	9.8	0.0	0.0	10.2
21	2.9	37.2	79.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	5.9	11.1	0.0	0.1	17.3
22	3.0	35.3	42.6	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	5.1	2.9	0.0	0.1	8.2
23	3.8	111.6	232.5	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	4.4	0.9	0.0	0.1	5.9
24	4.7	9.3	127.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.1
R-Square[a]				0.0	0.1	0.0	0.5	0.5	0.4	0.4	0.4	0.5	0.1	0.4	0.0	0.1	0.1	0.1	0.2	0.1	0.5
Average			168.3	0.1	0.4	0.1	17.9	1.8	43.4	11.6	5.3	0.1	17.7	91.2	1.2	13.8	18.3	6.3	0.1	0.4	229.7
Percentage Contribution				0.0%	0.2%	0.0%	7.8%	0.8%	18.9%	5.1%	2.3%	0.0%	7.7%	39.7%	0.5%	6.0%	8.0%	2.8%	0.0%	0.2%	100.0%

a. R^2 between hourly distance-weighted emissions and monitored concentrations

Figure 3-2
Distance-Weighted Emissions for Cowtown (CWT) Monitor on High Wind Day
4/27/2008

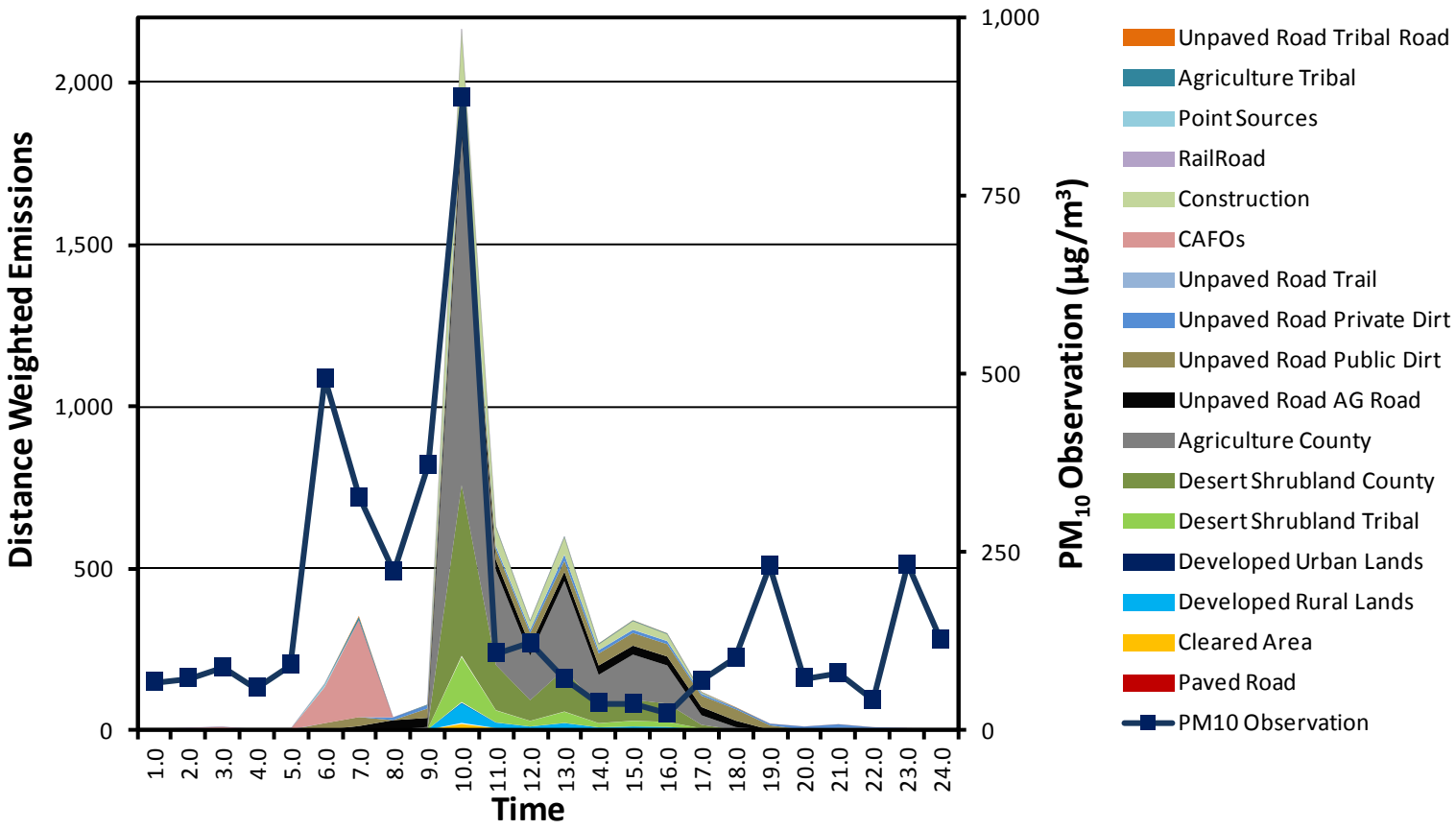

Table 3-3
Distance-Weighted Emissions for the High Wind Day Modeling Domain at Maricopa on 10/27/2008

Hour	SPD mph (H=10m)	WD	PM_{10} Obser-vation ($\mu g/m^3$)	Rail Road	Paved Road	Construc-tion	CAFOs	Cleared Area	Desert Shrubland	Develop-ed Rural Lands	Develop-ed Urban Lands	Agriculture		Unpaved Road					Total
												County	Tribal Land	AG Road	Public Dirt	Private Dirt	Trail	Tribal Road	
1	3.8	160.0	239.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4	0.0	0.0	1.2
2	2.0	106.0	143.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	1.3	6.0	70.3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7
4	1.3	348.0	73.8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
5	2.5	290.0	98.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1.1
6	2.0	241.0	91.8	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8
7	1.3	215.0	129.8	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.0	0.0	0.0	0.0	3.1	7.4
8	5.6	82.0	160.4	0.0	6.8	55.5	0.0	0.0	0.0	0.0	0.0	0.5	0.3	10.1	3.2	1.4	0.0	0.0	77.7
9	13.0	84.0	326.2	0.0	0.0	232.1	0.0	55.7	32.4	22.4	23.4	82.5	0.3	14.8	3.7	3.8	0.3	0.0	471.2
10	16.1	85.0	852.9	0.0	0.0	1222.0	0.0	340.5	189.2	130.6	155.2	506.1	0.3	43.5	9.9	16.6	1.5	0.0	2615.3
11	18.3	81.0	496.5	0.0	0.0	1098.9	0.0	304.1	169.0	116.6	138.6	452.1	0.3	40.5	8.7	14.0	1.4	0.0	2344.2
12	16.3	82.0	293.2	0.0	0.0	511.2	0.0	132.8	73.8	50.9	60.5	197.7	0.3	23.4	6.1	8.7	0.6	0.0	1066.0
13	17.0	79.0	176.0	0.0	0.0	444.0	0.0	113.3	63.0	43.5	51.7	168.8	0.3	21.5	5.2	6.7	0.5	0.0	918.4
14	16.8	74.0	141.9	0.0	0.0	375.7	0.0	88.1	49.0	33.8	40.2	131.4	0.3	17.4	3.8	3.9	0.4	0.2	744.3
15	15.4	72.0	84.8	0.0	0.0	200.6	0.0	38.4	22.4	15.4	16.1	57.1	0.3	11.8	0.7	2.2	0.2	0.7	365.9
16	13.6	71.0	76.6	0.0	0.0	120.5	0.0	13.9	8.1	5.6	5.8	21.0	0.3	9.3	0.2	1.2	0.1	0.7	186.9
17	13.0	72.0	68.6	0.0	0.0	105.3	0.0	9.3	5.4	3.7	3.9	14.2	0.3	9.1	0.2	1.0	0.1	0.6	153.1
18	8.7	62.0	60.4	6.6	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	5.9	0.0	0.3	0.0	0.6	18.2
19	7.2	61.0	56.2	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	3.0
20	7.4	68.0	45.1	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2	2.1
21	9.6	70.0	36.1	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2	2.4
22	9.8	80.0	30.8	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	2.7
23	9.2	82.0	33.2	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.0	0.0	1.9
24	8.9	78.0	38.7	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	1.4
R-Square[a]				0.0	0.1	0.8	0.0	0.8	0.8	0.8	0.8	0.8	0.1	0.7	0.8	0.8	0.8	0.0	0.8
Average			159.4	0.3	1.1	181.9	0.0	45.7	25.5	17.6	20.6	68.0	0.2	8.6	1.8	2.6	0.2	0.3	374.5
Percentage Contribution				0.1%	0.3%	48.6%	0.0%	12.2%	6.8%	4.7%	5.5%	18.2%	0.0%	2.3%	0.5%	0.7%	0.1%	0.1%	100.0%

a. R^2 between hourly distance-weighted emissions and monitored concentrations

Figure 3-3
Distance-Weighted Emissions for Maricopa Monitor on High Wind Day
10/27/2008

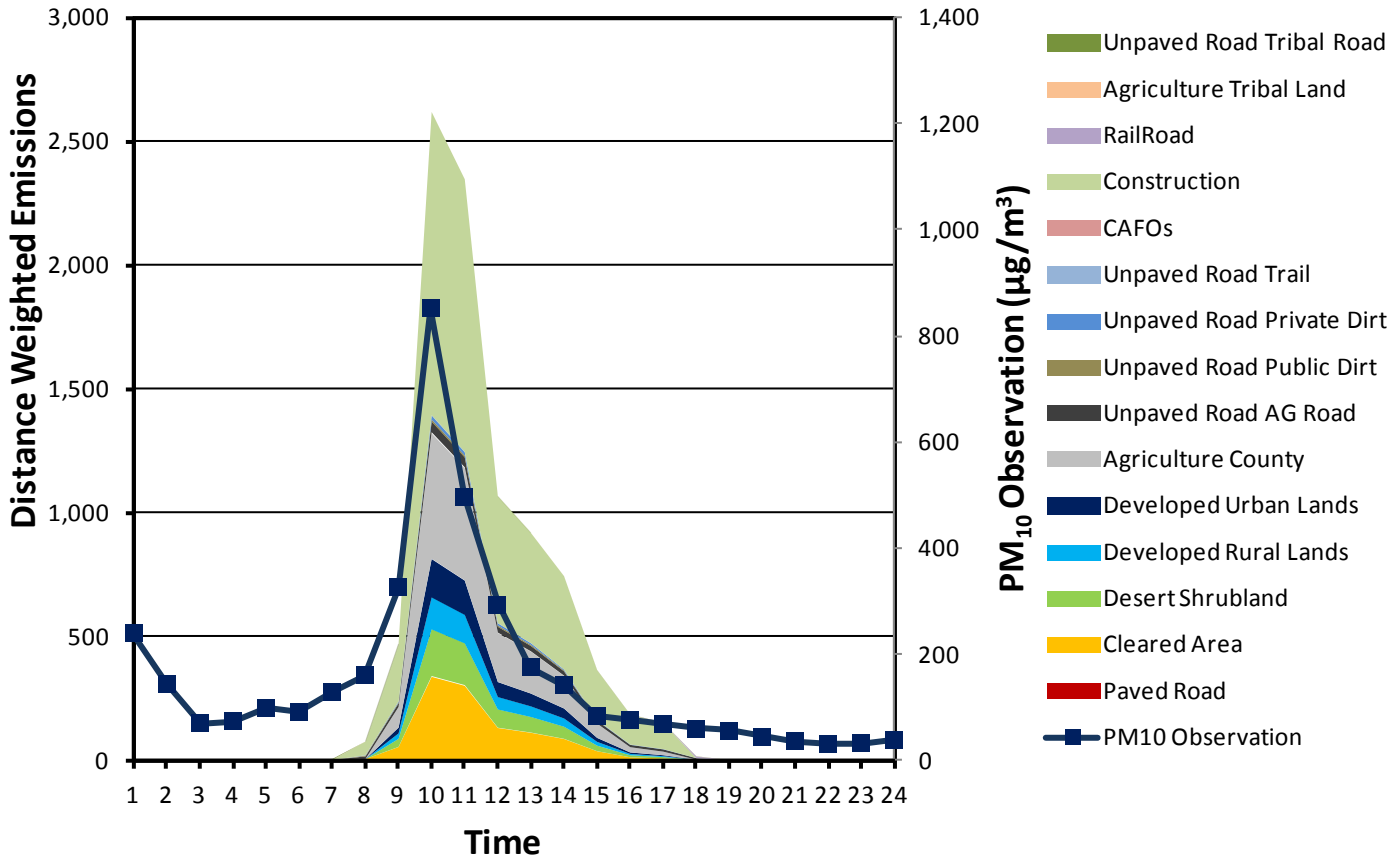

Table 3-4
Distance-Weighted Emissions for the High Wind Day Modeling Domain at STF on 11/21/2008

Hour	SPD mph (H=10m)	WD	PM_{10} Observation ($\mu g/m^3$)	Paved Road	Construction	CAFOs	Cleared Area	Desert Shrubland	Developed Rural Lands	Developed Urban Lands	Agriculture	Unpaved Road				Total
												AG Road	Public Dirt	Private Dirt	Trail	
1	4.1	119.2	112.4	0.1	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.3	0.0	3.9
2	3.5	161.6	59.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.8	0.0	2.1
3	3.9	117.3	157.4	0.1	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.7	0.0	6.3
4	4.3	125.4	158.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	1.4
5	3.7	274.2	102.3	0.1	0.0	27.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	27.8
6	4.0	240.9	234.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.1	0.0	3.8
7	15.9	85.5	357.4	0.0	0.0	53.8	10.8	66.3	4.1	0.9	350.1	62.0	36.8	41.8	2.7	629.3
8	18.3	81.9	326.6	0.0	0.0	74.4	17.8	108.7	6.7	1.5	566.0	77.3	43.2	27.0	4.6	927.2
9	20.4	82.2	584.6	0.0	0.0	254.5	78.0	477.6	29.4	6.7	2445.9	188.7	61.0	41.8	18.8	3602.2
10	19.9	81.1	429.2	0.0	0.0	107.9	28.9	177.2	10.9	2.5	915.0	97.9	45.1	66.8	7.6	1459.8
11	20.0	80.2	334.3	0.0	0.0	75.9	19.7	120.5	7.4	1.7	626.1	76.9	37.6	44.6	5.4	1015.9
12	18.2	80.4	186.1	0.0	0.0	44.2	9.1	55.6	3.4	0.8	295.3	57.1	39.5	66.8	2.9	574.7
13	14.7	79.2	93.9	0.0	0.0	9.4	3.3	21.1	1.3	0.3	110.3	46.5	36.8	47.8	1.5	278.3
14	13.4	78.5	65.1	0.0	0.0	4.0	1.4	8.9	0.6	0.1	53.8	43.7	40.9	75.7	1.1	230.2
15	12.3	75.3	64.8	0.0	0.0	1.6	0.6	3.6	0.2	0.0	33.3	43.0	46.0	60.1	0.9	189.5
16	9.9	77.2	65.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	41.2	50.3	63.9	0.8	168.7
17	7.1	74.7	87.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	42.1	46.9	46.5	0.8	149.5
18	4.7	73.8	104.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	12.5	42.3	42.3	38.7	0.9	137.1
19	6.3	75.1	88.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.8	40.7	0.0	64.7
20	5.6	86.2	56.1	0.3	0.0	38.5	0.0	0.0	0.0	0.0	0.0	0.0	16.8	31.0	0.0	86.5
21	2.6	158.4	98.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	2.8	0.0	8.3
22	2.2	230.2	249.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.9	0.0	2.3
23	2.9	270.1	171.6	0.1	0.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	8.8
24	2.4	291.4	99.5	0.0	0.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	8.4
R-Square[a]				0.1	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.1	0.0	0.7	0.7
Average			178.6	0.1	0.0	29.8	7.1	43.3	2.7	0.6	226.3	34.1	24.2	29.2	2.0	399.4
Percentage Contribution				0.0%	0.0%	7.5%	1.8%	10.8%	0.7%	0.2%	56.7%	8.5%	6.1%	7.3%	0.5%	100.0%

a. R^2 between hourly distance-weighted emissions and monitored concentrations

Figure 3-4
Distance-Weighted Emissions for Stanfield (STF) Monitor on High Wind Day
11/21/2008

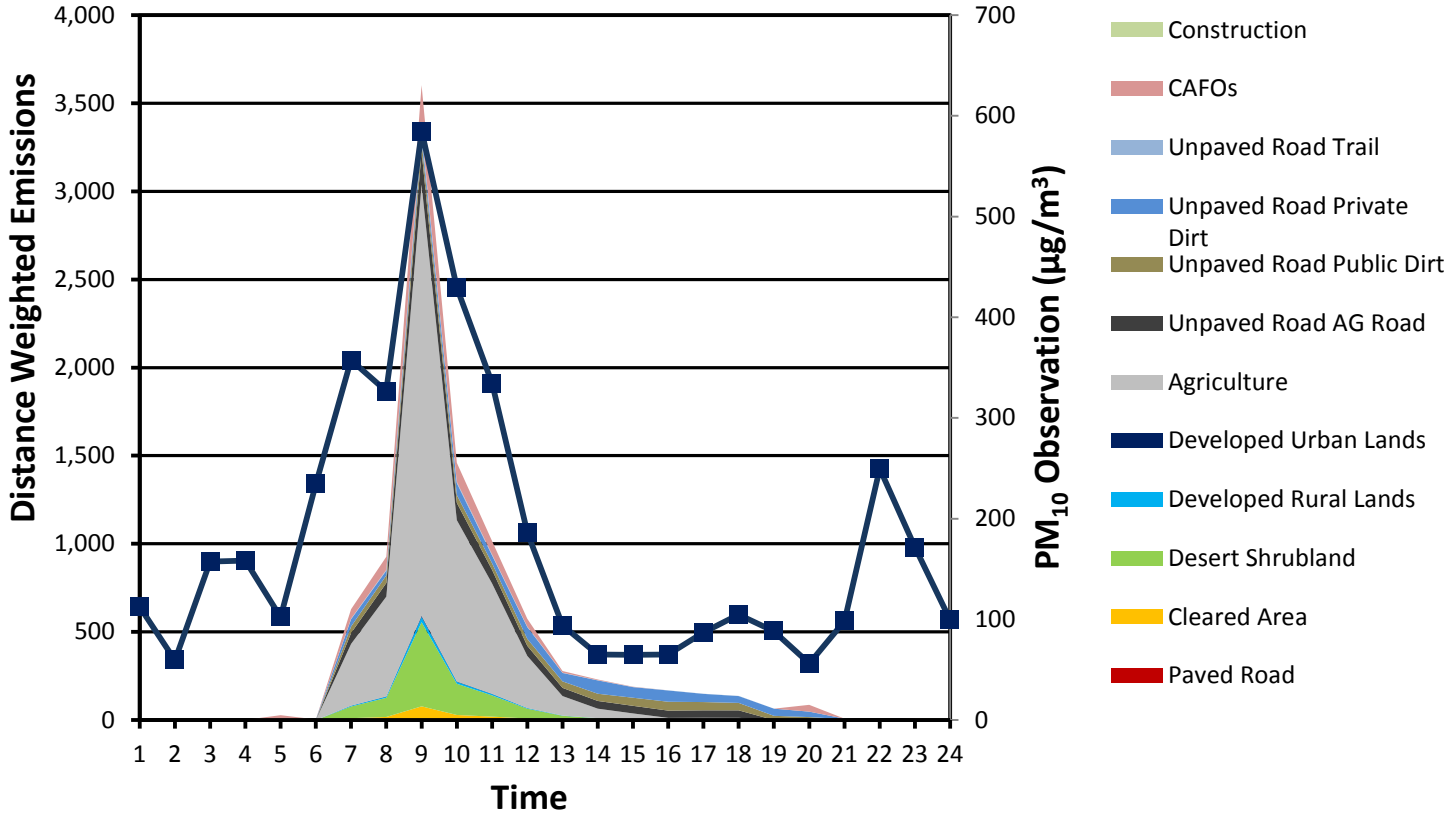

Figure 3-5
High Wind Design Day Source Contributions

ENCLOSURE 4

State Implementation Plan Revision
Public Comment and Hearing Documentation

Public Notice
Certification of the Public Hearing (Affidavit of Publication)
Public Hearing Agenda
Public Hearing Sign-in Sheet
Public Hearing Transcript
Public Hearing Officer Certification
Compilation of Public Comments
Responsiveness Summary

