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STAFF REPORT TO THE PLANNING COMMISSION FOR THE WORK SESSION ON OCTOBER 7, 2013

AMEND OFF-STREET PARKING REGULATIONS – NON-RESIDENTIAL ACCESS CASE FILE # PC-2013-2900

SECTION 1. INTRODUCTION

The Off-Street Parking and Loading standards of Multnomah County Code (MCC) .4100 *et. seq.* apply to non-residential proposals (MCC .4165). The most common applications subject to these standards include commercial uses and Type B and C home occupations[1].

These Off-Street Parking and Loading regulations are generally intended to assure safe and convenient vehicular access to a non-residential use which is accomplished through application of access development and maintenance requirements. These standards regulate the number of required parking spaces, appropriate parking and access drive dimensions, surfacing requirements, lighting needs, parking area setbacks and landscaping needs.

Implementation of one particular component of the Off-Street Parking and Loading Code has been identified as problematic, particularly where a proposed business site is not located close to a public or private street:

§ *.4170* ACCESS

(A) Where a parking or loading area does not abut directly on a public street or private street approved under MCC 33.7700 et seq., the Land Division Chapter, there shall be provided an unobstructed paved drive not less than 20 feet in width for two-way traffic, leading to a public street or approved private street. Traffic directions therefore shall be plainly marked.

[1] Neither single family dwellings, nor Type A home occupations are subject to the Off-Street Parking and Loading requirements.

More specifically, concerns have been repeatedly raised around the cost of constructing a 20-foot wide paved driveway and whether this should be required in all cases regardless of the site conditions. Additionally, it has been argued that the environmental impacts caused by tree removal, permanent alterations to the topography, and additional storm water runoff generated from new pavement could be reduced in some circumstances with additional design flexibility added to county code. A copy of the Off-Street Parking and Loading subchapter in its entirety is presented as Exhibit A.

This project was not identified on the 2013 Planning Commission Work Program and has been taken up to address concerns raised by the community.

Section 1.1 Assessing options related to the 20-foot width requirement

County code generally consolidates a list of dimensional standards from which justifiable departure can be granted within the Adjustments and Variances section: .7606(A) *&* (B), respectfully. A copy of the County's Adjustment and Variances standards for the West Hills is provided in Exhibit B, as an example.

The Adjustment and Variance code contains a number of street dimensional standards which can potentially be amended including cul-de-sac length, cul-de-sac turnaround radius, and dimensions of a private street[2]. The 20-foot wide access requirement at hand applies to private driveways, and not private streets, which means dimensions of a private driveway serving a non-residential use cannot be currently adjusted through the Adjustment or Variance process.

It seems counterintuitive that dimensional standard relief is not also available for a private driveway serving only one property, when the code provides an avenue to vary the more intensive private street dimensions serving more than one property[3]. One approach that was considered by staff initially was to simply add private driveways to the list of dimensional standards that may be modified under either an Adjustment or Variance process. Although this is one possibility, staff believe adding additional standards to the existing Access section within the Off-Street parking and loading code is the better approach for the Planning Commission to initially consider for a few reasons.

First, the Off-Street Parking and Loading code currently contains an exceptions process from the required number of parking or loading spaces (MCC .4215) which helps create a complete and stand alone Off-Street Parking and Loading subchapter simplifying implementation. Second, as the concept of providing flexibility in the driveway design standards was explored by staff, unique review standards began to surface addressing

[2] A private street is defined in .0005 as *"a private accessway built on a separate lot from the lots it serves, connecting more than one property to the local public road system and..."* Alternatively, a private driveway is defined as *"a private means of access to a public road which is part of and provides access only to one lot or parcel."*

[3] It should be noted that dimensions of a private street are varied through the county's land use code because private street dimensions do not fall under the purview of County Transportation Planning (Road Rules section 12.100).

potential impacts not currently captured in the Adjustment and Variance section of County code.

Finally, proposed standards contemplating relief to the 20-foot wide driveway requirement have been added directly to the Off-street Parking and Loading subchapter because this code currently contains alternative surfacing requirements for parking, loading and maneuvering areas and it would seem logical to also address driveway width amendments within the same subchapter. It also would be most convenient if all avenues for relief to Off-Street Parking and Loading standards were contained within the same subchapter of county code.

Additional options related to the pavement requirement are assessed in section 1.2 below.

Section 1.2 Assessing options related to the paved surface requirement

Although the existing Access requirements of .4170(A) alone do not indicate flexibility exists in the paving requirement; Surfacing Improvement section .4180(A)(1) notes blacktop (i.e. asphalt), Portland cement or other durable and dustless surface may be appropriate for all areas used for parking, loading or maneuvering.

Draft language has been added to .4180 clarifying that gravel used for the parking, loading and maneuvering area, typically adjacent to the business, can be considered under (A)(1) and the standards of (A)(2) provide an avenue to consider the use of gravel along the length of the driveway.

Shaded boxes containing staff notes have been inserted within the Proposed Amendments of Section 2 below to help explain why specific language is being proposed. Staff's hope is that explaining these specific details to the Planning Commission within the structure of the code, rather than within this Introduction Section of the report will help keep the reader's orientation as the proposed language is reviewed. Staff comment boxes are for review and discussion purposes only and will be removed prior to adoption of any amendments.