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ADEQ
Arizona Department of Environmental Quality
Janice K. Brewer, Governor
Henry R. Darwin, Director

PUBLIC NOTICE

30 DAY PUBLIC COMMENT PERIOD AND PUBLIC HEARING ON THE PROPOSED ARIZONA STATE IMPLEMENTATION PLAN REVISION FOR THE WEST PINAL COUNTY PM10 NONATTAINMENT AREA FOR 1987 24-HOUR PARTICULATE MATTER (PM_{10}) NATIONAL AMBINET AIR QUALITY STANDARDS

The Arizona Department of Environmental Quality (ADEQ) opens a thirty day public comment period with the publication of this notice on November 7, 2013, for the proposed Arizona State Implementation Plan (SIP) Revision for the West Pinal County PM_{10} Nonattainment Area for the 1987 24-hour PM_{10} National Ambient Air Quality Standards (NAAQS).

A public hearing on the proposed SIP revision will be held on Monday, December 9, 2013, at 2:00 p.m., in Conference Room 145 at ADEQ, 1110 W. Washington St., Phoenix, AZ 85007. All interested parties will be given an opportunity at the public hearing to submit comments, data, and views, orally and in writing. Written comments may be submitted prior to or during the public hearing and must be postmarked or received at ADEQ by 5:00 p.m. on December 9, 2013.

Written comments should be addressed, faxed, or e-mailed to Lisa Tomczak, Air Quality Division, State Implementation Plan Section, Arizona Department of Environmental Quality, 1110 W. Washington St., Phoenix, AZ 85007, FAX: (602) 771-2366, E-Mail: tomczak.lisa@azdeq.gov.

Copies of the proposed SIP are available for review beginning Thursday, November 7, 2013, Monday through Friday, between 8:30 a.m. and 4:30 p.m., at the ADEQ Records Center, 1110 W. Washington St., Phoenix, AZ 85007, (602) 771-4380. An electronic copy of the proposed SIP can also be viewed online at http://www.azdeq.gov/environ/air/plan/index.html by selecting Air Quality – Public Notices, Meetings, and Hearings.

Persons with a disability may request a reasonable accommodation such as a sign language interpreter, by contacting Alicia Pollard at (602) 771-4791, or via email: pollard.alicia@azdeq.gov. TDD line for hearing impaired individuals, (602) 771-4829. Requests should be made as early as possible to allow time to arrange the accommodation.

STATE OF ARIZONA
COUNTY OF PINAL } ss.

30 DAY PUBLIC COMMENT PERIOD AND PUBLIC HEARING ON THE PROPOSED ARIZONA STATE IMPLEMENTATION PLAN REVISION FOR THE WEST PINAL COUNTY PM_{10} NONATTAINMENT AREA FOR 1987 24-HOUR PARTICULATE MATTER (PM_{10}) NATIONAL AMBINET AIR QUALITY STANDARDS

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No. of publications: 2; dates of publications: Nov. 7, 8, 2013.

Affidavit of Publication

RUTH A. KRAMER first being duly sworn deposes and says: That he/she is a native born citizen of the United States of America, over 21 years of age, that I am an agent and/or publisher of the Casa Grande Dispatch, a daily newspaper published at Casa Grande, Pinal County, Arizona, Tuesday through Sunday of each week; that a notice, a full, true and complete printed copy of which is hereunto attached, was printed in the regular edition of said newspaper, and not in a supplement thereto, for TWO issues the first publication thereof having been on the

7TH day of NOVEMBER A.D., 2013

Second publication NOVEMBER 08, 2013

Third publication _____

Fourth publication _____

Fifth publication _____

Sixth publication _____

CASA GRANDE DISPATCH

By _____
agent and/or publisher of the Casa Grande Dispatch

Sworn to before me this 11th
day of November A.D., 2013

Debbie L. Mumme

Notary Public in and for the County
of Pinal, State of Arizona

Official Seal
NOTARY PUBLIC, State of Arizona
County of Pinal
DEBBIE L. MUMME
My Comm. Expires 10-23-17

317873

AFFIDAVIT OF PUBLICATION

ADEQ
AIR QUALITY DIVISION

13 NOV 14 AM 10: 46

THE ARIZONA REPUBLIC

6840 State Agency Public Notices

30 DAY PUBLIC COMMENT PERIOD AND PUBLIC HEARING ON THE PROPOSED ARIZONA STATE IMPLEMENTATION PLAN REVISION FOR THE WEST PINAL COUNTY PM10 NONATTAINMENT AREA FOR 1987 24-HOUR PARTICULATE MATTER (PM10) NATIONAL AMBINET AIR QUALITY STANDARDS

The Arizona Department of Environmental Quality (ADEQ) opens a thirty day public comment period with the publication of this notice on November 7, 2013, for the proposed Arizona State Implementation Plan (SIP) Revision for the West Pinal County PM10 Nonattainment Area for the 1987 24-hour PM10 National Ambient Air Quality Standards (NAAQS).

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Pub: November 7, 8, 2013

STATE OF ARIZONA
COUNTY OF MARICOPA } SS.

Tabitha Weaver, being first duly sworn, upon oath deposes and says: That she is a legal advertising representative of the Arizona Business Gazette, a newspaper of general circulation in the county of Maricopa, State of Arizona, published at Phoenix, Arizona, by Phoenix Newspapers Inc., which also publishes The Arizona Republic, and that the copy hereto attached is a true copy of the advertisement published in the said paper on the dates as indicated.

The Arizona Republic

November 7, 8, 2013

Sworn to before me this
8st day of
November A.D. 2013

MELISSA HOEKSTRA
Notary Public - Arizona
Maricopa County
My Comm. Expires Aug 1, 2014

Notary Public

ADEQ Arizona Department of Environmental Quality
Janice K. Brewer, Governor
Henry R. Darwin, Director

Public Hearing Agenda

AIR QUALITY DIVISION
PUBLIC HEARING ON THE PROPOSED ARIZONA STATE IMPLEMENTATION PLAN FOR THE WEST PINAL COUNTY 1987 24-HOUR PARTICULATE MATTER (PM_{10}) NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

Monday, December 9, 2013, at 2:00 p.m.
Arizona Department of Environmental Quality, Conference Room 145
1110 W. Washington St., Phoenix, AZ 85007

Pursuant to 40 CFR § 51.102 notice is hereby given that the above referenced meeting is open to the public.

1. Welcome and Introductions
2. Purposes of the Oral Proceeding
3. Procedure for Making Public Comment
4. Brief Overview of the Proposed West Pinal County 1987 24-Hour PM_{10} SIP
5. Question and Answer Period
6. Oral Comment Period
7. Adjournment of Oral Proceeding

Copies of the proposed SIP are available for review, Monday through Friday, between 8:30 a.m. and 4:30 p.m., at the ADEQ Records Center, 1110 W. Washington St., Phoenix, AZ 85007. To reach the Records Center, please call (602) 771-4380. An electronic copy of the proposed SIP can also be viewed on ADEQ's Website at http://www.azdeq.gov/environ/air/plan/index.html by selecting Air Quality – Public Notices, Meetings, and Hearings. For additional information regarding the hearing please call Lisa Tomczak, ADEQ Air Quality Division, at (602) 771 - 4450 or 1-800-234-5677, Ext. 771-4450.

Persons with a disability may request a reasonable accommodation such as a sign language interpreter, by contacting Alicia Pollard at (602) 771-4791, or via email: pollard.alicia@azdeq.gov. TDD line for hearing impaired individuals, (602) 771-4829. Requests should be made as early as possible to allow time to arrange the accommodation.

ADEQ
Arizona Department of Environmental Quality

Air Quality Division Sign-In Sheet

Please Sign In

SUBJECT: Proposed PM_{10} State Implementation Plan for the West Pinal County Nonattainment Area DATE December 9, 2013

NAME	ORGANIZATION	PHONE	E-MAIL (primary method of contact)
1. Phillip Fargotstein	Fennemore Craig, PC	602 916 5453	pfargotstein@fclaw.com
2. Lou Snow	Snow Consulting	602-7997010	Snowconsult@aol.com
3. Mike Sundblom	Pinal County	520-866-6960	Michael.Sundblom@pinalcountyaz.gov
4. Kate Walch	Pinal County	520-866-6860	kate.walch@pinalcountyaz.gov
5. Mike Bourne	NISSAN	520 421 4103	mike.bourne@nissan-usa.com
6. Scott DiBiase	Pinal County	520 8666969	
7. Hao Zhang	Trinity Consultants	602-274-2903	hzhang@trinityconsultants.com.

	NAME	ORGANIZATION	PHONE	E-MAIL
8.	Ana Kennedy	A2FB		anakennedy@azfb.org
9.	Michael Burton	ADEQ		mb116@azdeq.gov
10.	BAS AJA	ACA		baja@arizonabeef.org
11.	Tom Ekren	MCAQD	602-506-6707	
12.	Spencer Kamps	HBACA	602-274-6545	kampss@hbaca.org
13.				
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PROPOSED ARIZONA AIR QUALITY
STATE IMPLEMENTATION PLAN (SIP)

HEARING ON A PROPOSED ARIZONA STATE IMPLEMENTATION PLAN FOR THE WEST PINAL COUNTY 1987 24-HOUR PARTICULATE MATTER (PM_{10}) NATIONAL AMBINET AIR QUALITY STANDARDS (NAAQS)

Oral Proceeding
Hearing Officer Script
December 9, 2013

Danielle Hazeltine: Good afternoon, thank you for coming. I now open this hearing on the proposed Arizona State Implementation Plan for the West Pinal County 1987 24-hour Particulate Matter (or PM_{10}) National Ambient Air Quality Standards or the (NAAQS).

It is now Monday, December 9, 2013; the time 2:03 p.m. The location is Arizona Department of Environmental Quality, 1110 West Washington St, Phoenix, AZ 85007, conference room 145.

My name is Danielle Hazeltine, and I have been appointed by the Director of the Arizona Department of Environmental Quality (ADEQ) to preside at this proceeding.

The purposes of this proceeding are to provide the public an opportunity to:

hear about the substance of the proposed SIP;
ask questions regarding the SIP; and,
present oral arguments, data and views regarding the SIP in the form of comments on the record.

Steve Calderon is here representing ADEQ from the Air Quality Division, State Implementation Plan Section.

Public notice appeared in the Arizona Republic, Casa Grande Valley Newspapers Incorporated, and ADEQ's website beginning November 7, 2013. Copies of the proposed SIP revision were made available at the ADEQ Phoenix Records Center and ADEQ's website beginning November 7, 2013.

The procedure for making a public comment on the record is straightforward. If you wish to comment, you need to fill out a speaker slip, which is available at the sign-in table, and give it to me. Using speaker slips allows everyone an opportunity to be heard and allows us to match the name on the official record with the comments. You may also submit written comments to me today.

Please note, the comment period for the proposed SIP revision ends today, December 9, 2013. All written comments whether they were sent via U.S. mail or via e-mail or via FAX must be postmarked or received by ADEQ by 5:00 p.m. today.

Comments made during the formal comment period are required by law to be considered by ADEQ when preparing the final SIP. This is done through the preparation of a responsiveness summary in which the Department responds in writing to written and oral comments made during the formal comment period.

The agenda for this hearing is simple. First, we will present a brief overview of the proposed SIP.

Second, I will conduct a question and answer period. The purpose of the question and answer period is to provide information that may help you in making comments on the proposed SIP. And that I asked that if anybody is going to make or ask a question please state your name clearly for the record before you ask a question and

Thirdly, I will conduct the oral comment period to call speakers in the order that I have received their speaker slips.

Please be aware that any comments at today's hearing that you want the Department to formally consider must be given either in writing or on the record at today's hearing during the oral comment period of this proceeding.

At this time, Mr. Calderon will give a brief overview of the proposal.

Steve Calderon: Effective July 2, 2012, the U.S. Environmental Protection Agency (EPA) designated a portion of western Pinal County as a "nonattainment" area for the 1987 24-hour PM_{10} National Ambient Air Quality Standards.

The designation of the West Pinal County PM_{10} nonattainment area is based on recorded violations of the PM_{10} standard at various monitoring sites within the county. An area is considered in violation of the 24-hour PM_{10} NAAQS if it exceeds the standard more than once per year on average over three years. In order to attain the NAAQS for the 24-hour PM_{10} standard, an air quality monitor cannot measure levels of PM_{10} greater than 150 micrograms per cubic meter (µg/ m3) more than once per year on average over a consecutive three-year period.

Under the authority granted by the Governor and the State of Arizona, the Arizona Department of Environmental Quality (ADEQ) is responsible for preparation and submittal of a State Implementation Plan (SIP) to demonstrate how the nonattainment area will attain the 1987 24-hour PM_{10} NAAQS.

The current proposed SIP contains Information on the ambient monitoring network, emissions inventory, base year modeling, and ADEQ's commitments to comply with additional Clean Air Act requirements. By June 2, 2014, ADEQ has committed to comply with remaining Clean Air Act requirements by submitting to the EPA: control measure selection and analysis, reasonable further progress, prevention of significant deterioration/new source review, transportation conformity, contingency measures, attainment demonstration, and commitments.

Ms. Hazeltine: This concludes the explanation period of this proceeding on the proposed SIP. Are there any questions before we move to the oral comment period?

"Hearing none"

This concludes the question and answer period of this proceeding on the proposed SIP.

I now open this proceeding for oral comments.

And I will call you and I only got two and please come to the podium to speak, just so we can hear it better and state your name before your comment. So Lou Snow is the first.

Lou Snow: My name is Louis Snow I'm with Lou Snow Consulting and my comment is more of a question. We have discussed since this year the data was obtained. Has there has been any data obtained since that point to current. And if so, what data is that and how has it been documented? Question

Bryan Paris: Data going back to the base year…

Mr. Snow: Going back to the base and bring it forward to current…

Mr. Paris: Since the finalization of the emission inventory document we have received some information on to review, to see how if any that will affect the base year inventory. Most of it has to do with future year modeling. But, what I can do is get your information and review that data and get back to you and what if any

Mr. Snow: I think it's important that we include that because we have a lot of different changes and improvements within the nonattainment area. So, I would like to see that brought current if we could.

Mr. Paris: And if there is anything specific that you know of that you think that we need to unveil you need to let us know so I'll review that data and get back to you

Mr. Snow: okay, thank you.

Ms. Hazeltine: Thank you, next speaker is Ana Kennedy

Ana Kennedy: Thank you and Good Afternoon, my name is Ana Kennedy and I'm here today representing the Arizona Farm Bureau. Thank you for the opportunity to provide comments regarding the State Implementation Plan for the West Pinal County PM_{10} Nonattainment area. The written comments we submitted on the issue, are issues we believe should be address and consider to ensure the intentions made for the PM_{10} emissions modeling are valid. So I don't want to go through all the details of what we brought up I just want to highlight some of the areas that we covered. The first was the unpaved roads each of the definition we would like some further analysis or consideration in terms of the main speed. The data that was used, the sole content as well as the total length of miles used for each modeling made on the unpaved roads emission calculations. The other area was the high winds that you did on dust methodology in particular the disturbance level for a non agricultural land used and Pinal high wind annual emissions inventory. The next was the high wind emissions inventory specifically to agriculture windblown emission crop disturbance levels. And finally the fugitive dust emission from unpaved roads and that particular area that has some data missing that made it a little bit difficult to analyze what was there. In conclusion among all other sources emitting PM_{10} there is no doubt that farming and other agriculture activities create dust. The food and fiber that we depend upon cannot be grown without disturbing the soil to some degree. However because of the level of disturbance and emission must be calculated for this nonpoint source pollutant the state implementation plan and emissions inventory should be developed with the most accurate data and valid assumptions. Our written comments are suggestions and treatments to this assumptions and calculations. The Arizona Farm Bureau has worked closely on this issue with other industry partners and we fully support the comments that are being submitted by the Arizona Cattle Feeders Association as well

Thank you very much.

Ms. Hazeltine: So, that was it for speakers slips, is there anyone else who would like to make a comment on the record?

This concludes the oral comment period of this proceeding.

If you have not already submitted written comments, you may submit them to me at this time. Again, the comment period for this proposed SIP ends today, December 9, 2013, at 5:00 p.m.

Thank you for attending.

The time is now 2:12 p.m. I close this oral proceeding.

ADEQ
Arizona Department of Environmental Quality

Air Quality Division

Public Hearing Presiding Officer Certification

I, Danielle Hazeltine, the designated Presiding Officer, do hereby certify that the public hearing held by the Arizona Department of Environmental Quality was conducted on December 9, 2013, at the Arizona Department of Environmental Quality, Conference Room 145, 1110 West Washington Street, Phoenix, Arizona, in accordance with public notice requirements by publication in *The Arizona Republic and Casa Grande Dispatch* beginning November 7, 2013. Furthermore, I do hereby certify that the public hearing was recorded from the opening of the public record through concluding remarks and adjournment, and the transcript provided contains a full, true, and correct record of the above-referenced public hearing.

Dated this 18 day of December 2013.

Danielle Hazeltine

State of Arizona)
) ss.
County of Maricopa)

Subscribed and sworn to before me on this 18 day of December 2013.

Notary Public State of Arizona
Maricopa County
Laura McFarland
My Commission Expires 04/02/2016

Notary Public

My commission expires: 4/2/2016

Lisa M. Tomczak

From: Nick Simonetta <nick@pivotalpolicyconsulting.com>
Sent: Saturday, December 07, 2013 1:10 AM
To: Lisa M. Tomczak
Cc: Ron McEachern; Brian Betcher
Subject: Comments - Pinal County Non-attainment area PM-10 Inventory Modeling

Importance: High

Lisa,

With respect to the public meeting to be held on December 9th, these comments are presented on behalf of the Central Arizona Irrigation and Drainage District and other irrigation districts within the Pinal County non-attainment area.

While efforts continue among ADEQ, EPA and the Ag stakeholder community, including the irrigation districts, to determine the appropriate balance regarding the final fashioning of BMP definitions and rules at least partly in the context of what the proposed inventory may be, it is important to point out that there are various concerns regarding the current inventory formulation -- most notably regarding the unpaved road concerns.

There seems to be relatively substantial uncertainty as to what counts as an Ag road and what counts as a public road. There is further uncertainty as to whether canal bank roads and irrigation district maintenance roads were counted as Ag roads for purposes of the modeling. At the December 2nd State Ag BMP Committee meeting it was indicated that maps would be provided by or at the direction of ADEQ in order to attempt to clarify some of these issues.

We agree with the point of discussion that what counts as a private Ag or irrigation district road should carry with it the notion that the owner should be able to control ingress and egress if it is to be held accountable to employ best management practices and reduce emissions on such a road. If access cannot be denied, then public use on such land should dictate that such road should not be designated as an Ag or irrigation district road and that the modeling attributing certain dust production to different parties overall and specifically with respect to such roads must be adjusted appropriately, and this therefore would ultimately and appropriately affect the control measure or BMP configurations in terms of the responsible parties and accordingly what would be required/applied (and by what entity) in the context of such road related inventories.

Most immediately, and prior to furthering the current inventory modeling, there must be an opportunity for irrigation district and other Ag stakeholders to receive the road mappings and the breakdown of the attribution of to Ag regarding roads as indicated at recent stakeholder meetings, and further, as noted above, a breakdown of how irrigation district related roads are being counted.

Please let me know if you have any questions, or require any clarification regarding the foregoing.

Thank you.

--Nick

NICK SIMONETTA

PIVOTAL POLICY CONSULTING

Legislative & Government Relations
340 E. Palm Lane, Suite 330
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ADEQ
Arizona Department of Environmental Quality

Air Quality Division
Speaker Slip

SPEAKER SLIP

Date: 12-9-2013

Speaker Slip No.

Name: Lou Snow

Representing: Snow Consulting

Mailing Address: On File

- [x] I wish to make an oral statement.
- [x] I have submitted written comments.
- [ ] I will submit written comments at a later time.

Subject:

Lisa M. Tomczak

From: SnowConsults@aol.com
Sent: Tuesday, November 26, 2013 9:10 AM
To: Lisa M. Tomczak
Subject: Fwd: COMMENTS ON PROPOSED WEST PINAL COUNTY PM10 PLAN

Louis Snow

C.P.E.S.C. #1244
www.LouSnowConsulting.com
(602) 799 7010

From: SnowConsults@aol.com
To: tomczak.lisa@azadeq.gov
CC: snowconsults@aol.com
Sent: 11/26/2013 9:04:44 A.M. US Mountain Standard Time
Subj: Fwd: COMMENTS ON PROPOSED WEST PINAL COUNTY PM10 PLAN

Louis Snow

C.P.E.S.C. #1244
www.LouSnowConsulting.com
(602) 799 7010

From: SnowConsults@aol.com
To: Tomczak.Lisa@azadeq.gov
CC: snowconsults@aol.com
Sent: 11/26/2013 8:45:52 A.M. US Mountain Standard Time
Subj: COMMENTS ON PROPOSED WEST PINAL COUNTY PM10 PLAN

Lisa,
Just an overall comment that I feel should be stated in the Proposed Pinal County PM10 Nonattainment Area Plan to the EPA.
It should be noted that since statistics were obtained and documented as of 2008, there has been a considerable amount of changes that have taken place thru out the nonattainment area that has not been documented on the proposal to the EPA.
I feel it is important to identify these changes since 2008 and so note on the proposed report to the EPA.
I am willing to discuss these changes in detail upon request.
Regards,

Louis Snow

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ADEQ
Arizona Department of Environmental Quality

Air Quality Division
Speaker Slip

SPEAKER SLIP

Date: 12/9/13

Speaker Slip No.

Name: BAS AJA

Representing: AZ CATTLE FEEDERS ASSOC.

Mailing Address: 1401 N. 24TH ST
PHOENIX, AZ 85008

- [ ] I wish to make an oral statement.
- [x] I have submitted written comments.
- [ ] I will submit written comments at a later time.

Subject:

ACFA

ARIZONA CATTLE FEEDERS' ASSOCIATION

1401 NORTH 24TH STREET, SUITE #4
PHOENIX, ARIZONA 85008 • (602) 273-7414

December 9, 2013

Lisa Tomczak
Air Quality Division
State Implementation Plan Section
Arizona Department of Environmental Quality
1110 W. Washington St.
Phoenix, AZ 85007

RE: Comments on Proposed SIP Revision for West Pinal County PM-10 Nonattainment Area

The following comments represent the review by the Arizona Cattle Feeders' Association (ACFA) of the Arizona State Implementation Plan Revision for the West Pinal County PM10 Nonattainment Area. The ACFA reserves the right to continue to provide comments regarding the development of this revision to the Arizona State Implementation Plan (SIP).

General Comments

The Arizona Department of Environmental Quality (DEQ) is to be commended for its consistent outreach and transparency in developing these SIP revision documents. The DEQ's process has been very fair and open for the agricultural community to participate. This serves in contrast to the efforts on the part of Pinal County where transparency and objectivity seem to be lacking. In addition, this research reflects some of the bias brought forward by Pinal County.

This SIP revision includes a PM10 design day and source apportionment data for a Special Purpose Monitor (SPM) monitor (Cowtown) which had previously been a long-term lease on private land that was slated for development and earlier this year the lease was not renewed. The landowner had allowed the data to be collected on a 30 day basis and now the inclusion of this site as a design day has become questionable as the private landowner has issued a cease and desist notice for the site and is scheduling the property for development. This is unfortunate but not unseen. The failure of Pinal County personnel to develop or plan for alternative sites demonstrates a measure of ineptitude. Their "bull in the china closet"

mentality has now left the SIP process with no other choice but to proceed under the direction of the legal framework currently in place and that framework directs the PM10 monitor at the site to be removed/shutdown after December 31, 2013. Planning for anything else is a waste of resources. This SIP process needs to be adjusted so that data and information from only State and Local Air Monitoring System (SLMS) is utilized within the framework of this SIP.

Specific Comments

The SIP contains data for a Stagnation Design Day of October 29, 2008 for the Cowtown monitoring site. While the general comments above reflect the weakness or failure of utilizing this site for these planning purposes the following disparities also need to be recognized.

This SIP designates CAFOS as 75.05% of the emissions for the Stagnation Design Day of October 28, 2008. While these numbers reflect a "paper" process developed some 5 years after the occurrence – there is more pertinent data for this site which was ignored. The Pinal County Air Quality Division conducted two separate "Source Apportionment" studies at the Cowtown site in 2003 and 2009. The data from these two source apportionment studies conflicts with the information in this SIP.

In 2003 the Source Apportionment Study reflected that the CAFOS were 59% of the PM10 average source contribution at Cowtown. This source apportionment was verified via a chemical analysis "fingerprint" for the soils located at the feed yard site. The predominant category for emissions in this study of various monitoring sites in Pinal County reflects that "soil" was the predominant category everywhere except for the Cowtown monitor site (where CAFOS were 59%).

This SIP also demonstrates that the largest contribution of low wind emissions in the nonattainment comes from "soil" via unpaved roads (44,100 tons/year). This similarity would seem to reflect that the CAFOS contribution at Cowtown should be similar between both the 2003 Source Apportionment Study and the SIP's October 28, 2008 Design Day emissions. They are not. They seem to be inflated by approximately 20%. These SIP numbers become even more questionable when you compare them to the 2009 "RARE" Pinal County Source Apportionment Study where the average course particle (between PM10 and PM2.5) emissions at Cowtown were reflected as only 11% from feedlot dust; 20% crustal; and 30% Primary

Biological. Even if you attributed 100% of these three categories to CAFOS (which you cannot as the "Primary Biological" category include pollens and other natural factors), they only total 61%.

During Pinal County's 2009 "RARE" Pinal County Source Apportionment Study the data collected was verified and fingerprinted – unlike the data developed for this SIP. The "RARE" study said,

"Differentiation between several fugitive dust sources was facilitated by the collection of bulk samples from several known sources of fugitive dust within the region. These crustal materials were resuspended in the laboratory environment and chemically analyzed to create fingerprint profiles for each source, representative of particles that could be suspended as PM10 (particles with an AD less than 10 μm) and PM2.5. These source signatures were compared to the source profiles generated by PMF modeling for validation of the modeled results."

This depth of analysis was not reached during the development of this SIP. Therefore, the percentages reflected for the Cowtown Design Day are inflated, biased or flawed. Given the questionable nature of the SIP's numbers for Cowtown coupled with the legal impediments to continuing to monitor PM10 at the site, this design day needs to be scrapped and focus on the Stagnation Day at Stanfield needs to be brought to the forefront.

Summary

In addition to the above mentioned concerns, ACFA has concerns regarding other categories which have been inflated due to bias or intent on the part of certain Pinal County personnel. It is possible that this SIP process has been skewed to the intent of the County's regulatory personnel's personal bias – not science. The clear and complete science contained in the County's 2003 and 2009 Source Apportionment studies are more complete, conducted in a timelier manner and are without bias as the process was conducted with a chemical fingerprint analysis. The data reflected in these two studies seems to be lacking in the final analysis of this SIP.

Also, the ACFA supports the comments submitted by the Arizona Farm Bureau Federation.

Sincerely,

Basilio F. Aja
ACFA Executive Vice President

CC: Pinal County Board of Supervisors
Senator Steve Pierce
Senator Gail Griffin
Representative Brenda Barton
Representative Frank Pratt
Kevin Kinsall, Governor's Office

ADEQ
Arizona Department of Environmental Quality

Air Quality Division
Speaker Slip

SPEAKER SLIP

Date: 12/9/13

Speaker Slip No. 2

Name: Ana Kennedy

Representing: Arizona Farm Bureau

Mailing Address:

- [x] I wish to make an oral statement.
- [x] I have submitted written comments.
- [ ] I will submit written comments at a later time.

Subject:

Arizona Farm Bureau Federation

December 9, 2013

Lisa Tomczak
Air Quality Division, State Implementation Plan Section
Arizona Department of Environmental Quality
1110 W. Washington St.
Phoenix, AZ 85007

Re: Proposed Arizona State Implementation Plan Revision for the West Pinal County PM10 Nonattainment Area for 1987 24-Hour Particulate Matter (PM10) National Ambient Air Quality Standards

Thank you for the opportunity to provide comments regarding the State Implementation Plan for the West Pinal County PM10 Nonattainment Area. The comments below highlight the issues that the Arizona Farm Bureau believes should be addressed and considered to ensure that the assumptions made for PM10 emissions modeling are valid.

Comments:

3.1.4 Unpaved Road Fugitive Dust Emissions
Measurements Used to Characterize Unpaved Road Emission Factors in the Pinal County PM10 Nonattainment Area (Table 3-30)
Mean Speed
Assumptions for a number of the mean speeds used for the Unpaved Road Fugitive Dust Emissions calculations are underestimated, in particular for Public Dirt Roads B through E. The Analysis of Unpaved Roads in Pinal County PM10 Nonattainment Area states, "The proposed speeds represent estimated average speed for the class of road." Given the average daily trip (ADT) data that corresponds to miles per hour (mph) for each class of road and the Arizona Department of Transportation (ADOT) data provided on page A-11 of the same analysis, average vehicle speeds range from 34.1 mph to 40.5 mph for roads with average ADTs ranging from 118 to 646. The miles per hour for Class B, C, and D roads should be increased to 40 mph to accurately reflect driving speeds on county unpaved roads.

Silt Content
The PCAQCD's analysis of unpaved roads (Appendix 1) was very small for such a large non-attainment area. The silt content data they collected had an average value of 20.2%, while the ADEQ analysis (Appendix 2) involved a greater number of samples and had an average value of 11.9%. The emission inventory calculations are based on the Pinal County Analysis in Appendix 2 (pages 2-10 and 2-11), which

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www.azfb.org

combines the ADEQ analysis with two additional studies- the PCAQCD's analysis and one done by the ADOT which only analyzed county maintained unpaved roads. Adding the higher silt content values from the PCAQCD analysis skewed the average silt content percentage higher for unpaved agricultural apron roads and agricultural fields. The average silt content percentage for private unpaved roads remained the same, as no additional samples were added to ADEQ's analysis and remained unchanged for county maintained unpaved roads as well, since the added data was similar in nature to that of ADEQ's (included ADOT's analysis). Adding the PCAQCD analysis to ADEQ's study only serves to inflate the average soil content percentage for agricultural apron roads and fields due to the small sample size used in the PCAQCD analysis for such a large nonattainment area, that in addition only reflects higher soil content percentages. The emission inventory should use the silt content data collected by ADEQ as reflected in Table 6 (Statistical Analysis of the Four Sample Types) in Appendix 2 (page 2-8).

Total Length (miles) of Each Type of Unpaved Roads Used for Each Modeling Doman in the Unpaved Road Emissions Calculation (Table 3-33)
Given the much smaller area of the High Wind Day, Low-Wind Hour Modeling Domains as compared to the Low-Wind Modeling Domain, how is it possible that there would be nearly the same number of agricultural unpaved roads for each domain? For example Stanfield Low-Wind Modeling Domain shows 297.8 miles and the Stanfield High Wind Day, Low-Wind Hour Modeling Domain shows 290.2 miles, yet the latter domain is significantly smaller and contains a fraction of the roads. The miles should be revised to accurately represent the miles of unpaved agricultural roads in each domain.

3.2 High Wind Fugitive Dust Methodology:
Disturbance Level for Non-Agricultural Land Used in Pinal High Wind Annual Emission Inventory (Table 3-39)
What is the justification for Unpaved Roads (Private Dirt, Ag Road, and Trail) having 100% disturbance and 0% stabled disturbance levels while Unpaved Public Roads has a 75% to 25% disturbance to stable breakdown? It seems at the very least the 75% to 25% percent breakdown should apply to all unpaved roads.

5.2 High Wind Emission Inventory - High Wind Inventory- Agricultural windblown emissions
Crop Disturbance levels (Table 5-18)
The 83.3% disturbance level for Forage seems rather high especially given that alfalfa is included in this crop type. Although alfalfa is harvested throughout the year, as noted on page 104, "dense vegetative cover produced by alfalfa eliminates windblown dust throughout the year..." (3.2 High Wind Fugitive Dust Methodology). The methodology for determining disturbance levels across the year should be revised to account for crops such as alfalfa which maintain vegetative cover even in times of harvest.

5.1.4 Fugitive Dust Emissions from Unpaved Roads
Pinal County Inputs to AP-42 Equation fro Unpaved Roads (Table 5-8)
Page 127 references Table 5-8 twice. The second statement, "The speed, ADT, and total mileage for each subcategory are identified in Table 5-8." However Table 5-8 on page 128 does not contain the referenced ADT or the mileage data, in particular the breakdown for the agricultural subcategories- operations, inspection, and harvest. Please provide the missing data to allow for a more complete review of this section.