SECTION 2. PROPOSED AMENDMENTS

Please note the following formatting styles used within this section:

Bold = Existing Code Language
Double Underline = New Code Language
~~Strikethrough~~ = Language to be Deleted

Section 2.1 Proposed amendments to Off-Street Parking and Loading standards to Multnomah County Code Chapters 33, 34, 35 and 36:

OFF-STREET PARKING AND LOADING – OP

§ 33.4170 ACCESS [The same changes are proposed for MCC 34.4170, 35.4170 and 36.4170]

(A) Where a parking or loading area does not abut directly on a public street or private street approved under MCC 33.7700 et seq., the Land Division Chapter, there shall be provided an unobstructed ~~paved~~ driveway not less than 20 feet in width for two-way traffic, leading to a public street or approved private street. Traffic directions therefore shall be plainly marked.

Staff Comments: The term 'paved' has been removed from the ACCESS section .4170 above because the following IMPROVEMENTS Section .4180 specifies surfacing options which can include paving (i.e. blacktop) or cement and other porous surfacing materials in some circumstances such as gravel. Leaving the term 'paved' in .4170 potentially could incorrectly suggest paved surfacing is the only option.

The general term 'drive' has also been amended to 'driveway' because drive is not defined in land use regulations or within the County Road Rules policy document (Exhibit C). However, both documents define the term 'driveway'. Land use regulations define private driveway as *"a private means of access to a public or private road which is part of and provides access only to one lot or parcel (.0005)."*

(1) Alterations to the driveway width requirement of (A) of this section shall meet the following:

(a) The need to reduce the width is based on unique physical characteristics of the site;

(b) The fire service provider determines the proposal is in compliance with the adopted structural fire service provider standards for properties located inside the boundaries of a residential fire service provider. Or, the building official determines the proposal is in compliance with the Oregon Fire Code for properties located outside the boundaries of a residential fire service provider; and

(c) The applicant demonstrates the proposal is in compliance with all applicable County Road Rules and/or Design and Construction Manual Standards.

Staff Comments: In 2011, the county amended administrative procedures Chapter 29 to defer review of Oregon Fire Codes (including property access & fire flow) to fire service providers. Copies of the coordination forms used for fire service agency review are attached as Exhibits D & E. Subsection (1)(b) language has been provided as a reminder of this authority.

Although the fire service providers are considered experts on whether emergency services can access a property, the draft code acknowledges that it would be appropriate for the county to also consider a driveway width reduction to confirm the reduction is justifiable based on the unique site conditions. The county's consideration of this standard would also provide neighboring properties an opportunity to become

aware of the reduction and participate in the review.

(B) Parking or loading space in a public street shall not be counted in fulfilling the parking and loading requirements of this section. Required spaces may be located in a private street when authorized in the approval of such private street.

§ 33.4180 IMPROVEMENTS [The same changes are proposed for MCC 34.4180, 35.4180 and 36.4180]

(A) Surfacing

(1) All areas used for parking, loading or maneuvering of vehicles shall be surfaced with two inches of blacktop on a four inch crushed rock base or six inches of portland cement or other material providing a durable and dustless surface capable of carrying a wheel load of 4,000 pounds. Parking areas with fewer than four required parking spaces may be surfaced with four inches of gravel.

(2) Alternate porous surfacing systems<u>, including gravel,</u> which provide a durable dustless surface capable of carrying a wheel load of 4,000 pounds may be used <u>for the length of the driveway</u> instead of the blacktop or cement materials in (1) above when<u>:</u>

Staff Comments: Language has been added above to clarify that gravel is one type of porous surfacing. Other types of porous surfacing can also be considered under these provisions.

The 'for the length of the driveway' language has also been added in (A)(2) to clarify that (A)(1) is intended to apply to areas used for parking, loading or maneuvering which generally can be thought of as the parking area adjacent to the business; whereas (A)(2) applies to the length of the driveway connecting the parking area to the public or private road.

Staff's research suggests fugitive dust becomes a concern when vehicles are moving down a gravel drive at speed more so than the slow speed vehicular maneuvering in and out of parking / loading spaces. This concept supports an argument for a simpler, less discretionary test for when gravel is appropriate in a parking area vs. along the length of the driveway. Therefore, the existing language in (A)(1) allows gravel for parking areas with fewer than four spaces, yet proposed language in (A)(2) contemplates how dust resulting from gravel surfacing along the driveway length could impact neighboring properties, agricultural enterprises and local water quality.

Staff should note that dust is not the only impact to consider when gravel surfacing is proposed for a parking area. A rutted, muddy surface can also result if a graveled parking area is subjected to heavy usage, and also when a gravel parking surface is not properly maintained. Staff understands that the existing 'less than four' parking space was defined by the Planning Commission in 2011 (case PC-2011-1398) as an appropriate gravel surfacing threshold. Although staff is not advocating the Planning Commission revisit this threshold in (A)(1) at this time; this project could be an opportunity to research this threshold further if desired by the Commission.

(a). Approved by the structural fire service provider for properties located inside the boundaries of a residential fire service provider. Or, the building official determines the proposal is in compliance with the Oregon Fire Code for properties located outside the boundaries of a residential fire service provider;

Staff Comments: This standard provides the emergency service provider an opportunity to confirm the alternative porous surface will provide adequate traction and strength to support emergency service vehicles.

(b) Approved by the County Engineer. However, approaches to public rights-of-way shall be paved for a minimum distance of 21 feet from the fog line, or for a greater distance when required by the County Engineer.;

(c) The proposal will not impact agricultural practices;

(d) The proposal will not impact water quality; and

(e) Excluding the building(s) served by the driveway; either no residence is located within 200-feet of any portion of the driveway, or a professional engineer confirms the proposal, including any dust control mitigation measures, will not cause harm to neighbors.

Staff Comments: The standards of (c) – (e) above attempt to provide the ability to assess how fugitive dust might impact local farming practices, water quality and neighborhood livability.

The EPA estimates up to 40% of fugitive dust in the atmosphere originates from upaved roads (page 1, Exhibit F). The effects of heavy dust on plants includes reduced photosynthesis due to reduced light penetration through the leaves, increased incidence of plant pests and disease (dust can act as a fungal disease medium), reduced effectiveness of pesticide sprays and reduced produce yields (page 7, Exhibit G).

Human health effects are mainly associated with fugitive dust particles that are inhaled on a regular basis (page 5, Exhibit G). Health issues aside, dust routinely falling on windowsills, parked cars, drying laundry, patio equipment etc. can simply become a nuisance. The quantity of dust created from an unpaved road most closely correlates to the volume of traffic, the speed of traffic and the fraction of silt sized particles in the road surface materials (<75-micrometers); (page 35, Exhibit G & page 13.2.2-1, Exhibit H). Therefore, focusing on these variables is most effective when attempting to reduce fugitive dust. For example, reducing vehicle speed down a gravel road from roughly 20-mph to roughly 10-mph can reduce dust emissions by 50% (page 35, Exhibit G).

A study from the Pennsylvania State University found dust fall residue on plants adjacent to a gravel road dropped roughly to half the amount 60-90 feet from the road and again a reduction of roughly half that amount of residue again was found once a sample was collected 120-150 feet from the road (page 14, Exhibit F). This means that distance to a gravel road is also relevant when considering impacts.

This particular finding informed the 200-foot buffer recommendation in (e) above and

the attempt to avoid placing a highly traveled gravel driveway too close to a dwelling, which theoretically would be a common use occupied full time. It should be noted that the draft language in (e) above would not prohibit a gravel drive within the 200-foot buffer but rather would require that a professional engineer consider mitigation methods including speed reduction strategies (speed limits, speed humps, etc.), gravel size gradation design, gravel maintenance requirements, surface binding treatments, etc. The intent is not to specify mitigation measures within the standard but simply provide an avenue for this analysis to occur.

(3) Large parking fields for intermittent uses such as special events associated with farm stands and public parks, sporting events, and the like may be surfaced with gravel or grass and spaces may be unmarked if the parking of vehicles is supervised.

Section 2.2 Proposed amendments to Off-Street Parking and Loading standards to Multnomah County Code Chapter 38:

OFF-STREET PARKING AND LOADING – OP

§ 38.4170 ACCESS

(A) Where a parking or loading area does not abut directly on a public street or private street approved under MCC 38.7700 et seq., the Land Division Chapter, there shall be provided an unobstructed ~~paved~~ driveway not less than 20 feet in width for two-way traffic, leading to a public street or approved private street. Traffic directions therefore shall be plainly marked.

(1) Alterations to the driveway width requirement of (A) of this section shall meet the following:

(a) The need to reduce the width is based on unique physical characteristics of the site;

(b) The fire service provider determines the proposal is in compliance with the adopted structural fire service provider standards for properties located inside the boundaries of a residential fire service provider. Or, the building official determines the proposal is in compliance with the Oregon Fire Code for properties located outside the boundaries of a residential fire service provider; and

(c) The applicant demonstrates the proposal is in compliance with all applicable County Road Rules and/or Design and Construction Manual Standards.

(B) Parking or loading space in a public street shall not be counted in fulfilling the parking and loading requirements of this section. Required spaces may be located in a private street when authorized in the approval of such private street.

§ 38.4180 IMPROVEMENTS

(A) Surfacing

(1) All areas used for parking, loading or maneuvering of vehicles shall be surfaced with ~~either gravel or~~ two inches of blacktop on a four inch crushed rock base or six inches of portland cement or other material providing a durable surface capable of carrying a wheel load of 4,000 pounds. Parking areas with fewer than four required parking spaces may be surfaced with four inches of gravel.

(2) Alternate porous surfacing systems, including gravel, which provide a durable dustless surface capable of carrying a wheel load of 4,000 pounds may be used for the length of the driveway instead of the blacktop or cement materials in (1) above when:

(a). Approved by the structural fire service provider for properties located inside the boundaries of a residential fire service provider. Or, the building official determines the proposal is in compliance with the Oregon Fire Code for properties located outside the boundaries of a residential fire service provider;

(b) Approved by the County Engineer. However, approaches to public rights-of-way shall be paved for a minimum distance of 21 feet from the fog line, or for a greater distance when required by the County Engineer.;

(c) The proposal will not impact agricultural practices;

(d) The proposal will not impact water quality; and

(e) Excluding the building(s) served by the driveway; either no residence is located within 200-feet of any portion of the driveway, or a professional engineer confirms the proposal, including any dust control mitigation measures, will not cause harm to neighbors.

~~(2)~~(3) Large parking fields for intermittent uses such as special events associated with farm stands and public parks, sporting events ~~amusement parks, race tracks, stadiums~~, and the like may be surfaced with gravel or grass and spaces may be unmarked if the parking of vehicles is supervised.