Conclusion:

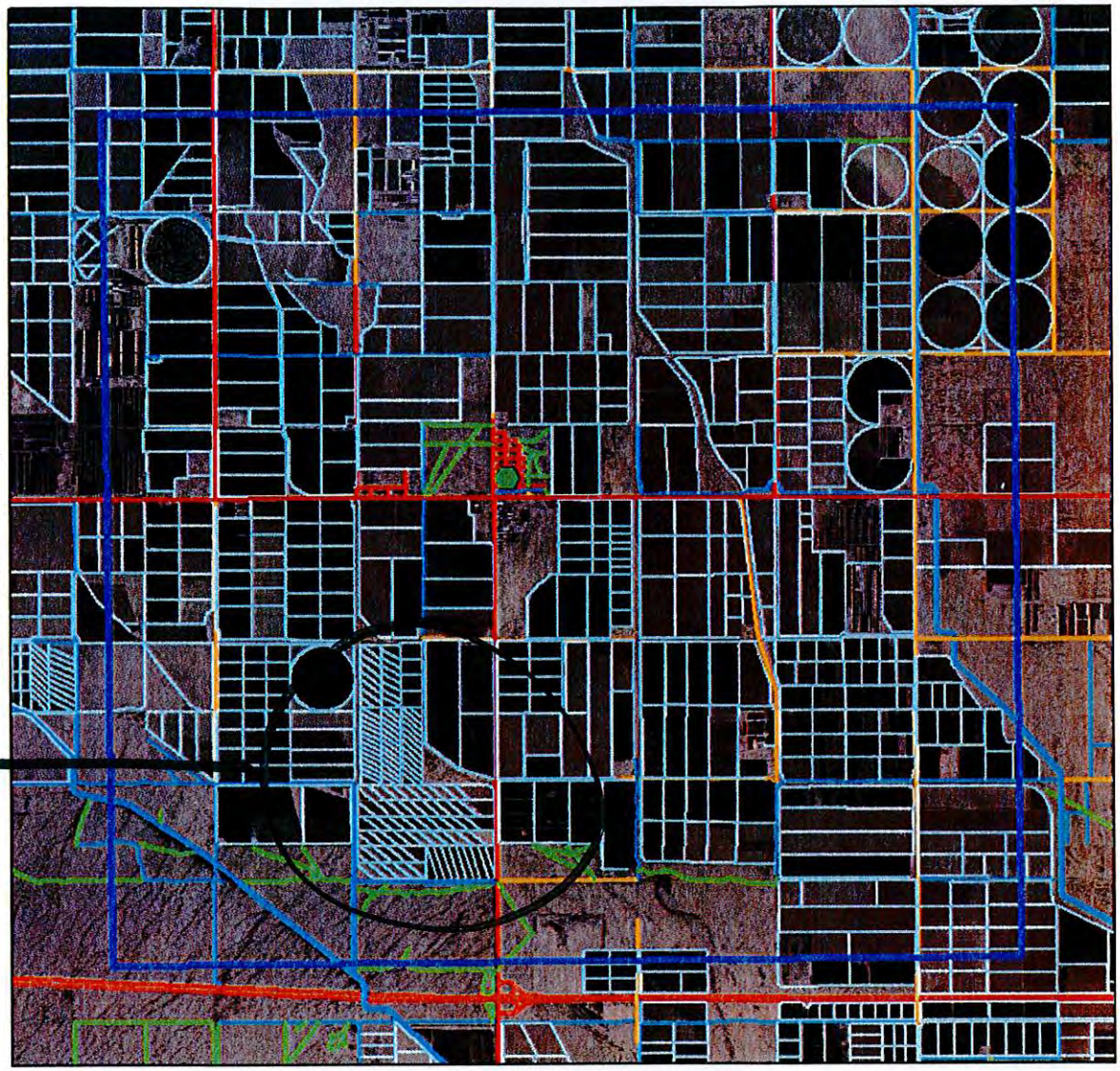
Among all the other sources emitting PM10, there is no doubt that farming and other agricultural activities creates dust. The food and fiber we depend on cannot be grown without disturbing the soil to some degree. However because the level of disturbance and emissions must be calculated for this nonpoint source "pollutant," the state implementation plan and emissions inventory must be developed with the most accurate data and valid assumptions. The comments contained herein are suggested improvements to those assumptions and calculations.

The Arizona Farm Bureau has worked closely on this issue with other industry partners and fully supports the comments submitted by the Arizona Cattle Feeders Association.

Sincerely,

Ana M. Kennedy,
Government Relations Manager

Stanfield Stagnation Day Roads



Please verify if these are in fact agricultural apron roads.

Legend

STF_Stagnaion

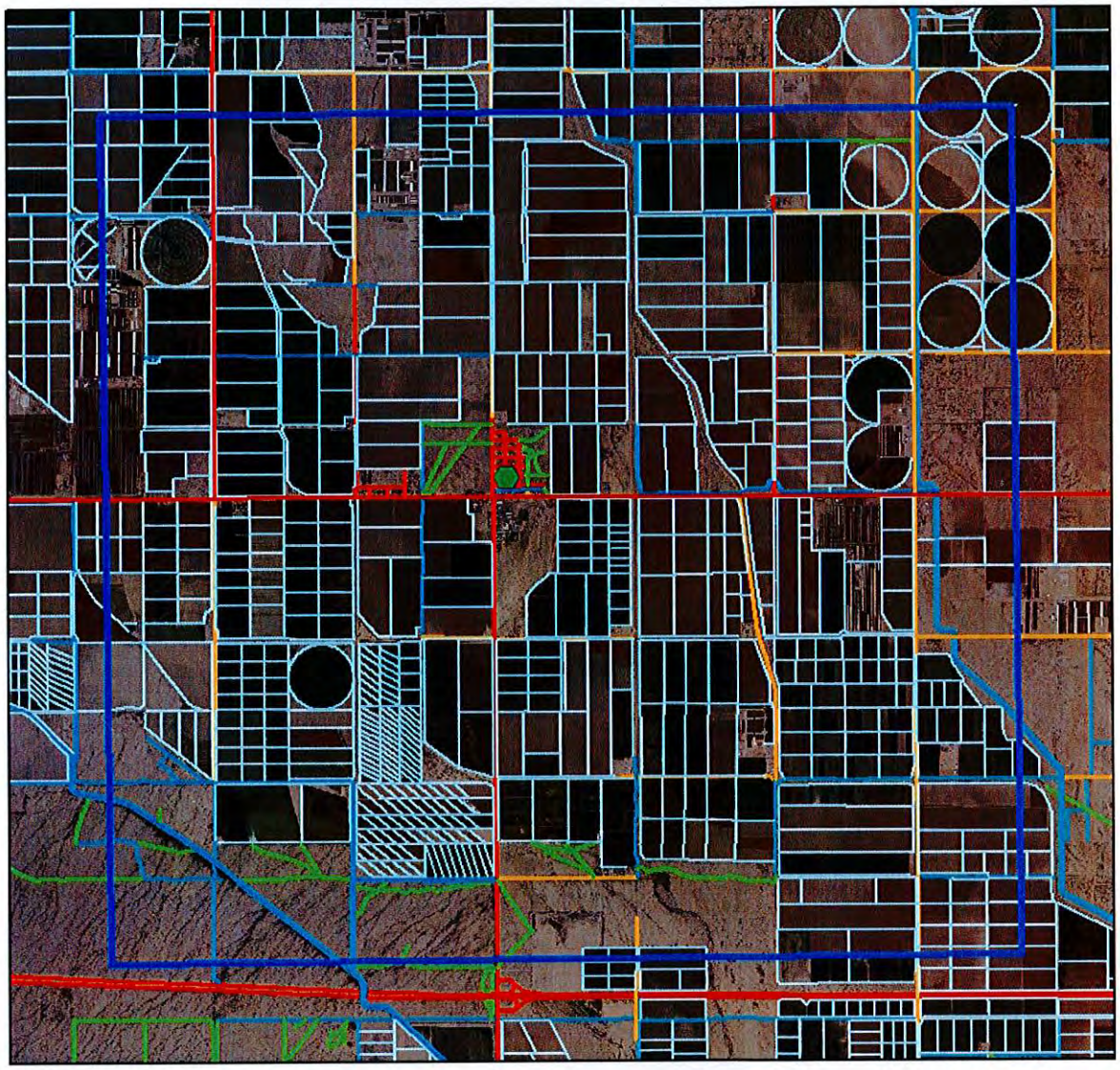
D_SURFACE

- PAVED
- COUNTY MAINTAINED DIRT
- PRIVATE DIRT
- AGRICULTURE 297.8
- TRAIL
- RAILROAD

0 0.5 1 2 3 4 Miles

ADEQ
Arizona Department of Environmental Quality

Stanfield Stagnation Day Roads



Legend

STF_Stagnaion

D_SURFACE

- PAVED
- COUNTY MAINTAINED DIRT
- PRIVATE DIRT
- AGRICULTURE 297.8
- TRAIL
- RAILROAD

0 0.5 1 2 3 4 Miles

ADEQ
Arizona Department of Environmental Quality

ADEQ
Arizona Department of Environmental Quality

Air Quality Division
Speaker Slip

SPEAKER SLIP

Date: 12/11/13

Speaker Slip No.

Name: Phillip Fargotstein

Representing: VW Group of America, Inc.

Mailing Address: Fennemore Craig, PC
~~20~~ 2394 E Camelback Road Suite 600
Phoenix, AZ 85016 7429

☐ I wish to make an oral statement.

☒ I have submitted written comments.

☐ I will submit written comments at a later time.

Subject:

318899

ADEQ
AIR QUALITY DIVISION
13 DEC -9 PM 12: 17

FENNEMORE CRAIG, P.C.

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December 6, 2013

Via Electronic Mail
Tomczak.lisa@azdeq.gov

Lisa Tomczak
Air Quality Division
State Implementation Plan Section
Arizona Department of Environmental Quality
1110 W. Washington Street
Phoenix, AZ 85007

Re: PM-10 Non-Attainment State Implementation Plan for Western Pinal County

Dear Ms. Tomczak:

We are writing on behalf of Volkswagen Group of America, Inc. ("VW"), which owns and operates a vehicle test facility), at 17169 North Murphy Road, Pinal County, Maricopa, Arizona (the "APG"). The APG is located within that portion of Western Pinal County, which has been designated by EPA as non-attainment for PM-10. On November 9, 2013, the Arizona Department of Environmental Quality ("ADEQ") published a notice of a 30-day public comment period and public hearing on the Proposed Arizona State Implementation Plan ("SIP") Revision For The West Pinal County PM-10 Non-Attainment Area for 1987, 24-hour Particulate Matter (PM-10) National Ambient Air Quality Standards ("the "Proposed Non-Attainment SIP"). The notice indicated that the public comment period would extend through 5:00 p.m., on December 9, 2013. The notice also provided that there is a public hearing scheduled for 2:00 p.m., on December 9, 2013, at ADEQ concerning the Proposed Non-Attainment SIP. The following comments are submitted on behalf of VW and the APG. VW understands that the current public comments period is focused on the emissions inventory and that additional opportunities for public comments will be available for any proposed controls. VW submits the following comments to educate ADEQ concerning unique issues affecting vehicle test facilities in Pinal County.

APG BACKGROUND

History: VW first began vehicle testing in Arizona in 1979 and moved to the North Murphy Road location in 1992. Since then it has made significant investments in infrastructure at the APG. VW has designated the APG as (1) the primary hot weather test site for all VW affiliates worldwide (which includes, but is not limited to, VW, Audi, Bentley, Porsche, Lamborghini, Bugatti, Ducati and VW Commercial Vehicles).

The APG consists of approximately 1600 acres and includes both outdoor and indoor test evaluation facilities. These include, among other things, a high-speed paved oval, interior prototype dust oval and an off-road vehicle integrity/durability test track, miscellaneous maintenance roads, and undisturbed scrub land areas. The APG employs more than 200 permanent personnel and hosts more than 1500 visiting engineers and technicians from VW operations worldwide, while tests are conducted on vehicles and products. Many of the permanent APG employees live in the local (Pinal County) area and/or are members of the local Indian communities. APG's financial contribution to the Pinal County economy is significant.

APG Air Quality Permit: The APG is currently operating under an air quality permit issued by the Pinal County Air Quality Control District. The APG is in compliance with all permit terms and conditions. In addition to complying with the permit, the APG has instituted its own dust control plan to control and reduce PM-10 emissions but still allow necessary vehicle testing to be conducted.

VW submits that the Proposed Non-Attainment SIP should take into consideration the activities at the APG, as well as similar activities at other automotive proving grounds in Pinal County such as NISSAN, which are critical to allowing such facilities to remain viable.

PROPOSED NON-ATTAINMENT SIP EMISSIONS INVENTORY

1. Population Assumptions: The draft emissions inventory contains summaries of the Pinal County economy. (Draft SIP, p. 10-11.) It is unclear whether the APG facility fits within the population categories set forth in the draft emissions inventory. As previously discussed, the APG employs 200 full-time personnel that live and work in Pinal County and adjoining Indian reservations and hosts an additional 1500 seasonal personnel in connection with the testing of vehicles. It is unclear which category was intended to cover the APG, if any. VW is concerned that the APG's contribution to the employment base for Pinal County has not been properly acknowledged or included in the analysis. The APG submits that it should be included in Table 1.4 to the extent the fulltime and part-time employment statistics have not already been included. It is further suggested that the most logical category for the APG would be "Manufacturers" since the testing conducted at the APG is part of the research and development ("R&D") and manufacturing process of the vehicles.

2. Emission Sources: Based upon geographical location, the Cowtown monitor is the closest monitor to the APG and is located approximately 1.75 miles southwest of the APG. The draft emissions inventory identifies several monitors and categories of emission sources. The Cowtown monitor includes the following categories of emissions source categories at Figure 4.1 relating to Stagnation Day Emissions: Paved road (1.91%), unpaved ag. Road (4.7%), unpaved road public road (8.1%), unpaved road tribal road (1.3%), and others (2.7%).

By comparison, the High Wind Cowtown monitor (Figure 4.7) includes the following emission source categories: Unpaved ag. road (6%); unpaved road public dirt (8%); unpaved road private dirt (2.7%); construction (2.3%); desert scrub land, non-tribal (18.9%); desert scrub land tribal (5.1%); agriculture county (39.7); others (1.7%); developed urban lands (_____%); CAFOs (7.7%).

Based upon the foregoing, it appears that the emissions inventory is premised upon the conclusion that the APG does not contribute to the Stagnant Air modeling (due to the absence of any private dirt road category), but may be considered an emissions source with respect to the High Wind modeling (in view of the private dirt road category). The emissions inventory does not identify what portion, if any, of the private dirt road category is attributed to the APG and, in particular, the dirt test tracks, or the other on-site maintenance roads. VW submits that in view of the PM-10 Rose (Figure 2-3) set forth in the emission inventory and the relative location of the APG to the Cowtown monitor, the APG contribution to the High Wind modeling for the Cowtown monitor is insignificant. This is inconsistent with the statement in Appendix A that the PM-10 Rose Plot at Figure 2-3 "shows that the prevailing winds at Cowtown are from the southeast, with the southwest quadrant contributing the highest fraction of wind hours." (Appendix A, p. 13.) The APG is northeast of the Cowtown monitor.

APG TESTING

As part of the vehicle test evaluation process, vehicles are subjected to outdoor tests to determine dust infiltration and durability. This requires vehicles to be run on the following outdoor test tracks:

Perimeter Dirt Test: Vehicles are required to traverse the dirt test track within the bounds of the APG to test and measure dust infiltration to verify design and highlight additional product improvement requirements.

Interior Prototype Dust Oval: Test vehicles are also subject to dust infiltration integrity testing using this open test track.

Off-Road Vehicle Integrity/Durability Test Track: As part of the durability and integrity testing of the vehicles on this off-road course, dust accumulation and impact on vehicle component parts are measured.

The above testing cannot be conducted inside. Some dust is created during vehicle testing. VW is concerned that any Non-Attainment SIP should take into consideration the need to conduct such testing in order to preserve the viability of the APG and avoid any unintended consequences.

APG PROPOSED PROVISIONS

Recognizing the need to address PM-10 and the need to ensure that the APG and other automotive proving grounds in Pinal County such as NISSAN can remain viable and continue to contribute to the Pinal County economy, VW submits it would be appropriate to include provisions in the Proposed Non-Attainment SIP addressing the unique nature of the APG. In particular, VW requests that provisions similar to those contained in the Maricopa County PM-10 non-attainment SIP be included in any Western Pinal County PM-10 Non-Attainment SIP. In particular, VW requests that provisions relating to opacity and stabilization be included in the Western Pinal County Non-Attainment SIP similar to the following:

1. Opacity: Maricopa County Air Pollution Control Regulation Rule 310 relating to dust-generating operations was amended in 2010 concerning vehicle test development facilities and operations. Section 303.2(c) contains the following opacity provision for vehicle test facilities:

> **Vehicle Test and Development Facilities and Operations:**
>
> The visible emissions limit described in Section 303.1(a) [20% opacity] of this rule shall not apply to vehicle test and development facilities and operations when dust is required to test and validate design integrity, product quality, and/or commercial acceptance, if such testing is not feasible within enclosed facilities. However, all areas used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized after such testing, in compliance, with Appendix C (Fugitive Dust Test Methods) of these rules. All areas not used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized, in compliance with Appendix C (Fugitive Dust Test Methods) of these rules. In addition, vehicle test and develop facilities may require a Dust Control permit in accordance with Section 302 of this rule.

Stabilization: Rule 310, Section 304.4, was instituted at the same time as the foregoing provision and relates to stabilizing unpaved surfaces. That section provides as follows:

> **Vehicle Test and Development Facilities and Operations:** No stabilization requirement shall apply to vehicle test and development facilities and operations when dust is required to test and validate design integrity, product quality, and/or commercial acceptance, if such testing is not feasible within closed facilities. However, all areas used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized after such testing, in compliance with Appendix C (Fugitive Dust Test Methods) of these rules. All areas not used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized, in compliance with Appendix C (Fugitive Dust Test Methods) of these rules. In addition, vehicle test and development facilities may require a Dust Control permit . . .

The foregoing provisions relating to vehicle test development facilities were submitted to and approved by EPA on December 15, 2010. 75 Fed. Reg. 78167.

EPA and ADEQ recognized that the more stringent opacity and stabilization requirements needed in Maricopa County to ensure compliance with the Clean Air Act in response to PM-10 non-attainment status required special consideration to be given to vehicle test facilities, which, by their nature, require the generation of dust for product testing. The two provisions referenced above are intended to ensure that vehicle test facilities contribute towards the attainment goal, while at the same allowing those test facilities to continue to function as viable facilities. VW requests that similar consideration be given with respect to Western Pinal County Non-Attainment SIP. It should also be noted that the referenced provisions would not apply to other maintenance roads or undeveloped areas at the APG, which would be subject to any Non-Attainment SIP requirements.

CONCLUSION

In view of all the foregoing, VW requests that the Pinal County Air Quality Control District and ADEQ incorporate into any amended Western Pinal County PM-10 Non-Attainment SIP similar provisions relating to vehicle test and development facilities and operations relating to opacity and stabilization requirements.

If you have any questions concerning these comments or would like additional information regarding the APG, please contact the undersigned. VW appreciates the opportunity to submit comments to ADEQ relating to critical issues affecting the continued viability of the APG.

Yours very truly,

FENNEMORE CRAIG, P.C.

Phillip F. Fargotstein

PFF/elp

cc: Director, Pinal County Air Quality Control Department

PFARGOTS/8708202.2/030473.0001

NISSAN

NISSAN NORTH AMERICA, INC.
NISSAN TECHNICAL CENTER
NORTH AMERICA
Arizona Test Center
7815 N. White & Parker Road
Stanfield, AZ 85272
Telephone: 520.421.4100

December 4, 2013

Arizona Department of Environmental Quality
Lisa Tomczak
Air Quality Division
State Implementation Plan Section
1110 W. Washington Street
Phoenix, AZ 85007

Ms. Tomczak:

Nissan North America, Inc. ("Nissan") appreciates the opportunity to comment on the proposed Arizona State Implementation Plan (SIP) Revision for the West Pinal County PM10 Nonattainment Area for the 1987 24-hour PM10 National Ambient Air Quality Standards (NAAQS). Nissan is concerned the potential revision of the Pinal County Air Quality Control District Code of Regulations as proposed in the SIP could create economic challenges for its Arizona Test Center. These comments are intended to suggest appropriate modifications to ensure air quality goals are met, while also ensuring the County encourages and maintains business investments and jobs with its larger employers.