Section 2.3 Proposed amendments to Off-Street Parking and Loading standards to Multnomah County Code Chapter 11.15:

OFF-STREET PARKING AND LOADING – OP

11.15.6128 Access

A. Where a parking or loading area does not abut directly on a public street or private street approved under MCC 11.45, the Land Division Chapter, there shall be provided an unobstructed ~~paved~~ driveway not less than 20 feet in width for two-way traffic, leading to a public street or approved private street. Traffic directions therefore shall be plainly marked.

(1) Alterations to the driveway width requirement of (A) of this section shall meet the following:

(a) The need to reduce the width is based on unique physical characteristics of the site;

(b) The fire service provider determines the proposal is in compliance with the adopted structural fire service provider standards for properties located inside the boundaries of a residential fire service provider. Or, the building official determines the proposal is in compliance with the Oregon Fire Code for properties located outside the boundaries of a residential fire service provider; and

(c) The applicant demonstrates the proposal is in compliance with all applicable County Road Rules and/or Design and Construction Manual Standards.

B. Parking or loading space in a public street shall not be counted in fulfilling the parking and loading requirements of this section. Required spaces may be located in a private street when authorized in the approval of such private street.

11.15.6132 Improvements

A. Surfacing

1. All areas used for parking, loading or maneuvering of vehicles shall be surfaced with two inches of blacktop on a four inch crushed rock base or six inches of portland cement or other material providing a durable and dustless surface capable of carrying a wheel load of 4,000 pounds. Parking areas with fewer than four required parking spaces may be surfaced with four inches of gravel.

2. Alternate porous surfacing systems, including gravel, which provide a durable dustless surface capable of carrying a wheel load of 4,000 pounds may be used for the length of the driveway instead of the blacktop or cement materials in (1) above when:

(a). Approved by the structural fire service provider for properties located inside the boundaries of a residential fire service provider. Or, the building official determines the proposal is in compliance with the Oregon Fire Code for properties located outside the boundaries of a residential fire service provider;

(b) Approved by the County Engineer. However, approaches to public rights-of-way shall be paved for a minimum distance of 21 feet from the fog line, or for a greater distance when required by the County Engineer.;

(c) The proposal will not impact agricultural practices;

(d) The proposal will not impact water quality; and

(e) Excluding the building(s) served by the driveway; either no residence is located within 200-feet of any portion of the driveway, or a professional engineer confirms the proposal, including any dust control mitigation measures, will not cause harm to neighbors.

3. ~~2.~~Large parking fields for intermittent uses such as special events associated with farm stands and public parks, sporting events ~~amusement parks, race tracks, stadiums~~, and the like may be surfaced with gravel or grass and spaces may be unmarked if the parking of vehicles is supervised.

SECTION 3. EXHIBITS

The attachments listed below are part of this staff report:

Exhibit A	Multnomah County Off-Street Parking and Loading Standards (Chapter 33 example)
Exhibit B	Multnomah County Adjustment and Variance Criteria (Chapter 33 example)
Exhibit C	Multnomah County Road Rules; March 23, 2004
Exhibit D	Multnomah County Development Review Application Form: Fire Service Agency Review
Exhibit E	Multnomah County Development Review Application Form: Fire Code Application Guide For Development in Unincorporated Multnomah County
Exhibit F	White Deer Creek Road Dust Suppressant Testing; Silsbee and Bloser, Pennsylvania State University (2003)
Exhibit G	Good Practice Guide for Accessing and Managing the Environmental Effects of Dust Emissions; Ministry for the Environment, Wellington New Zealand (2001)
Exhibit H	Emission Factors AP 42, Chapter 13.2.2 – Unpaved Roads; U.S. Environmental Protection Agency (2006)

EXHIBIT A

OFF-STREET PARKING AND LOADING - OP

§ 33.4100- PURPOSE

The purposes of this subdistrict and these off-street parking and loading regulations are to reduce traffic congestion associated with residential, commercial, manufacturing, and other land uses; to protect the character of neighborhoods; to protect the public's investment in streets and arterials and to provide standards for the development and maintenance of off-street parking and loading areas.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4105 GENERAL PROVISIONS

In the event of the erection of a new building or an addition to an existing building, or any change in the use of an existing building, structure or land which results in an intensified use by customers, occupants, employees or other persons, off-street parking and loading shall be provided according to the requirements of this Section. For nonconforming uses, the objectives of this section shall be evaluated under the criteria for the Alteration, Modification, and Expansion of Nonconforming Uses.
(Ord. 1128, Amended, 01/29/2009; Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4110 O-P CLASSIFICATION

Land classified as Off-Street Parking and Loading (O-P) on the Zoning Map shall not be used for any purpose other than off-street parking and loading without a change of district.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4115 CONTINUING OBLIGATION

The provision for and maintenance of off-street parking and loading facilities without charge to users shall be a continuing obligation of the property owner. No building or any other required permit for a structure or use under this or any other applicable rule, ordinance or regulation shall be issued until satisfactory evidence in the form of a site development plan, plans of existing parking and loading improvements, a deed, lease, contract or similar document is presented demonstrating that the property is and will remain available for the designated use as a parking or loading facility.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4120 PLAN REQUIRED

A plot plan showing the dimensions, legal description, access and circulation layout for vehicles and pedestrians, space markings, the grades, drainage, setbacks, landscaping and abutting land uses in respect to the off-street parking area and such other information as shall be required, shall be submitted in duplicate to the Planning Director with each application for approval of a building or other required permit, or for a change of classification to O-P.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4125 USE OF SPACE

(A) Required parking spaces shall be available for the parking of vehicles of customers, occupants, and employees without charge or other consideration.

(B) No parking of trucks, equipment, materials, structures or signs or the conducting of any business activity shall be permitted on any required parking space.

(C) A required loading space shall be available for the loading and unloading of vehicles concerned with the transportation of goods or services for the use associated with the loading space.

(D) Except for residential and local commercial districts, loading areas shall not be used for any purpose other than loading or unloading.

(E) In any district, it shall be unlawful to store or accumulate equipment, material or goods in a loading space in a manner which would render such loading space temporarily or permanently incapable of immediate use for loading operations.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4130 LOCATION OF PARKING AND LOADING SPACES

(A) Parking spaces required by this Section shall be provided on the lot of the use served by such spaces.

(B) Exception – The Planning Director may authorize the location of required parking spaces other than on the site of the primary use, upon a written finding by the Director that:

(1) Parking use of the alternate site is permitted by this Ordinance;

(2) The alternate site is within 350 feet of the use;

(3) There is a safe and convenient route for pedestrians between the parking area and the use;

(4) Location of required parking other than on the site of the use will facilitate satisfaction of one or more purposes or standards or requirements of this Chapter; and,

(5) There is assurance in the form of a deed, lease, contract or other similar document that the required spaces will continue to be available for off-street parking use according to the required standards.

(C) Loading spaces and vehicle maneuvering area shall be located only on or abutting the property served.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4135 IMPROVEMENTS REQUIRED

(A) Required parking and loading areas shall be improved and placed in condition for use before the grant of a Certificate of Occupancy under MCC 33.0525, or a Performance Bond in favor of Multnomah County equivalent to the cost of completing such improvements shall be filed with the Planning Director.

(B) Any such bond shall include the condition that if the improvement has not been completed within one year after issuance of the Certificate of Occupancy, the bond shall be forfeited.

Any bond filed hereunder shall be subject to the approval of the Planning Director and the County Attorney.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4140 CHANGE OF USE

(A) Any alteration of the use of any land or structure under which an increase in the number of parking or loading spaces is required by this Section shall be unlawful unless the additional spaces are provided.

(B) In case of enlargement or change of use, the number of parking or loading spaces required shall be based on the total area involved in the enlargement or change in use.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4145 JOINT PARKING OR LOADING FACILITIES

(A) In the event different uses occupy the same lot or structure, the total off-street parking and loading requirements shall be the sum of the requirements for each individual use.

(B) Owners of two or more adjoining uses, structures, or parcels of land may utilize jointly the same parking or loading area, when approved by the Planning Director, upon a finding by the Director that the hours of operation do not overlap and provided satisfactory legal evidence is presented to the Director in the form of a deed, lease, contract or similar document, securing full access to such parking or loading areas for all the parties jointly using them.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4150 EXISTING SPACES

Off-street parking or loading spaces existing prior to July 26, 1979 may be included in calculating the number of spaces necessary to meet these requirements in the event of subsequent enlargement of the structure or change of use to which such spaces are

accessory. Such spaces shall meet the design and improvement standards of this Section.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4160 STANDARDS OF MEASUREMENT

(A) *Square feet* means square feet of floor or land area devoted to the functioning of the particular use and excluding space devoted to off-street parking and loading.

(B) When a unit or measurement determining the number of required off-street parking or off-street loading spaces results in a requirement of a fractional space, any fraction up to and including one-half shall be disregarded, and any fraction over one-half shall require one off-street parking or off-street loading space.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4165 DESIGN STANDARDS: SCOPE

(A) The design standards of this section shall apply to all parking, loading, and maneuvering areas except those serving a single family dwelling on an individual lot. Any non-residential use approved on a parcel containing a single family dwelling shall meet the design standards of MCC 33.4170 through 33.4200.

(B) All parking and loading areas shall provide for the turning, maneuvering and parking of all vehicles on the lot. After July 26, 1979 it shall be unlawful to locate or construct any parking or loading space so that use of the space requires a vehicle to back into the right-of-way of a public street.
(Ord. 1197, 02/16/2013; Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4170 ACCESS

(A) Where a parking or loading area does not abut directly on a public street or private street approved under MCC 33.7700 et seq., the Land Division Chapter, there shall be provided an unobstructed paved drive not less than 20 feet in width for two-way traffic, leading to a public street or approved private street. Traffic directions therefore shall be plainly marked.

(B) Parking or loading space in a public street shall not be counted in fulfilling the parking and loading requirements of this section. Required spaces may be located in a private street when authorized in the approval of such private street.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4175 DIMENSIONAL STANDARDS

(A) Parking spaces shall meet the following requirements:

(1) At least 70% of the required off-street parking spaces shall have a minimum width of nine feet, a minimum length of 18 feet, and a minimum vertical clearance of six feet, six inches.

(2) Up to 30% of the required off-street parking spaces may have a minimum width of eight-and-one-half feet, a minimum length of 16 feet, and a vertical clearance of six feet if such spaces are clearly marked for compact car use.

(3) For parallel parking, the length of the parking space shall be 23 feet.

(4) Space dimensions shall be exclusive of access drives, aisles, ramps or columns.

(B) Aisle width shall be not less than:

(1) 25 feet for 90 degree parking,

(2) 20 feet for less than 90 degree parking, and
(3) 12 feet for parallel parking.

(4) Angle measurements shall be between the center line of the parking space and the center line of the aisle.