Nissan respectfully requests that the Pinal County Air Quality Control District and the State of Arizona, incorporate into any revised code of regulations for Pinal County similar provisions adopted by Maricopa County exempting vehicle test and development facilities and operations from requirements relating to opacity and dust stabilization.

1. BACKGROUND - NISSAN'S ARIZONA TEST CENTER.

Nissan owns and operates a vehicle test facility known as the Arizona Test Center (ATC) at 7815 N. White & Parker Road, Stanfield, Pinal County, Arizona. Nissan's ATC world class automotive testing facility opened in 1987. Nissan has invested more than $61 million in infrastructure improvements at the facility since 1987. The facility, located on approximately 3,020 acres of land located about 5 miles north of Stanfield, Arizona within the non-attainment area of Western Pinal County provides regular employment for more than 150 people on a regular basis, 60% of which reside in the Pinal County area.

The primary activities at the facility are related to vehicle testing, inspection, maintenance, repair, and disassembly; shipping and receiving; security operations; and general office functions. More than 55% of the site is active agriculture and leased as a farm.

Nissan's ATC facility includes 36 lane miles of asphalt-paved testing roads, 2.5 miles of dirt and/or gravel vehicle test roads, a number of buildings and other associated structures, asphalt-paved parking lots, asphalt-paved driveways and access roads, and dirt access roads. All test roads are contained within the boundaries of the 5.7 mile High Speed Oval test course. A large portion of the facility is under cultivation with a local farmer. The 10-mile perimeter of the facility is fenced with a dirt patrol road inside the fence line. Dirt/gravel access roads are also located throughout the facility and are mainly used for maintenance and security purposes as well as the agricultural activities.

2. VITAL STATISTICS

Nissan's ATC consists of approximately 3,020 acres used for its automotive testing activities.

- Established in 1987.
- 3020 acres, with 10 miles of fence line on the perimeter of the property.
- Approximately 36 lane miles of test roads.
- Total regular employment at the site is +150.
- Visitors to the site average 15 to 100 each day.
- 60% of staff resides locally in Pinal County.
- Testing is conducted 21.5 hours/day, 7 days/week.
- Investments >$61 million in infrastructure site improvements.
- Accumulate approximately 2 million miles annually on the proving ground and 2 million miles on the public roads.

3. Type of vehicle testing performed at Nissan's ATC

- Reliability/Durability (Structural integrity, corrosion, quality, dust intrusion)
- Chassis performance (stability, ride and handling)
- Powertrain (Acceleration, driveability, towing)
- Braking performance (government regulatory requirements)
- NVH (Wind, road, acceleration related noises)
- HVAC (Air conditioning, cooling performance)
- Vehicle Evaluation (General evaluation from customer view)

4. RECENT EPA REDESIGNATION:

Effective July 2, 2012, the United States EPA issued a final determination designating western Pinal County (which includes the Nissan's ATC) from unclassifiable for PM-10 to nonattainment. 77 Fed. Reg. 32024 (May 31, 2012).

This redesignation triggers the requirement under the Federal Clean Air Act for Pinal County and the State of Arizona to review and amend as necessary the Pinal County portion of the State Implementation Plan ("SIP") within 18 months of the redesignation to demonstrate that the western portion of Pinal County can achieve attainment status.

Pinal County and the state have begun the process of identifying and revising portions of the Pinal County Air Quality Control District Code of Regulations, as amended October 13, 2010.

The potential revision of the Pinal County Air Quality Control District Code of Regulations as proposed in the SIP could have adverse consequences for the long term existence of the Nissan's ATC and other automotive proving grounds in Pinal County including Volkswagen, unless an appropriate solution is also incorporated into the revised regulations.

5. CURRENT AIR QUALITY PERMIT:

The ATC is currently operating under Air Quality Permit No. B30952.R01, issued by Pinal County Air Quality Control District on February 13, 2009, revised on February 10, 2011, and currently in the renewal process. Nissan is in compliance with all permit terms and conditions including controlling fugitive dust.

Nissan complies with its air permit as it relates to Particulate Emissions for Controlling Fugitive Dust with reasonable precautions by implementing its own dust control plan to control and minimize PM-10 but still allow necessary vehicle testing to be conducted. The ATC Dust Control Plan includes operator training and certification, specific guidelines to controlling fugitive dust on the unpaved roads, and using recycled asphalt millings for high traffic areas to minimize fugitive dust.

6. POTENTIAL PROBLEM:

The potential problem created by the EPA redesignation for PM-10 is the possibility that the opacity limit will be lowered below 40% as part of the revised SIP provisions. This is based upon the fact that Maricopa County, which also is non-attainment for PM-10, has approved a SIP opacity level of 20%.

Instituting a 20% opacity limit for western Pinal County would have significant adverse effects on the ability of Nissan's ATC to operate as it has for more than 25 years and similarly impact other automotive proving grounds in Pinal County such as Volkswagen with similar operations.

As part of the vehicle test development process, vehicles are subjected to vehicle testing to determine dust infiltration and durability. This requires vehicles to be tested on various test tracks including:

½ mile Gravel Oval test track: Vehicles are required to operate on this test track within the boundaries ATC to test for dust infiltration to be measured to verify, design and highlight additional product improvement requirements; and

Various dirt roads inside the High Speed Oval: Vehicles are required to operate on various dirt roads within the boundaries of Nissan's ATC High Speed Oval to test for dust infiltration to be measured to verify, design and highlight additional product improvement requirements.

None of the above tests can be conducted inside a laboratory environment.

While Nissan's ATC is in compliance guidelines within its air quality permit, any significant change to the current regulatory requirements could jeopardize the ability to fully utilize ATC for vehicle testing.

7. THE MARICOPA COUNTY SOLUTION:

Maricopa County Air Pollution Control Regulation, Rule 310, relates to dust generating operations and was amended in 2010 concerning vehicle test development facilities and operations.

Section 303.2(c) includes the following opacity exemption for vehicle test facilities:

Vehicle Test and Development Facilities and Operations:

The visible emissions limit described in Section 303.1(a) [20% opacity] of this rule shall not apply to vehicle test and development facilities and operations when dust is required to test and validate design integrity, product quality, and/or commercial acceptance, if such testing is not feasible within enclosed facilities. However, all areas used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized after such testing, in compliance, with Appendix C (Fugitive Dust Test Methods) of these rules. All areas not used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized, in compliance with Appendix C (Fugitive Dust Test Methods) of these rules. In addition, vehicle test and develop facilities may require a Dust Control permit in accordance with Section 302 of this rule.

Rule 310, Section 304.4 was instituted at the same time exempting such facilities from stabilizing unpaved surfaces. That section provides as follows:

Vehicle Test and Development Facilities and Operations: No stabilization requirement shall apply to vehicle test and development facilities and operations when dust is required to test and validate design integrity, product quality, and/or commercial acceptance, if such testing is not feasible within closed facilities. However, all areas used to test and validate design integrity,

product quality, and/or commercial acceptance shall be stabilized after such testing, in compliance with Appendix C (Fugitive Dust Test Methods) of these rules. All areas not used to test and validate design integrity, product quality, and/or commercial acceptance shall be stabilized, in compliance with Appendix C (Fugitive Dust Test Methods) of these rules. In addition, vehicle test and development facilities may require a Dust Control permit.

The Maricopa County Air Quality Control regulations exempting vehicle test development facilities were submitted to and approved by EPA on December 15, 2010, 75 Fed. Reg. 78167, as part of the Arizona SIP applicable to Maricopa County.

Maricopa County, Arizona, and EPA recognized that the more stringent opacity and stabilization requirements necessary to ensure compliance with the Clean Air Act in response to PM-10 non-attainment status required special consideration to be given to facilities such as vehicle test facilities, which by their nature require the generation of dust for product testing.

8. CONCLUSION:

The automotive proving grounds owned by Nissan and Volkswagen make up ~0.5% of the total land area classified as non-attainment in Pinal County. This fact and the tried-and-true, proactive implementation of dust control plans at each respective automotive testing proving ground to control fugitive dust have very minimal, if any, contribution to the PM10 and PM2.5 in the County's non-attainment area.

Nissan respectfully requests that the Pinal County Air Quality Control District and the State of Arizona incorporate into any revised code of regulations for Pinal County similar provisions adopted by Maricopa County exempting vehicle test and development facilities and operations from requirements relating to opacity and dust stabilization.

Please contact me at 520.421.4103, if you have any questions or would like to discuss this matter.

Sincerely,

Mike Bourne

Manager, Corporate Services

Cc: Don Gabrielson – Pinal County

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GAME AND FISH DEPARTMENT
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KURT R. DAVIS, PHOENIX
EDWARD "PAT" MADDEN, FLAGSTAFF
DIRECTOR
LARRY D. VOYLES
DEPUTY DIRECTOR
TY E. GRAY

December 9, 2013

Lisa Tomczak
Arizona Department of Environmental Quality
Air Quality Division
1110 West Washington Street
Phoenix, Arizona 85007

Dear Ms. Tomczak:

The Arizona Game and Fish Department (Department) submits the following comments in regards to the proposed Arizona State Implementation Plan (SIP) Revision for the West Pinal County PM10 Nonattainment Area. The Department has an interest in the SIP and has been active in discussions with Pinal County Air Quality Control District for the last few years. The Department's primary interest is to maintain lawful, reasonable public access for the use of motor vehicles in Pinal County (County) for outdoor-related recreation.

As you are aware, there are significant numbers of people who recreate outdoors within the County and ensuring access to these recreational opportunities is a critical part of the Department's mission. There are several hundred thousand acres of rural, undeveloped, and uninhabited lands within the County that are potentially affected by the recommended SIP revision. The area includes portions of several game management units; all with small game and big game hunting opportunities for rabbit, quail, dove, waterfowl, javelina, deer, desert bighorn sheep, and various other species. Critical funding to manage and restore wildlife habitat and wildlife populations is generated directly from the sales of these hunting licenses and big game tags. The anticipated restrictions to motorized vehicle travel on these lands in an effort to gain compliance with national ambient air quality standards may result in an unacceptable loss of hunting and fishing opportunity and subsequent loss of funding for the Department. Furthermore, enacting more restrictive rules, restrictions, and/or ordinances on motorized travel on these lands will result in loss of wildlife watching opportunities and off-highway vehicle recreation, and significantly impact associated economic benefits to local communities within the County.

The Department appreciates involvement in the current stakeholder group and looks forward to assisting in identification, formulation, and analysis of any control measures and/or rulemaking process that may impact outdoor related recreation.

Thank you for the opportunity to submit comments. If you have any questions, please contact Tim Holt, our Wildlife Manager Supervisor in Mesa at (602)-359-1502.

Sincerely,

Rod Lucas
Regional Manager, Region VI

cc: Jim Hinkle, Assistant Director, Field Operations Division
Joyce Francis, Habitat Branch Chief, Wildlife Management Division
Tim Holt, Wildlife Manager Supervisor, Region VI
Kelly Wolff- Krauter, Habitat Program Manager, Region VI

318888

Maricopa County
Air Quality Department

ADEQ
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13 DEC -9 PM 12: 17

Office of the Director
William D. Wiley, P.E.
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Suite 125
Phoenix, Arizona 85004
(602) 506-6443 – desk
(602) 372-6440 – fax

December 6, 2013

Lisa Tomczak, Quality Division
State Implementation Plan Section
Arizona Department of Environmental Quality
1110 W. Washington Street
Phoenix, AZ 85007

RE: Comments on Proposed Arizona State Implementation Plan (SIP) Revision for the West Pinal County PM_{10} Nonattainment Area for the 1987 24-Hour Particulate Matter (PM_{10}) National Ambient Air Quality Standards (NAAQS)

Dear Ms. Tomcazk,

We appreciate the opportunity to follow the development of the State Implementation Plan for the West Pinal County PM_{10} Nonattainment Area. Maricopa County as a neighbor to Pinal County shares a common airshed and, as such, appreciates the efforts to improve air quality.

Maricopa County Air Quality Department (MCAQD) is aware that our work on the 2008 Periodic Emissions Inventory and several related methodologies were used in the development of the SIP, and that many approaches to controlling PM_{10} have been successfully applied in Maricopa County. We anticipate that Pinal County could achieve many of the same results should they choose to employ similar approaches in their nonattainment area.

It is our understanding that this SIP will be submitted to EPA Region 9 by the close of 2013. In addition, Pinal County and stakeholders will continue to discuss control measures and any necessary analyses during the first half of 2014, followed by a SIP revision to be submitted later in 2014. We will continue to assist any way we can in the development of the West Pinal PM_{10} Nonattainment Area SIP and look forward to a plan that will assure improved air quality for both the counties.

We look forward to working with all stakeholders in this process.

Sincerely,

William D. Wiley
Director

Greg Stanley
Assistant County Manager

Development Services

Don Gabrielson
Air Quality Director

PINAL • COUNTY
wide open opportunity

Greg Stanley
Interim County Manager

319157

ADEQ
AIR QUALITY DIVISION
13 DEC 12 PM 12: 17

December 9, 2013

Via 1st Class Mail and Email to Tomczak.Lisa@azdeq.gov

Arizona Department of Environmental Quality
Attention: Lisa Tomczak
Air Quality Division
State Implementation Plan Section
1110 W. Washington Street
Phoenix, AZ. 85007

Ms. Tomczak,

Thank you for the opportunity to review and provide comments on the November 2013 Proposed Arizona State Implementation Plan Revision for the West Pinal County PM10 Nonattainment Area and associated appendices. Please accept the following comments on behalf of Pinal County Air Quality Control District.

Our comments follow.

Sincerely,

/dpg/

Don Gabrielson
Director
Pinal County Air Quality Control District

General Comments

Initially, I congratulate ADEQ on pressing this lengthy and difficult process through to completion. Particularly in view of the sparse or even non-existent day-specific data, the conclusions as a whole reflect a reasonable foundation upon which to build a plan to bring the West Pinal PM-10 nonattainment area back into attainment.

However, the Executive Summary and detailed design day discussions should acknowledge in a straightforward manner that none of the selected design days for wind events and for Cowtown reflect worst-case conditions.

In addition, reasoned conjecture can only conclude that this PM-10 inventory will not be the last for the West Pinal nonattainment area. To facilitate current understanding and future analysis, the Executive Summary should frankly acknowledge in concept the uncertainties that are implicit in the reality that:
- the underlying data is incomplete;
- averaging has been invoked to calculate day-specific data;
- gap-filling and simplifying assumptions have been embraced where deemed necessary;
- and algorithms and methodologies used to calculate the annual emissions rates and the design day source attributions contain their own uncertainties.

For purposes of supporting both current understanding and the long-term nature of this effort the respective sections of the inventory that involve emission calculations and source attribution rates should acknowledge and quantify the range of uncertainty associated with the conclusions of the particular section.

Proposed Arizona State Implementation Plan Revision – West Pinal County PM_{10} Nonattainment Area

Page ii – It appears that the date for the modeled high wind episode day for the Cowtown monitor is incorrect for Figure 4.7. The date should be 4/27/08 rather than 11/21/08.

Page 3 – Table ES-1 – The Pinal County Air Quality Control District's (PCAQCD) fugitive dust rules currently in the State Implementation Plan (SIP) should also be included in this table.

Page 4, section 1.1 Statement of Introduction and Purpose – It appears that an end quote is missing from the word "u nclassifiable" in the first sentence of the section.

Figure 1.1 (pg. 6) and Figure 2.1(pg. 19) – Map of West Pinal County PM10 Nonattainment Area – The County border should be included in the map legend.

Page 7, Section 1.5.1 Geography and Climate, Table 1.1 – Names and Elevations of Pinal County Cities. The footnote to the source appears to be incorrect. The footnote number should be 11 rather than 3.

Page 10, Table 1.4 - Pinal County Civilian Employed Population 16 Years and Over. Perhaps the year of the data in the table can be included in the title of the table.

Page 18, Section 2.1, Paragraph 6 - Pinal County does not operate the ambient monitoring network under a delegation agreement with ADEQ. Pinal County maintains authority under A.R.S 49-473 and

PCAQCD Code 1-1-040 to conduct ambient surveillance. In December of 2013 ADEQ and PCAQCD entered a memorandum of agreement to clarify and define the responsibilities of a Primary Quality Assurance Organization (PQAO). The agreement also implements a mechanism to distribute Pinal County's portion of EPA grant fund for PM2.5 network operations and maintenance.

Page 20, Table 2.1 – The Cowtown Road TEOM (AQS ID 04-021-3013 POC 3) has not been designated as SLAMS. The monitor currently maintains an SPM designation in AQS. (However, please also note that in a letter conveyed on November 20, 2013, the EPA did indicate that the Cowtown monitor should be designated as a SLAMS monitor.)

Page 20 Table 2.1 – The Maricopa Complex TEOM (AQS ID 04-021-3010 POC 3) has not been designated as SLAMS. The monitor currently maintains an SPM designation in AQS.

Page 20, Footnote 29 & 32 – The 2013 Pinal County Network Plan identifies a collocated medium volume PM10 samplers at the Coolidge Maintenance Yard effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

Page 20, Footnote 30 & 33 – The 2013 Pinal County Network Plan identifies a single medium volume PM10 sampler at the Eloy County Complex effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

Page 20, Table 2.1 – The Cowtown Road monitor is Special Purpose Monitor (SPM). The Coolidge Maintenance Yard and Eloy County Complex monitors are High Volume monitors. Perhaps the Maricopa Complex monitor site name could be changed to City of Maricopa Complex.

Page 21, Section 2.2 PM_{10} Data Summary – Figure 2.2: Three-Year Average Expected Rate of Exceedances. The Pinal County site should actually be named Pinal County Housing. The 2011 and 2012 expected rate of exceedances appears to be missing for Stanfield, City of Maricopa and Pinal County Housing.

Page 21, footnote 31. There have been no EPA concurrences on flagged PM_{10} exceptional events in the West Pinal PM_{10} Nonattainment Area.

Page 22, Table 2.2: 2010 to 2012 Maximum 24-Hour Average PM10 Compliance – Continuous PM10 TEOM – Site ID numbers should be included in this table. In addition, the following should be corrected in the table.