(C) Loading spaces shall meet the following requirements:

(1)

District	Minimum Width	Minimum Depth
All	12 Feet	25 Feet

(2) Minimum vertical clearance shall be 13 feet.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4180 IMPROVEMENTS

(A) Surfacing

(1) All areas used for parking, loading or maneuvering of vehicles shall be surfaced with two inches of blacktop on a four inch crushed rock base or six inches of portland cement or other material providing a durable and dustless surface capable of carrying a wheel load of 4,000 pounds. Parking areas with fewer than four required parking spaces may be surfaced with four inches of gravel.

(2) Alternate porous surfacing systems which provide a durable dustless surface capable of carrying a wheel load of 4,000 pounds may be used instead of the blacktop or cement materials in (1) above when approved by the County Engineer. However, approaches to public rights-of-way shall be paved for a minimum distance of 21 feet from the fog line, or for a greater distance when required by the County Engineer.

(3) Large parking fields for intermittent uses such as special events associated with farm stands and public parks, sporting events, and the like may be surfaced with gravel or grass and spaces may be unmarked if the parking of vehicles is supervised.

(B) Curbs and Bumper Rails

(1) All areas used for parking, loading, and maneuvering of vehicles shall be physically separated from public streets or adjoining property by required landscaped strips or yards or in those cases where no landscaped area is required, by curbs, bumper rails or other permanent barrier against unchanneled motor vehicle access or egress.

(2) The outer boundary of a parking or loading area shall be provided with a bumper rail or curbing at least four inches in height and at least three feet from the lot line or any required fence except as provided in (3) below.

(3) Except for development within the BRC, CFU-1, CFU-2 and CFU-5 zones, the outer boundary of a parking or loading area with fewer than four required parking spaces may use a five foot wide landscape strip or yard planted with a near-continuous number of shrubs and/or trees. If the outer boundary of the parking area is within 50 feet of a dwelling on an adjacent parcel, the plant materials shall create a continuous screen of at least four feet in height except at vision clearance areas where it shall be maintained at three feet in height.

(C) Marking – All areas for the parking and maneuvering of vehicles shall be marked in accordance with the approved plan required under MCC 33.4120, and such marking shall be continually maintained. Except for development within the BRC zone, a graveled parking area with fewer than four required parking spaces is exempt from this requirement.

(D) Drainage – All areas for the parking and maneuvering of vehicles shall be graded and drained to provide for the disposal of all surface water on the lot.

(E) Covered Walkways – Covered walkway structures for the shelter of pedestrians only, and consisting solely of roof surfaces and necessary supporting columns, posts and beams, may be located in an O-P district. Such structures shall meet the setback, height and other requirements of the district which apply.

(Ord. 1197, 02/16/2013; Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4185 LIGHTING

Any artificial lighting which may be provided shall be shielded or deflected so as to not shine into adjoining dwellings or other types of living units, and so as not to create a hazard to the traveling public on any street.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4190 SIGNS

Signs, pursuant to the provisions of MCC 33.7465.
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4195 DESIGN STANDARDS: SETBACKS

(A) Any required yard which abuts upon a street lot line shall not be used for a parking or loading space, vehicle maneuvering area or access drive other than a drive connecting directly to a street perpendicularly.

(B) In the BRC district, off-street parking for new, replacement or expansion of existing commercial or industrial developments on a parcel less than 1 acre shall provide a minimum of 10 foot landscaped front yard or street side setback. All other minimum yard dimensions for parking shall be as required in the Off-Street Parking and Loading Code Section.

(C) A required yard which abuts a street lot line shall not be paved, except for walkways which do not exceed 12 feet in total width and not more than two driveways which do not exceed the width of their curb cuts for each 150 feet of street frontage of the lot.
(Ord. 1197, 02/16/2013; Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4200 LANDSCAPE AND SCREENING REQUIREMENTS

(A) The landscaped areas requirements of MCC 33.7055 (C) (3) to (7) shall apply to all parking, loading or maneuvering areas which are within the scope of design standards stated in MCC 33.4165 (A).
(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4205 MINIMUM REQUIRED OFF-STREET PARKING SPACES

(A) Residential Uses

(1) Single Family Dwelling – Two spaces for each dwelling unit.

(2) Two Family Dwelling – Two spaces for each dwelling unit.

(3)Motel or Hotel – One space for each guest room or suite.

(4) Group Care Facility, Home for Aged, or Children's Home – One space for each four beds.

(B) Public and Semi-Public Buildings and Uses

(1) Auditorium or Meeting Room (except schools) – One space for each 60 square feet of floor area in the auditorium or, where seating is fixed to the floor, one space for each four seats or eight feet of bench length.

(2) Church – One space for each 80 square feet of floor area in the main auditorium or, where seating is fixed to the floor, one space for each four seats or eight feet of bench length.

(3) Church Accessory Use – In addition to spaces required for the church, one space for each ten persons residing in such building.

(4) Club or Association – These shall be treated as combinations of uses such as hotel, restaurant, auditorium etc., and the required spaces for each separate use shall be provided.

(5) Senior High School and Equivalent Private and Parochial School – One space for each 56 square feet of floor area in the auditorium or, where seating is fixed to the floor, one space for each eight seats or 16

feet of bench length, or one space for each ten seats in classrooms, whichever is greater.

(6) College, University, Institution of Higher Learning and Equivalent Private or Parochial School – One space for each five seats in classrooms or 45 square feet of floor area.