- Pinal County Housing 2010 Maximum 24-hr average PM_{10} should be 1,761 ug/m^3
- Pinal County Housing 2011 Maximum 24-hr average PM_{10} should be 2,040 ug/m^3
- Casa Grande Downtown 2012 Maximum 24-hr average PM_{10} should be 233 ug/m^3
- Pinal County Housing 2012 Maximum 24-hr average PM_{10} should be 542 ug/m^3

Pages 25-32 Tables 3.1-3.7 – Formatting suggestion – have either a double line or thick line between the PM_{10} Observation (ug/m^3) column and the emissions source categories (lbs/hour) column. In addition, the inclusion of units (lbs/hour) to the "Tot al" column heading may be useful to alleviate any confusion over comparison between the total emissions (lbs/hour) and Average PM_{10} observation (ug/m^3).

Page 33, Table 3.8 Summary of the 2008 Annual High Wind Emissions in Western Pinal County. It would be useful to have the Unpaved roads split out by type (i.e. public, private) in this table. In addition, PM10 should be added to the table title.

Page 34, Table 3.9 Summary of the 2008 Annual PM_{10} Emissions in the Western Pinal County Nonattainment Area. It would be useful to have the Unpaved roads split out by type (i.e. public, private) in this table.

Appendix A - Inventory Preparation Plan

Page F-1. Table F1. Statistics of the PM10 High Wind Exceedance Days at Maricopa in 2008. The table should be sorted by PM_{10} concentration similar to the other tables in Appendices C & D along with similar color coding.

Page G-1, Table G1. Statistics of the PM2.5 Exceedance Days at Cowtown in 2008. The table should be sorted by $PM_{2.5}$ concentration similar to the other tables in Appendices C, D and F along with similar color coding.

Appendix B, Volume 1 - Emissions Inventory

Page 30, Table 3-4: Crop Distribution for Stagnation Design Day Modeling Domains. A row should be added for totals of the crop distribution by modeling domains.

Page 89, 2nd paragraph from top of page. Should not the increase in unpaved road emissions range be in percent? "...(ranging from 0.17-0.24 for unpaved roads)."

Page 92, Construction emissions - Please add more description about the overall construction control effectiveness. Since the overall control effectiveness for construction is 54%, does that mean that 46% of the land area associated with construction is assumed to be disturbed? That's important for quantification of windblown PM_{10} emissions/source attribution. In addition, since Pinal's construction registration program grew from the historic understanding that activity-related emissions were the principal cause of construction-related PM-10, it is not clear how the compliance data from administration of that program was used to calculate disturbance/stabilization rates. Further explanation would be valuable in attempting to define what additional measures may be required to achieve reductions in wind-blown PM-10 associated with construction sites.

Page 92, Section 3.1.9 - Permitted Source Emission Methodology -

The discussions in section 3.1.9 talk about NEI data and Pinal County Air Quality permitted Potential To Emit (PTE) data. Pinal County Air Quality annually collects data from all permitted sources based on actual process throughput. This information is used to create emission inventory data. The 2008 actual data supplied by Pinal County Air Quality should be used in this modeling since the purpose is to reflect what actually occurred. If the objective was to look at worst case scenarios the PTE data would be appropriate, but that is not the function of an emission inventory.

Page 93, Cowtown Monitoring Station -

The following stationary sources area also in the low wind modeling domain. Nissan Technical Center, aka Arizona Test Center, Volkswagen Group of America, aka Arizona Proving Grounds.

The Nissan permit lists a PTE for PM10 from unpaved roads as 1.3 LBS/HR and 5.5 TPY along with paved roads as 2.1 LBS/HR and 9.0 TPY. Unfortunately the annual report for this source does not ask for usage information related to the roads and thus 2008 actual PM10 emission information is not available at this time. The source might be able to provide estimates that could be used to produce 2008 actual emissions.

The Volkswagen permit does not quantify the area source emissions from paved and dirt roads. The permit lists emissions from fuel storage and thus the 2008 actuals only list VOCs.

The Phoenix Regional Airport is also in the Cowtown low wind modeling domain.

The following stationary sources near the Phoenix Regional Airport are in the low wind modeling domain:

- Alpha Tech Coatings - 2008 PM10 actuals of 0.003 tons reported
- Arizona Castings -2008 PM10 actuals of 4.82 tons reported
- Mobile Mini - 2008 actuals report HAPs and VOCs only
- SH Engineering - 2008 actuals report VOCs only

Pinal Energy 2008 PM10 actuals as reported based on throughput are 7.92 TPY.

Reliant Processing is a CO2 plant and does not list any PM10 emissions. The permit accounts for HAPs and VOCs.

Please provide supporting detail for the analysis and conclusions described in the following section located in the third paragraph of the Cowtown Monitoring Station section:

"Review of the Arizona Grain/Eagle Milling permit indicated that two stationary sources at this facility emitted the majority of PM10: the railcar unloading shed, and the airsweep systems that exhausted suspended PM10 from the railcar and truck unloading sheds. Permit conditions allow for lower-than-average capture and control efficiencies for systems installed to reduce PM10 emissions from these sources. Using these permitted capture and control efficiencies, PM10 emissions were calculated to be higher than the estimates reported in the permit."

Regarding the entire third paragraph in the Cowtown Monitoring Station - 2008 PM10 actual emissions based throughput were reported to be 14 TPY. The calculations should use the estimated actual emissions that are based on throughput.

Regarding the Pinal Feeding permit paragraph - 2008 actual PM10 emissions based on throughput are reported as 74.9 TPY.

Regarding the Scotts Company paragraph - The 2008 actual PM10 emissions are available and are reported as 3.4 TPY based on throughput. In addition, please provide additional detail on the following analysis.

Page 103, Table 3-41 - Disturbance Assumptions for Agricultural Lands Identified in Cotton Research and Protection Council Shapefile for High Wind Modeling Domains. The static 0.7 (i.e. 70%) vegetative cover assumed for cotton seems arbitrary considering the design days used for modeling cover various times of the year (January, November, April and October). Therefore Vegetative cover varies dramatically over different times of the year (i.e. different design days), therefore a blanket 0.7 vegetative cover fraction doesn't appear to reflect the dynamic agricultural reality.

Page 103, Table 3-41 – Please add a footnote as to where the rainfall measurements used in Table 3-41 were taken from.

Page 104, equation used to calculate windblown dust emissions for disturbed agricultural land. It appears that the vegetative cover portion of the equation may be incorrect. Should not the vegetative cover in the equation be (1-V')? For example, cotton is assumed to have a blanket 0.7 (i.e. 70%) vegetative cover and in the equation as it stands in the draft document the windblown dust emissions from disturbed agricultural lands would include multiplication of 0.7 for cotton, as if 70% of the ag land was disturbed. Also, an example calculation would be useful.

Page 104 – There appears to be an erroneous reference to details in Appendix 7 for $EF_{Disturbed,\ bin}$ (Windblown dust emission factor developed for disturbed soil for that wind speed bin). There does not appear to be any Appendix which includes details on the windblown dust emission factor. Therefore details on this particular emission factor seems to be missing from the draft documentation.

Page 105 – The same comment as above goes for $EF_{Stable,\ bin}$.

Page 105. Is the Emission Adjustment factor parameter in the windblown dust emissions from stable agricultural land equation the same as the reservoir depletion factor used in the disturbed agricultural windblown dust equation?

Page 112, Table 4-3 - Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at PCH on 10/29/2008. Is the permitted point sources emissions contribution (13.6%) mainly due to the cotton gins PTE? If so, that value may be over-stated. See the discussion above regarding actual emission data.

Page 113, Figure 4-1 - Summary of Stagnation Design Day Source Distribution by Modeling Domain. The pie charts in this figure appear to be missing the label for each respective monitoring site.

Page 114, Table 4-4 - Emissions Inventory (lbs/hour) for the High wind Day at PCH on 1/1/2008. The 10 on PM10 needs to be changed from superscript to subscript.

Page 118, Figure 4-2 - Summary of High Wind Design Day Source Distribution by Modeling Domain. The pie charts in this figure appear to be missing the label for each respective monitoring site.

Page 135, footnote 111 – The exclusion of days where moisture levels exceeded 0.01" of rainfall from the hourly counts is arbitrary. There have been days with rainfall totals over 0.01" where monitors have exceeded (i.e. 9/3/09, 12/7/09, 12/22/09, etc.).

Page 136, Second paragraph under Agriculture – The sentence " 10 periods with no activity were coded 0% activity." The sentence should probably include the word " day" prior to the word periods (i.e. 10 day periods with no activity....).

Page 138, Table 5-19 Summary of the 2008 Annual High Wind Emissions in Western Pinal County. Please include examples of sources in the "Other " land use category.

Appendix B, Volume 2 – Emissions Inventory

Page 9-4, Appendix 9 – The word acre appears to be missing from the following sentence in the first paragraph. "The total estimated mileage of Ag roadways in a 1,334 farm....".

Page 9-4, Appendix 9, Alfalfa Harvesting – Where did the 1,334 acre average farm size come from? In the 2008 Arizona Annual Agricultural Statistics Bulletin on page 22, the average farm size in Arizona is listed as 1,673 acres (source: http://www.nass.usda.gov/Statistics_by_State/Arizona/Publications/Bulletin/08bul/pdf/pg22.pdf).

RESPONSIVENESS SUMMARY
Comments Taken at the Public Hearing and Written Comments Received on the Proposed Arizona State Implementation Plan Revision for the West Pinal County PM_{10} Nonattainment Area for the 1987 24-Hour Particulate Matter National Ambient Air Quality Standards

The Arizona Department of Environmental Quality has made revisions to state implementation plan revision to reflect grammatical and editorial errors.

General Comments

(1) Comment: Since statistics were obtained and documented as of 2008, there has been a considerable amount of changes that have taken place within the nonattainment area that has not been documented on the proposal to the EPA. It is important to identify these changes since 2008 and note them on the proposed report to the EPA.

(Comment submitted by Lou Snow Consulting during the public hearing and hard copy.)

Response: The Arizona Department of Environmental Quality (ADEQ) recognizes the changes that have taken place between the current year and the base modeling year of 2008. ADEQ will model the appropriate changes when performing future year modeling. When this modeling is submitted, ADEQ will provide a list of the changes that have occurred since 2008.

(2) Comment: The Maricopa County Air Quality Department (MCAQD) is aware that work on the 2008 Periodic Emissions Inventory and several related methodologies were used in the development of the SIP, and that many approaches to controlling PM_{10} have been successfully applied in Maricopa County. MCAQD anticipates that Pinal County could achieve many of the same results should they choose to employ similar approaches in their nonattainment area.

(Comment submitted by the Maricopa County Air Quality Department.)

Response: ADEQ appreciates the assistance that MCAQD has provided during development of this SIP submission and looks forward to continuing to work with the County as necessary for future submittals.

(3) Comment: The Arizona Game and Fish Department (Department) has an interest in the proposed SIP for the West Pinal Nonattainment Area and has been active in discussions with Pinal County Air Quality Control District (PCAQCD) for several years. The Department's primary interest is to maintain lawful, reasonable public access for the use of motor vehicles in Pinal County for outdoor related recreation. The anticipated restrictions to motorized vehicle travel on these lands in an effort to gain compliance with national ambient air quality standards may result in an unacceptable loss of hunting and fishing opportunity and subsequent loss of funding for the Department. Furthermore, enacting more restrictive rules, restriction, and/or ordinances on motorized travel on these lands will result in loss of wildlife watching opportunities and off-highway vehicle recreation, and significantly impact associated economic benefits to local community within the County. The Department appreciates the opportunity to participate in the stakeholder process and will assist in identification, formulation, and analysis of any control measures and/or rulemaking process that may impact outdoor related recreation.

(Comment submitted by the Arizona Game and Fish Department.)

Response: Currently, ADEQ is not proposing any regulations that would limit legal motorized recreation within the nonattainment area. ADEQ understands the position of the Arizona Game and Fish Department and welcomes them to participate in the stakeholder process to ensure that its views and concerns are heard during the development of future SIP submittals.

(4) Comment: Page ii – It appears that the date for the modeled high wind episode day for the Cowtown monitor is incorrect for Figure 4.7. The date should be 4/27/08 rather than 11/21/08.

Response: ADEQ has determined this was a typographical error and has corrected the date.

(5) Comment: Page 3, Table ES-1 – The Pinal County Air Quality Control District's (PCAQCD) fugitive dust rules currently in the State Implementation Plan (SIP) should also be included in this table.

Response: Based on its final rule with an effective date August 31, 2007, the U.S. Environmental Protection Agency (EPA) finalized a limited approval of the PCAQCD fugitive dust rules that were submitted into the SIP. The limited approval applies to the following rules: 4-2-020, 4-2-030, 4-2-040, and 4-2-050. These rules have been included in Table ES-1.

(6) Comment: Page 4, section 1.1, Statement of Introduction and Purpose – It appears that an end quote is missing from the word "unclassifiable" in the first sentence of the section.

Response: ADEQ has corrected the typographical error.

(7) Comment: Figure 1.1 (pg. 6) and Figure 2.1(pg. 19) – Map of West Pinal County PM_{10} Nonattainment Area – The County border should be included in the map legend.

Response: ADEQ has revised the maps to include the county border.

(8) Comment: Page 7, Section 1.5.1 Geography and Climate, Table 1.1 – Names and Elevations of Pinal County Cities. The footnote to the source appears to be incorrect. The footnote number should be 11 rather than 3.

Response: ADEQ has corrected the typographical error.

(9) Comment: Page 10, Table 1.4 - Pinal County Civilian Employed Population 16 Years and Over. Perhaps the year of the data in the table can be included in the title of the table.

Response: ADEQ agrees with the comment and has revised the table.

(10) Comment: Page 18, Section 2.1, Paragraph 6 – Pinal County does not operate the ambient monitoring network under a delegation agreement with ADEQ. Pinal County maintains authority under A.R.S 49-473 and PCAQCD Code 1-1-040 to conduct ambient surveillance. In December of 2013 ADEQ and PCAQCD entered a memorandum of agreement to clarify and define the responsibilities of a Primary

Quality Assurance Organization (PQAO). The agreement also implements a mechanism to distribute Pinal County's portion of EPA grant fund for $PM_{2.5}$ network operations and maintenance.

Response: ADEQ has verified that Pinal County maintains authority under A.R.S 49-473 and PCAQCD Code 1-1-040 to conduct ambient surveillance. The Memorandum of Agreement (MOA# ADEQ13-033141) between ADEQ and PCAQCD was executed in February 2013. The agreement clarifies and defines the responsibilities of a Primary Quality Assurance Organization (PQAO). ADEQ also verified that the MOA implements a mechanism to distribute Pinal County's portion of EPA grant fund for $PM_{2.5}$ network operations and maintenance.

11) Comment: Page 20, Table 2.1 – The Cowtown Road TEOM (AQS ID 04-021-3013 POC 3) has not been designated as SLAMS. The monitor currently maintains an SPM designation in AQS. (However, please also note that in a letter conveyed on November 20, 2013, the EPA did indicate that the Cowtown monitor <u>should</u> be designated as a SLAMS monitor.)

Response: ADEQ has verified the information and has corrected the designation.

12) Comment: Page 20 Table 2.1 – The Maricopa Complex TEOM (AQS ID 04-021-3010 POC 3) has not been designated as SLAMS. The monitor currently maintains an SPM designation in AQS.

Response: ADEQ has verified the information and has corrected the designation.

13) Comment: Page 20, Footnote 29 & 32 – The 2013 Pinal County Network Plan identifies a collocated medium volume PM_{10} samplers at the Coolidge Maintenance Yard effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

Response: ADEQ has verified the information and has corrected the designation.

14) Comment: Page 20, Footnote 30 & 33 – The 2013 Pinal County Network Plan identifies a single medium volume PM_{10} sampler at the Eloy County Complex effective June 30, 2013. The samplers operate on a 1 in 6 day schedule.

Response: ADEQ has verified the information and has corrected the designation.

15) Comment: Page 20, Table 2.1 – The Cowtown Road monitor is Special Purpose Monitor (SPM). The Coolidge Maintenance Yard and Eloy County Complex monitors are High Volume monitors. Perhaps the Maricopa Complex monitor site name could be changed to City of Maricopa Complex.

Response: The 2013 Pinal County Monitoring Network Plan refers to the Maricopa Complex site as "Maricopa County Complex (City of Maricopa)". ADEQ has revised the site name to reflect the title in Pinal County's monitoring plan.

16) Comment: Page 21, Section 2.2 PM_{10} Data Summary – Figure 2.2: Three-Year Average Expected Rate of Exceedances. The Pinal County site should actually be named Pinal County Housing. The 2011

and 2012 expected rate of exceedances appears to be missing for Stanfield, City of Maricopa and Pinal County Housing.

Response: The 2013 Pinal County Monitoring Network Plan refers to the Pinal County monitor site as the "Pinal County Housing Complex." ADEQ has revised the site name to reflect the title in Pinal County's monitoring plan. ADEQ reviewed the graph and has corrected the error.

17) Comment: Page 21, footnote 31. There have been no EPA concurrences on flagged PM_{10} exceptional events in the West Pinal PM_{10} Nonattainment Area.

Response: The AQS report obtained on May 17, 2013, stated that the data excluded regionally concurred events. ADEQ has insert language to clarify that EPA has not concurred on any exceptional events in the region.

(18) Comment: Page 22, Table 2.2: 2010 to 2012 Maximum 24-Hour Average PM_{10} Compliance – Continuous PM10 TEOM – Site ID numbers should be included in this table. In addition, the following should be corrected in the table.

- Pinal County Housing 2010 Maximum 24-hr average PM_{10} should be 1,761 ug/m^3
- Pinal County Housing 2011 Maximum 24-hr average PM_{10} should be 2,040 ug/m^3
- Casa Grande Downtown 2012 Maximum 24-hr average PM_{10} should be 233 ug/m^3
- Pinal County Housing 2012 Maximum 24-hr average PM_{10} should be 542 ug/m^3

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ has revised Table 2.2 to include Site ID numbers for each monitor. ADEQ has verified that the data for the maximum 24-hour average PM_{10} concentrations for Pinal County Housing in 2010 and 2011 was incorrect and has revised the table.[1] ADEQ does not agree with revising the data for Casa Grande Downtown 2012 and Pinal County Housing 2012. Data obtained through the AQS is consistent with what is provided in Table 2.2.[2]

<u>Unpaved Roads</u>

(19) Comment: The Central Arizona Irrigation and Drainage District and other irrigation districts within the Pinal County nonattainment area have concerns regarding the current inventory formulation, primarily concerning unpaved roads. There seems to be uncertainty as to what counts as an agricultural road and what counts as a public road. There is further uncertainty as to whether canal bank roads and irrigation district maintenance roads were counted as agricultural roads for purposes of the modeling.