(7) Primary, Elementary, or Junior High and Equivalent Private or Parochial School – One space for 84 square feet of floor area in the auditorium, or one space for each 12 seats or 24 feet of bench length, whichever is greater.

(8) Kindergarten, Day Nursery, or Equivalent Private or Parochial School – One driveway, designed for continuous flow of passenger vehicles for the purpose of loading and unloading children plus one parking space for each two employees.

(9) Campground – One space for each campsite.

(C) Retail and Office Uses

(1) Store, Supermarket, and Personal Service Shop – One space for each 400 square feet of gross floor area.

(2) Service and Repair Shop – One space for each 600 square feet of gross floor area.

(3) Bank or Office, including Medical and Dental – One space for each 300 square feet of gross floor area.

(4) Restaurant, Coffee Shop, Tavern or Bar – One space for each 100 square feet of gross floor area.

(5) Mortuary – One space for each four chapel seats or eight feet of bench length.

(D) Manufacturing and Storage

(1) Manufacturing – One space for each two employee positions on the largest shift, or one space for each 800 square feet of non-storage gross floor area, whichever is greater.

(2) Storage – One space for each 5,000 square feet of storage area for the first 20,000 square feet, plus one additional space for each additional 50,000 square feet.

(E) Unspecified Uses

Any use not specifically listed above shall have the requirements of the listed use or uses deemed most nearly equivalent by the Planning Director.

(Ord. 1187, Amended, 11/17/2011; Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4210 MINIMUM REQUIRED OFF-STREET LOADING SPACES

(A) Commercial, Office or Bank

Square foot of Floor or Land Area	Minimum Loading Spaces Required
Under 5,000	0
5,000 - 24,999	1
25,000 - 59,999	2
60,000 - 99,999	3
100,000 - 159,000	4
160,000 - 249,999	5
250,000 - 369,999	6
370,000 - 579,999	7
580,000 - 899,999	8
900,000 - 2,999,999	9
Over 3,000,000	10

(B) Motel

Square foot of Floor or Land Area	Minimum Loading Spaces Required
Under 30,000	1
30,000 - 69,999	2
70,000 - 129,999	3
130,000 - 219,999	4
220,000 - 379,999	5

Square foot of Floor or Land Area	Minimum Loading Spaces Required
380,000 - 699,999	6
700,000 - 1,499,999	7
Over 1,500,000	8

(C) Manufacturing, Wholesale, Storage

Square foot of Floor or Land Area	Minimum Loading Spaces Required
Under 5,000	0
5,000 - 39,999	1
40,000 - 99,999	2
100,000 - 159,999	3
160,000 - 239,999	4
240,000 - 319,999	5
320,000 - 399,999	6
400,000 - 489,999	7
490,000 - 579,999	8
580,000 - 699,999	9
670,000 - 759,999	10
760,000 - 849,999	11
850,000 - 939,999	12
940,000 - 1,029,999	13
Over 1,030,000	14

(D) Public or Semi-Public Use: Treated as mixed uses.

(E) Unspecified Uses

Any use not specifically listed above shall have the requirements of the listed use or uses deemed most nearly equivalent by the Planning Director.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

§ 33.4215 EXCEPTIONS FROM REQUIRED OFF-STREET PARKING OR LOADING SPACES

(A) The Planning Director may grant an exception with or without conditions for up to 30% of the required number of off- street parking or loading spaces, upon a finding by the Director that there is substantial evidence that the number of spaces required is inappropriate or unneeded for the particular use, based upon:

(1) A history of parking or loading use for comparable developments;

(2) The age, physical condition, motor vehicle ownership or use characteristics or other circumstances of residents, users or visitors of the use; or

(3) The availability of alternative transportation facilities; and

(4) That there will be no resultant on-street parking or loading or interruptions or hazards to the movement of traffic, pedestrians or transit vehicles.

(B) The Director shall file with the application for the building or other required permit, findings in support of any exception, including any conditions of approval.

(C) An exception in excess of 15% of the required number of spaces shall include a condition that a plan shall be filed with the application, showing how the required number of spaces can be provided on the lot in the future.

(Ord. 997, Repealed and Replaced, 10/31/2002; Ord. 953 §2, Reorg&Renum, 11/30/2000)

EXHIBIT B

(Ord. 1082, Amended, 09/28/2006)

§ 33.7601 PURPOSE

(A) The regulations of this Zoning Code Chapter are designed to implement the Policies of the Comprehensive Framework Plan and each Rural Area Plan. However, it is also recognized that because of the diversity of lands and properties found in the county there should be a zoning provision that permits justifiable departures from certain Zoning Code dimensional standards where literal application of the regulation would result in excessive difficulties or unnecessary hardship on the property owner.

(B) To address those situations, modification of the dimensional standards given in MCC 33.7606 may be permitted if the approval authority finds that the applicant has satisfactorily addressed and met the respective approval criteria in MCC 33.7611, Adjustments, or 33.7616, Variances. If an Adjustment or Variance request is approved, the approval authority may attach conditions to the decision to mitigate adverse impacts which might result from the approval.

(C) The Adjustment review process provides a mechanism by which certain dimensional standards may be modified no more than 40 percent if the proposed development continues to meet the intended purpose of the regulations. Adjustment reviews provide flexibility for unusual situations and allow for alternative ways to meet the purposes of the regulation.