The irrigation districts believe that the categorizing of a road as a private agricultural road or irrigation district road should connote control of ingress and egress if they are to be held accountable for implementing best management practices to reduce emissions. Accordingly, if access to these roads cannot be denied and are used by the public, those roads should not be designated as an agricultural or irrigation district road. Based on this, the emissions inventory and modeling should be revised appropriately to reflect any changes in how those roads are classified and ultimately revise the contribution from those source categories to PM_{10} emissions, where necessary. These changes may also

[1] U.S. Environmental Protection Agency, Air Quality System (AQS), Accessed October 17, 2013.
[2] Ibid.

affect the control measure or best management practice implemented by the ultimately appropriate responsible party, as well as, potentially, the overall requirements of the BMP program in Pinal County.

The irrigation districts and agricultural stakeholders need to be provided the opportunity to continue their involvement with revisions to the emissions inventory and modeling of control options. They need to have the opportunity to receive road maps as well as be involved with the discussions regarding how irrigation district and canal bank roads are being classified.

(Comment received from Pivotal Policy Consulting on behalf of the Central Arizona Irrigation District and other irrigation districts located within Pinal County.)

Response: Modeling domain road maps were provided to the Agriculture BMP Committee in pdf format (ADEQ Responses to Ag Committee Information Requests_20131203.pdf') on December 4, 2013, in response to the request made on December 2, 2013. This information was forwarded to the Central Arizona Irrigation and Drainage District on December 11, 2013. ADEQ welcomes the assistance and input from the Irrigation Districts regarding the classification and location of unpaved roads within their jurisdiction. ADEQ commits to revising documentation related to unpaved when more accurate information is received.

(20) Comment: Assumptions for a number of the mean speeds used for the Unpaved Road Fugitive Dust Emissions calculations are underestimated, in particular for Public Dirt Roads B through E. The Analysis of Unpaved Roads in Pinal County PM_{10} Nonattainment Area states, "The proposed speeds represent estimated average speed for the class of road." Given the average daily trip (ADT) data that corresponds to miles per hour (mph) for each class of road and the Arizona Department of Transportation (ADOT) data provided on page A-11 of the same analysis, average vehicle speeds range from 34.1 mph to 40.5 mph for roads with average ADTs ranging from 118 to 646. The miles per hour for Class B, C, and D roads should be increased to 40 mph to accurately reflect driving speeds on county unpaved roads.

(Comment submitted by the Arizona Farm Bureau.)

Response: ADEQ recognizes there is a difference in the Class B, C, and D travel speeds from roadways of similar ADT in the ADOT study, reported on page A-11; however, ADEQ does not feel this small sample ($n < 3$ for any corresponding Class type) is representative of all of the roadways in these Class types located within the Nonattainment Area. Furthermore, the speeds utilized in this study were presented to Pinal County Department of Public Works to assess the representativeness prior to the finalization of the emission inventory. On October 17, 2013, ADEQ received verification from Pinal County Public Works that the speeds assigned to each unpaved road class were reasonable. However, given the impact that unpaved road emissions have in this inventory, ADEQ commits to evaluating this issue further, and will revise the emission inventory as appropriate.

(21) Comment: The PCAQCD analysis of unpaved roads (Appendix 1) was very small for such a large non-attainment area. The silt content data they collected had an average value of 20.2%, while the ADEQ analysis (Appendix 2) involved a greater number of samples and had an average value of 11.9%. the emissions inventory calculations are based on the Pinal County Analysis in Appendix 2 (pages 2-10 and 2-11), which combines the ADEQ analysis with two additional studies, the PCAQCD's analysis and one done by the ADOT which only analyzed county maintained unpaved roads. Adding the higher silt content values from the PCAQCD analysis skewed the average silt content percentage higher for unpaved agricultural apron roads and agricultural fields. The average silt content percentage for private unpaved roads remained the same, as no additional samples were added to ADEQ's analysis and remained

unchanged for county maintained unpaved roads as well, since the added data was similar in nature to that of ADEQ's (included ADOT's analysis). Adding the PCAQCD analysis to ADEQ's only serves to inflate the average soil content percentage for agricultural apron roads and fields due to the small sample size used in the PCAQCD analysis for such a large nonattainment area, that in addition only reflects higher soil content percentages. The emission inventory should use the silt content data collected by ADEQ as reflected in Table 6 (Statistical Analysis of the Four Sample Types) in Appendix 2 (page 2-8).

(Comment submitted by the Arizona Farm Bureau.)

Response: Due to the size of the West Pinal County PM_{10} nonattainment area, ADEQ chose to amend its own unpaved road silt content analysis with other available silt road analyses, including the ADOT and PCAQCD analyses. The combination of the three studies acts to increase the sample size of the silt content analysis to be more representative of the entire nonattainment area. While ADEQ recognizes that the sample size of the ADOT and PCAQCD studies are smaller than that of the ADEQ study, the combination of all three studies only acts to increase the representativeness of the average silt contents calculated in Table 7 (page 2-11) by increasing the total sample size.

(22) Comment: Given the much smaller area of the High Wind Day, Low-Wind Hour Modeling Domains as compared to the Low-Wind Modeling Domain, how is it possible that there would be nearly the same number of agricultural unpaved roads for each domain? For example, Stanfield Low-Wind Modeling Domain shows 297.8 miles and the Stanfield High Wind Day, Low-Wind Hour Modeling Domain shows 290.2 miles, yet the latter domain is significantly smaller and contains a fraction of the roads. The miles should be revised to accurately represent the miles of unpaved agricultural roads in each domain.

(Comment submitted by the Arizona Farm Bureau.)

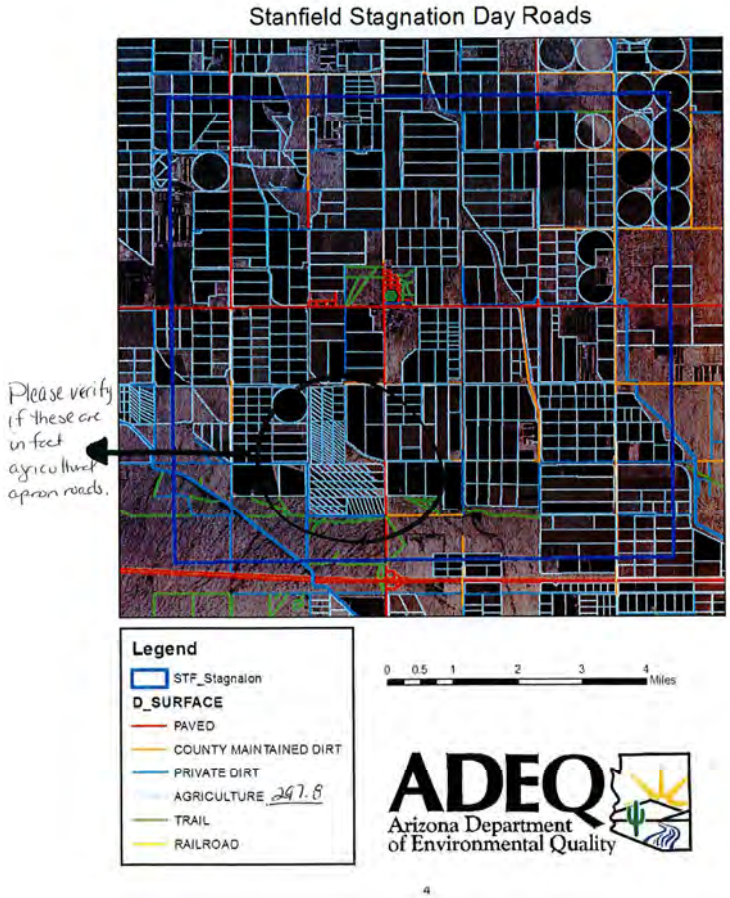
Response: Three separate modeling domains were defined for Stanfield Monitor: (1) Stagnation day domain (Figure 2-11), (2) High wind day, high wind hour domain (Figure 2-4D), and (3) High wind day, low wind hour domain (Figure 2-8C). The stagnation day and high wind day, low wind hour domains are similar. Therefore, the total length of agricultural unpaved roads located within these two domains is similar. ADEQ appreciates the comment but does not agree that the mileage needs to be revised.

The Stanfield monitor is the only monitor with similar unpaved road mileage between the two modeling domains. Comparisons of the Agricultural Unpaved Road mileage within each modeling domain and the total area of each modeling domain are given in the table below.

Area for each modeling domain used in the Pinal PM_{10} emission inventory (Square Miles) with Total Length (miles) of Agriculture Unpaved Roads in each modeling domain given in parentheses		
Monitors	**Stagnation Domain**	**High-Wind Day, Low-Wind Hour Modeling Domain**
Stanfield	38.7 (297.8)	34.53 (290.2)
Pinal County Housing	9.82 (62.8)	18.34 (110.2)
Cowtown	43.83 (162.2)	40.9 (148.2)
Maricopa	NA (NA)	37.85 (83.2)

(23) Comment: Please verify if the roads within the circled area on the map below are in fact agricultural apron roads.

(Comment submitted by the Arizona Farm Bureau.)



Response: ADEQ has confirmed that the circled, diagonal roadways in the image above are categorized as agricultural apron roads. ADEQ also identified the following non-apron roadways within the circled area: Carranza Rd, Peters Rd, Selma Hwy, Stanfield Rd (paved), Canton Way, a canal road, and five trails.

High Wind Fugitive Dust Methodology

(24) Comment: What is the justification for Unpaved Roads (private dirt, ag road, and trail) having 100% disturbance and 0% stable disturbance levels while unpaved public roads has a 75% to 25% disturbance to stable breakdown? It seems at the very least the 75% to 25% breakdown should apply to all unpaved roads.

(Comment submitted by the Arizona Farm Bureau.)

Response: The difference in the selected disturbance values reflects the benefits of known road maintenance activities. During discussions with public agencies, ADEQ confirmed that resources are allocated to the maintenance of unpaved public roads. However, these agencies have little if any information about maintenance and stabilization activities for private dirt, agricultural roads and trails.

Natural stabilization (i.e. rain) is taken into account when calculating high wind fugitive dust emissions and stagnation dust emissions (i.e. unpaved road dust entrainment from vehicles). Any day in which 0.1 mm of rain occurred was assumed to have no emissions from unpaved roadways in both the stagnation and high wind emission calculations. ADEQ has not been provided with information for maintenance activities on all roads and can only give credit for natural stabilization (0.1 mm of rain). ADEQ welcomes any documentation that can be provided regarding stabilization and maintenance activities in order to give credit where appropriate.

High Wind Emission Inventory

(25) Comment: The 83.3% disturbance level for range seems rather high especially given that alfalfa is included in this crop type. Although alfalfa is harvested throughout the year, as noted on page 104, "dense vegetative cover by alfalfa eliminates windblown dust throughout the year…" (3.2 High Wind Fugitive Dust Methodology). The methodology for determining disturbance levels across the year should be revised to account for crops such as alfalfa, which maintain vegetative cover event in times of harvest.

(Comment submitted by the Arizona Farm Bureau.)

Response: To avoid the selection of arbitrary disturbance levels, ADEQ used the crop calendar to determine the number of days each year when soil is being disturbed (i.e., planting and harvesting occur) and when the land is stable (the remaining days of the year). ADEQ does not agree with the requested revision because, in the case of alfalfa, the concern about the calculated disturbance is addressed through the use of a 0.0 vegetative cover factor, as shown in Table 3-41, for the Forage category. The use of a 0.0 vegetative factor eliminates disturbed high wind emissions for forage crops such as alfalfa.

The vegetative coverage (VC) factor originates from the USDA Soil erodibility formula and is used to account for variability in the percentage vegetative coverage different crops experience throughout their life cycle. The use of a 0.0 VC factor for alfalfa infers that the degree to which alfalfa fields are covered by vegetation throughout the year results in no windblown emissions originating from these crop fields. This can be seen when examining equation #1 on page 104 of the EI document. Suspended PM_{10} (E_{sj}) is the product of a number of factors including the vegetative coverage factor (VC or V'). Therefore, when V' (aka VC) equals 0.0, the windblown dust emissions rate (E_{sj}) also equals 0 and thus alfalfa fields produce no windblown dust. A hypothetical emissions estimate is presented below for a alfalfa field and an cotton field to better describe the windblown PM_{10} emission rate effect of an alfalfa VC factor of 0.0 as compared to a cotton field VC factor of 0.7.

Hypothetical example calculation:

a) A 100 acre (404,686 m^2) cotton field, where 75% of the soil is available for entrainment and the windblown dust emission factor is 1.0 $\mu g/m^2$.

$$E_{sj} = F_{EFAdjustment} \times A \times EF_{Disturbed,bin} \times V'$$

$F_{EFAdjustment} = 0.75$
$A = 404{,}686\ m^2$
$EF_{Disturbed,bin} = 1.0\ \mu g/m^2$
$V' = 0.7$

$$E_{sj} = 0.75 \times 404{,}686 \times 0.000001 \times 0.7 = 0.212\ g/sec$$

b) A 100 acre (404,686 m^2) alfalfa field, where 75% of the soil is available for entrainment and the windblown dust emission factor is 1.0 µg/m^2.

$$E_{sj} = F_{EFAdjustment} \times A \times EF_{Disturbed,bin} \times V'$$

$F_{EFAdjustment}$ = 0.75
A = 404,686 m^2
$EF_{Disturbed,bin}$ = 1.0 µg/m^2
V' = 0.0

$$E_{sj} = 0.75 \times 404{,}686 \times 0.000001 \times 0.0 = 0.000\ g/sec$$

Fugitive Dust Emissions from Unpaved Roads

(26) Comment: Pinal County Inputs to AP-42 equation from Unpaved roads (Table 5-8), Page 127 references Table 5-8 twice. The second statement, "the speed, ADEQ, and total mileage for each subcategory are identified in Table 5-8." However Table 5-8 on page 128 does not contain the referenced ADT or the mileage data, in particular the breakdown for the agricultural subcategories for operation, inspection, and harvest. Please provide the missing data to allow for a more complete review of this section.

(Comment submitted by the Arizona Farm Bureau.)

Response: ADEQ agrees with the comment and Table 5-9 has been modified to include the ADT and mileage values for each unpaved road category.

Vehicle Test Facilities

(27) Comment: The redesignation for PM_{10} has created a potential problem related to the possibility that the opacity limit will be lowered below 40% as part of the revised SIP provisions. This is based on the fact that Maricopa County, which also in nonattainment for PM_{10}, has approved a SIP opacity level of 20%. Instituting a 20% opacity limit for western Pinal County would have significant adverse effects of the ability of Nissan's test facility to operate as it has for more than 25 years and similarly impact other automotive proving rounds in Pinal County such as Volkswagen with similar operations.

The road tests that are conducted require vehicles to be tested on various test tracks to determine dust infiltration and durability. These tests cannot be conducted inside a laboratory environment. While Nissan's test facility is in compliance with the guidelines in its air quality permit, any significant change to the current regulatory requirements could jeopardize the ability to fully utilize the test facility for vehicle testing. Nissan respectfully requests that the Pinal County Air Quality Control District and the State of Arizona incorporate into any revised code of regulations for Pinal County similar provision adopted by Maricopa County exempting vehicle test and development facilities and operations from requirements relating to opacity and dust stabilization.

(Comment submitted by Nissan North America, Inc.)

Response: When requesting a list of permitted facilities in 2008 from the PCAQCD, ADEQ received a permit for Nissan testing facility; however, 2008 PM_{10} emissions were reported to be 0.0 tpy. ADEQ has recently learned that the Nissan facility has not reported fugitive emissions from entrainment of unpaved road dust in its annual emissions. In light of this information, ADEQ commits to further investigating the impact of the Nissan testing facility on local monitors. ADEQ will work with PCAQCD when evaluating options for the vehicle test facilities and take the required testing into consideration

(28) Comment: Volkswagen Group of America, Inc. (VW) owns and operates a vehicle test facility, referred to as APG, located within the portion of Western Pinal County that has been designated by the Environmental Protection Agency as nonattainment for PM_{10}. The facility is operating under an air quality permit issued by the Pinal County Air Quality Control District and is in compliance withy all permit terms and conditions. The APG has instituted its own dust control plan to control and reduce PM_{10} emissions but still allow necessary vehicle testing to be conducted. After reviewing the proposed plan, it is unclear whether the APG facility fits within the population categories set forth in the draft emissions inventory. It is also unclear which category is intended to covert the APG, if any. VW is concerned that APG's contribution to the employment base for Pinal County has not been properly acknowledge or included in the analysis. The APG submits that it should be included in Table 1.4 to the extent the fulltime and par-time employment statistics have not already been included. It is further suggested that the most logical category for the APG would be "Manufacturers" since the testing conducted at the APG is part of the research and development ("R&D") and manufacturing process of the vehicles.

Based on the emissions inventory, it appears that APG does not contribute to the stagnant air modeling (due to the absence of any private dirt road category), but may be considered an emissions source with respect to the high wind modeling (in view of the private dirt road category). The emissions inventory does not identify what portion, if any, of the private dirt road category is attributed to the APG and, in particular, the dirt test tracks, or the other on-site maintenance roads. VW submit that in view of the PM1- Rose (Figure 2-3) set forth in the emission inventory and the relative location of the APG to the Cowtown monitor, the APRG contribution to the High Wind modeling for the Cowtown monitor is insignificant. This is inconsistent with the statement in Appendix A that the PM10 Rose Plot at Figure 2-3 "shows that the prevailing winds at Cowtown are from the southeast, with the southwest quadrant contributing the highest fraction of wind hours." (Appendix A, p. 13) The APG is northeast of the Cowtown monitor.

As part of the vehicle test evaluation process, vehicles are subjected to outdoor tests to determine dust infiltration and durability, which are conducted on outdoor test tracks. VW is concerned that any nonattainment SIP should take into consideration the need to conduct such testing in order to preserve the viability of the APG and avoid any unintended consequences. VW request that provisions similar to those contained in the Maricopa County PM_{10} nonattainment SIP be included in any Western Pinal County PM_{10} nonattainment SIP relating to opacity and stabilization requirements.

(Comment submitted by Fennimore Craig, P.C. on behalf of Volkswagen Group of America, Inc.)

Response: When requesting a 2008 list of permitted facilities from the PCAQCD, ADEQ did not receive a permit for the Volkswagen testing facility for PM emissions. Revisions to opacity and stabilization requirements are dependent on the outcomes of the stakeholder process and discussion with Pinal County. ADEQ commits to further investigating the impact of the Volkswagen testing facility on local monitors. ADEQ will work with PCAQCD when evaluating options for the vehicle test facilities and take the required testing into consideration.

Animal Feeding Operations

(29) Comment: The SIP modeling attributes 75.05% of Cowtown emissions to CAFOs, a 2003 Source Apportionment study only attributed 59% to Cowtown and the RARE study, at most, attribute 61% of PM_{10} emissions to CAFOs.

(Comment submitted by the Arizona Cattleman's Association.)

Response: ADEQ recognizes that the current modeling exhibits the highest percent contribution of PM_{10} to the monitor by local concentrated animal feeding operations (CAFOs) when compared to the 2003 Source Apportionment Study and the RARE study; however, the time frames that are analyzed in the studies are important to take into consideration when comparing the three analyses. The current modeling takes place in the year of 2008, while the Source Apportionment study takes place in 2003, and the RARE study examined field information for the years of 2009 and 2010. ADEQ is unaware of how the local CAFO production may have changed between the years of 2003 and 2008; however, a substantial portion of CAFO pens were closed in 2009 near the Cowtown monitor. The closure of these pens would undoubtedly result in reduced CAFO impacts at the monitor for 2009 and 2010 data when compared to 2008 data. Therefore it is not unreasonable for the 2008 modeling results to exhibit larger impacts at the monitor as compared to the 2009 and 2010 RARE study results. ADEQ has also been informed that voluntary efforts to reduce PM_{10} emissions at CAFOs located near the Cowtown monitor have been implemented in the years following 2008. ADEQ commends the CAFOs for these efforts. The combination of these efforts and the closure of CAFO pens in the area have resulted in a drastically reduced number of violating days in recent years as compared to 2008.

Appendix A – Inventory Preparation Plan

(30) Comment: Page F-1. Table F1. Statistics of the PM_{10} High Wind Exceedance Days at Maricopa in 2008. The table should be sorted by PM_{10} concentration similar to the other tables in Appendices C & D along with similar color coding.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ appreciates the comment; however, after reviewing the document the Department does not agree that this change to the documentation will significantly enhance the information provided in Table F1.

(31) Comment: Page G-1, Table G1. Statistics of the PM2.5 Exceedance Days at Cowtown in 2008. The table should be sorted by PM2.5 concentration similar to the other tables in Appendices C, D and F along with similar color coding.

(Comment submitted by the Pinal County Air Quality Control District)

Response: ADEQ reviewed the document and does not agree that that this change will significantly enhance the information provided in Table G1.

Appendix B – Emissions Inventory

(32) Comment: Page 30, Table 3-4: Crop Distribution for Stagnation Design Day Modeling Domains. A row should be added for totals of the crop distribution by modeling domains.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ reviewed the Emission Inventory document and revised Table 3-4 to be consistent with Table 3-40 (Crop Distribution for High Wind Design Day Modeling Domains).

(33) Comment: Page 89, 2nd paragraph from top of page. Should not the increase in unpaved road emissions range be in percent? "…(ranging from 0.17-0.24 for unpaved roads)."

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ reviewed the language contained in the paragraph referenced in the comments and notes that the values are presented as percentages and revised the text to reflect the correct format.

(34) Comment: Page 92, Construction emissions – Please add more description about the overall construction control effectiveness. Since the overall control effectiveness for construction is 54%, does that mean that 46% of the land area associated with construction is assumed to be disturbed? That's important for quantification of windblown PM_{10} emissions/source attribution. In addition, since Pinal's construction registration program grew from the historic understanding that activity-related emissions were the principal cause of construction-related PM_{10}, it is not clear how the compliance data from administration of that program was used to calculate disturbance/stabilization rates. Further explanation would be valuable in attempting to define what additional measures may be required to achieve reductions in wind-blown PM_{10} associated with construction sites.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ reviewed the information referenced in the comment and notes that the calculation for control effectiveness is simply the compliance rate multiplied by control efficiency. As discussed on page 92, a compliance rate of 90% was combined with a control efficiency of 61% for an overall control effectiveness of 54% (0.9 x 0.61 = 0.54). This same method was used for the determination of stable / disturbed land for the windblown construction method, as discussed on page 106 and summarized in Table 3-39 on page 101. While developing the response to this comment, ADEQ discovered that the site development values presented in Table 3-39 are incorrect and revised the information to reflect the construction values of 46% disturbed and 54% stable.

(35) Comment: Please clarify the use of potential to emit (PTE) instead of Actual Point Source Emissions when calculating emissions.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The U.S. Environmental Protection Agency (EPA) PM_{10} SIP modeling guidance calls for the use of actual emissions in the base year and maximum allowable emissions in forecast years. This approach provides a framework to assess source specific contributions to the design day concentration; it also provides a reference point to assess the effect of growth allowed under existing permits (e.g. for

sources operating at reduced capacity, etc. in the base year). Potential to emit (PTE) values were extracted from permits to quantify the maximum allowable emissions for each point source. These values were used in the base year emission inventories so that modeling could be used to determine if any point source qualified as a significance source (i.e., exceeded the 5 $\mu g/m^3$ threshold). The modeling analysis determined that none of the point sources, using base year PTE values, were significant. ADEQ asserts that incorporating actual values in the base year inventory will not change this finding.

(36) Comment: Page 92, Section 3.1.9 – Permitted Source Emission Methodology – The discussions in section 3.1.9 talk about NEI data and Pinal County Air Quality permitted Potential To Emit (PTE) data. Pinal County Air Quality annually collects data from all permitted sources based on actual process throughput. This information is used to create emission inventory data. The 2008 actual data supplied by Pinal County Air Quality should be used in this modeling since the purpose is to reflect what actually occurred. If the objective was to look at worst case scenarios the PTE data would be appropriate, but that is not the function of an emission inventory.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: Please refer to ADEQ's response to comment #35.

(37) Comment: Page 93, Cowtown Monitoring Station – Please provide supporting detail for the analysis and conclusions described in the following section located in the third paragraph of the Cowtown Monitoring Station section:

> *"Review of the Arizona Grain/Eagle Milling permit indicated that two stationary sources at this facility emitted the majority of PM10: the railcar unloading shed, and the air sweep systems that exhausted suspended PM10 from the railcar and truck unloading sheds. Permit conditions allow for lower-than-average capture and control efficiencies for systems installed to reduce PM10 emissions from these sources. Using these permitted capture and control efficiencies, PM10 emissions were calculated to be higher than the estimates reported in the permit."*

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ has revised the language in the Emission Inventory TSD to reflect the permit conditions for the Arizona Grain/Eagle Milling facility. ADEQ used the maximum allowable throughput rate to calculate emissions, which represents a conservative emissions estimate for this facility and is consistent with the PTE approach taken for all of the point sources. Despite the conservative estimate of emissions, modeling showed that this facility did not significantly impact the Cowtown monitor under stagnation conditions. ADEQ has determined that revisions to incorporate actual values in the base year inventory will not change this finding. ADEQ commits to evaluating the use of actual emissions for the base year inventories and design day modeling in the future.

(38) Comment: Regarding the entire third paragraph in the Cowtown Monitoring Station - 2008 PM_{10} actual emissions based throughput were reported to be 14 TPY. The calculations should use the estimated actual emissions that are based on throughput.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The 2008 NEI confirms that PCAQCD reported annual emissions of PM_{10} for this facility of 14 tpy; however, since the actual emissions on the modeling day is unknown, ADEQ assumed worst case emissions for that day, which are based on permit limitations and conditions. Please note that point sources did not surpass the 5 $\mu g/m^3$ threshold of significance, even when using this conservative approach. Please refer to ADEQ's response to comment #35 regarding the use of potential to emit and actual emissions.

(39) Comment: Regarding the Pinal Feeding permit paragraph - 2008 actual PM_{10} emissions based on throughput are reported as 74.9 TPY.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: Please refer to ADEQ's response to comment #35.

(40) Comment: Regarding the Scotts Company paragraph - The 2008 actual PM_{10} emissions are available and are reported as 3.4 TPY based on throughput. In addition, please provide additional detail on the following analysis.

> *"The modeling of emissions from this facility used the calculated worst-case PM_{10} emission rate (144 lb/hr) that was much higher than that contained in the permit (1.1 lb/hr)."*

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ has removed reference to the 1.1 lb/hr PM_{10} emission rate listed in the Emission Inventory TSD as this is not an emission cap for the Scotts Company facility. ADEQ calculated emissions based on equipment design capacity, which represents a conservative emissions estimate for this facility and is consistent with the PTE approach taken for all of the point sources. Despite the conservative estimate of emissions, modeling showed that this facility did not significantly impact the Cowtown monitor under stagnation conditions. ADEQ has determined that revisions to incorporate actual values in the base year inventory will not change this finding. ADEQ commits to evaluating the use of actual emissions for the base year inventories and design day modeling in the future.

(41) Comment: Page 94, Pinal County Housing Monitoring Station – Why are PTE's ("Potential to emit") being used in this section? PCAQCD collects actual operating information on all permitted sources in order to produce annual emissions inventories. 2008 actual emissions based on reported through were 4.4 tons for the Eleven Mile Corner (EMC) Farmers Gin.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: Please refer to ADEQ's response to comment #35.

(42) Comment: The EMC Farmers Gin is permitted for a combined total of 33 lb/hr and 24 TPY for PM10. The short staple portion is permitted for 21 lb/hr and 15 TPY. The Long Staple portion of the facility did not operate in 2008 (actually the long staple portion of the facility has not operated since the year 2000). Thus at the very least the PTE of the long staple, 12 lbs/hr and 9 TPY, should not be used. As

stated in other comments actual reported emissions, or emissions calculated from throughput reports, should be used for 2008 instead of PTE estimates from the permit.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: Please refer to ADEQ's response to comment #35.

(43) Comment: Page 101, Table 3-39 - Disturbance Level for Non-Agricultural Land Used in Pinal High Wind Annual Emission Inventory. It appears that the stable percentages for Land Use ID A (Developed Urban Lands) and C (Paved roads) are incorrect. The Land Use ID A stable percentage should be 97.5% and 100% for Land Use ID C (Paved roads).

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The stable portion of Developed Urban Lands is assumed to have 100% coverage and produce no emissions under high wind conditions. ADEQ revised the footnote addressing this land use category to reflect this assumption. Paved roads are also assumed to have 100% coverage and no disturbance; thus they produce no emissions under high wind conditions.

(44) Comment: Page 103, Table 3-41 - Disturbance Assumptions for Agricultural Lands Identified in Cotton Research and Protection Council Shapefile for High Wind Modeling Domains. The static 0.7 (i.e. 70%) vegetative cover assumed for cotton seems arbitrary considering the design days used for modeling cover various times of the year (January, November, April and October). Therefore Vegetative cover varies dramatically over different times of the year (i.e. different design days), therefore a blanket 0.7 vegetative cover fraction doesn't appear to reflect the dynamic agricultural reality.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The crop calendar shows cotton to be harvested from mid-September through the end of January. This period covers the design days for Maricopa (10/27/08), Stanfield (11/21/08) and Pinal County Housing (01/01/08). The crop calendar also shows planting to occur from mid-March through mid-April. This period covers the design day for Cowtown (04/27/08). All four design days occur during periods of soil disturbance. The only non-California information on soil stability during periods of disturbance are the vegetative cover values by crop type developed by the USDA. ADEQ does not dispute that vegetative cover is likely to vary over the year; however, no information on this variance is available from the literature and no information on Pinal County variance was submitted from the industry for use in the preparation of the emissions inventory.

(45) Comment: Page 103, Table 3-41 – Please add a footnote as to where the rainfall measurements used in Table 3-41 were taken from.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The rainfall measurement was taken from Maricopa met station listed in the AZMET network (http://ag.arizona.edu/azmet/az-data.htm). ADEQ has added a footnote to document the source.

(46) Comment: Page 104, equation used to calculate windblown dust emissions for disturbed agricultural land. It appears that the vegetative cover portion of the equation may be incorrect. Should not the vegetative cover in the equation be (1-V')? For example, cotton is assumed to have a blanket 0.7 (i.e. 70%) vegetative cover and in the equation as it stands in the draft document the windblown dust emissions from disturbed agricultural lands would include multiplication of 0.7 for cotton, as if 70% of the ag land was disturbed. Also, an example calculation would be useful.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The equation presented on page 104 is used to calculate windblown dust from disturbed agricultural lands. Using the information presented in Table 3-41, all lands identified as cultivating cotton are assumed to be 100% disturbed on the selected design days. The inclusion of the vegetative cover factor from the U.S. Department of Agriculture equation modifies the disturbance emissions to account for effect of crop residue which reduces wind erosion of the soil. In the case of cotton, the factor is 0.7, which reduces the estimated disturbance emissions by 30% (i.e., the crop residue is 30% effective in reducing windblown emissions on disturbed cotton soil). In contrast, alfalfa has a vegetative cover factor of 0.0, which reduces the estimated disturbance emissions by 100%. Please refer to ADEQ's response to comment #25 for additional clarification.

(47) Comment: Page 104 – There appears to be an erroneous reference to details in Appendix 7 for EFDisturbed, bin (Windblown dust emission factor developed for disturbed soil for that wind speed bin). There does not appear to be any Appendix which includes details on the windblown dust emission factor. Therefore details on this particular emission factor seem to be missing from the draft documentation.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ has added tables to Appendix 7 that display the one mph speed bin emission factors calculated for each modeling domain.

(48) Comment: Page 105 – The same comment as for EFDisturbed, bin also applies for EFStable, bin.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ has added tables to Appendix 7 that display the one mph speed bin emission factors calculated for each modeling domain.

(49) Comment: Page 105. Is the Emission Adjustment factor parameter in the windblown dust emissions from stable agricultural land equation the same as the reservoir depletion factor used in the disturbed agricultural windblown dust equation?

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The Emission Adjustment factor used in the non-agricultural windblown emission calculation is the same as the adjustment factor used in the agricultural windblown dust equation. ADEQ has revised the text to document the value used in the equation.

(50) Comment: Page 112, Table 4-3 - Emissions Inventory (lbs/hour) for the Stagnation Day Modeling Domain at PCH on 10/29/2008. Is the permitted point sources emissions contribution (13.6%) mainly due to the cotton gins PTE? If so, that value may be over-stated. See the discussion above regarding actual emission data.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The cotton gin is the only point source located within the Pinal County Housing modeling domain and the emission estimate is based on the potential to emit value(s) specified in the permit. ADEQ agrees that this value is overstated, but the modeling analysis showed that its impact at the monitor was not significant (i.e., did not exceed 5 $\mu g/m^3$). Please refer to the ADEQ's response to comment #35 that addresses the use of PTE.

(51) Comment: Page 113, Figure 4-1 and Page 118, Figure 4-2 - Summary of Stagnation Design Day Source Distribution by Modeling Domain. The pie charts in this figure appear to be missing the label for each respective monitoring site.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ reviewed the document and the label was inadvertently lost when the file was converted from Word to PDF. ADEQ revised the document to include the label on the pie charts.

(52) Comment: Page 114, Table 4-4 - Emissions Inventory (lbs/hour) for the High wind Day at PCH on 1/1/2008. The 10 on PM10 needs to be changed from superscript to subscript.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ revised the text to address the comment.

(53) Comment: Page 135, footnote 111 – The exclusion of days where moisture levels exceeded 0.01" of rainfall from the hourly counts is arbitrary. There have been days with rainfall totals over 0.01" where monitors have exceeded (i.e. 9/3/09, 12/7/09, 12/22/09, etc.).

(Comment submitted by the Pinal County Air Quality Control District.)

Response: While ADEQ recognizes that there is the possibility of PM_{10} NAAQS 24-hour exceedances during days of rainfall, rainfall is readily recognized as a form of soil stabilization. For calculation of an annual inventory, the choice of removing high wind hours that occur on days of rainfall is consistent with and equivalent to EPA's methodology for calculating annual entrained dust emissions from unpaved roads3. In these calculations, EPA presents specific terms and equations to negate entrainment emissions for the days each year which experience 0.01 inches or more of precipitation. In this respect, ADEQ employed an equivalent technique when screening high wind hours for wind entrained dust and does not consider the criteria utilized as arbitrary.

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[3] Environmental Protection Agency. AP 42, Fifth Edition, Volume I Chapter 13.2.2. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

(54) Comment: Page 136, Second paragraph under Agriculture – The sentence "10 periods with no activity were coded 0% activity." The sentence should probably include the word "day" prior to the word periods (i.e. 10 day periods with no activity….).

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ revised the text to address the comment.

(55) Comment: Page 138, Table 5-19 Summary of the 2008 Annual High Wind Emissions in Western Pinal County. Please include examples of sources in the "Other" land use category.

(Comment submitted by the Pinal County Air Quality Control District.)

Response: ADEQ has revised the text to include examples of the "Other" category. ADEQ has also included an appendix that provides descriptions for each land use category.

(56) Comment: Page 9-4, Appendix 9 – The word acre appears to be missing from the following sentence in the first paragraph. "The total estimated mileage of Ag roadways in a 1,334 farm….".

(Comment submitted by Pinal County Air Quality Control District)

Response: ADEQ has adjusted the text to address the comment.

(57) Comment: Page 9-4, Appendix 9, Alfalfa Harvesting – Where did the 1,334 acre average farm size come from? In the 2008 Arizona Annual Agricultural Statistics Bulletin on page 22, the average farm size in Arizona is listed as 1,673 acres.
(source:http://www.nass.usda.gov/Statistics_by_State/Arizona/Publications/Bulletin/08bul/pdf/pg22.pdf)

(Comment submitted by the Pinal County Air Quality Control District.)

Response: The average farm size of 1,334 acres was reported by the USDA in the 2007 Census of Agriculture specifically for Pinal County.[4] The average farm size of 1,673 acres reported in the 2008 Agricultural Statistics Bulletin listed above is averaged over the entire State of Arizona. ADEQ chose to rely on the 2007 Census of Agriculture in order to utilize County specific data, assuming that total agricultural acreage is unlikely to change significantly between 2007 and 2008. For comparative purposes, the statewide average farm size was listed as 1,670 acres in 2007 and 1,673 acres by the USDA, only changing by 3 acres.

[4] http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Arizona/cp04021.pdf