(D) The Variance review process differs from the Adjustment review by providing a mechanism by which a greater variation from the standard than 40 percent may be approved for certain zoning dimensional requirements. The Variance approval criteria are based upon the traditional variance concepts that are directed towards consideration of circumstances or conditions on a subject property that do not apply generally to other properties in the same vicinity.

All proposed modification of the dimensional standards given in MCC 33.7606(A)(2) shall be reviewed under the Variance review process regardless of the proposed percentage modification.

(Ord. 1082, Add, 09/28/2006)

§ 33.7606 SCOPE

(A) Dimensional standards that may be modified under an Adjustment review (modified no more than 40 percent) are yards, setbacks, forest practices setbacks, buffers, minimum front lot line length, flag lot pole width, cul-de-sac length, cul-de-sac turnaround radius, and dimensions of a private street, except the following:

(1) Reduction of resource protection setback requirements within the Significant Environmental Concern (SEC) and Willamette River Greenway (WRG) overlay districts are prohibited. Additionally, reductions to the fire safety zones in the Commercial Forest Use zones are not allowed under the Adjustment process; and

(2) Reduction of yards and setback requirements within the Hillside Development overlay shall only be reviewed as a Variance; and

(3) Reduction of yards/setback/buffer/resource protection setback requirements within the Large Fills, Mineral Extraction, and Radio and Television Transmission Towers Code Sections and any increase to the maximum building height shall only be reviewed as Variances; and

(4) Minor modification of yards and setbacks in the off-street parking and design review standards are allowed only through the "exception" provisions in each respective Code section.

(B) Dimensional standards that may be modified under a Variance review are yards, setbacks, forest practices setbacks, buffers, minimum front lot line length, building height, sign height, flag lot pole width, cul-de-sac length,

cul-de-sac turnaround radius, and dimensions of a private street, except the following:

(1) Reduction of resource protection setback requirements within the Significant Environmental Concern (SEC) and Willamette River Greenway (WRG) overlay districts; and

(2) Modification of fire safety zone standards given in Commercial Forest Use districts; and

(3) Increase to any billboard height or any other dimensional sign standard.

(C) The dimensional standards listed in (A) and (B) above are the only standards eligible for Adjustment or Variance under these provisions. Adjustments and Variances are not allowed for any other standard including, but not limited to, minimum lot area, modification of a threshold of review (e.g. cubic yards for a Large Fill), modification of a definition (e.g. 30 inches of unobstructed open space in the definition of yard), modification of an allowed density in a Planned Development or houseboat moorage, or to allow a land use that is not allowed by the Zoning District.

(Ord. 1176, Amended, 03/03/2011; Ord. 1082, Add, 09/28/2006)

§ 33.7611 ADJUSTMENT APPROVAL CRITERIA

The Approval Authority may permit and authorize a modification of no more than 40 percent of the dimensional standards given in MCC 33.7606 upon finding that all the following standards in (A) through (E) are met:

(A) Granting the adjustment will equally or better meet the purpose of the regulation to be modified; and

(B) Any impacts resulting from the adjustment are mitigated to the extent practical. That mitigation may include, but is not limited to, such considerations as provision for adequate light and privacy to adjoining properties, adequate access, and a design that addresses the site topography, significant vegetation, and drainage; and

(C) If more than one adjustment is being requested, the cumulative effect of the adjustments results in a project which is still consistent with the overall purpose of the zoning district; and

(D) If the properties are zoned farm (EFU) or forest (CFU), the proposal will not force a significant change in, or significantly increase the cost of, accepted forestry or farming practices on the subject property and adjoining lands; and

(E) If in a Rural Residential (RR) or Burlington Rural Center (BRC) zone, the proposal will not significantly detract from the livability or appearance of the residential area.

(Ord. 1175, Amended, 02/10/2011; Ord. 1082, Add, 09/28/2006)

§ 33.7616 VARIANCE APPROVAL CRITERIA

The Approval Authority may permit and authorize a variance from the dimensional standards given in MCC 33.7606 upon finding that all the following standards in (A) through (F) are met:

(A) A circumstance or condition applies to the property or to the intended use that does not apply generally to other property in the same vicinity or zoning district. The circumstance or condition may relate to:

(1) The size, shape, natural features and topography of the property, or

(2) The location or size of existing physical improvements on the site, or

(3) The nature of the use compared to surrounding uses, or

(4) The zoning requirement would substantially restrict the use of the subject property to a greater degree than it restricts other properties in the vicinity or district, or

(5) A circumstance or condition that was not anticipated at the time the Code requirement was adopted.

(6) The list of examples in (1) through (5) above shall not limit the consideration of other circumstances or conditions in the application of these approval criteria.

(B) The circumstance or condition in (A) above that is found to satisfy the approval criteria is not of the applicant's or present property owner's making and does not result solely from personal circumstances of the applicant or property owner. Personal circumstances include, but are not limited to, financial circumstances.

(C) There is practical difficulty or unnecessary hardship to the property owner in the application of the dimensional standard.

(D) The authorization of the variance will not be materially detrimental to the public welfare or injurious to property in the vicinity or zoning district in which the property is located, or adversely affects the appropriate development of adjoining properties.

(E) The Variance requested is the minimum necessary variation from the Code requirement which would alleviate the difficulty.

(F) Any impacts resulting from the variance are mitigated to the extent practical. That mitigation may include, but is not limited to, such considerations as provision for adequate light and privacy to adjoining properties, adequate access, and a design that addresses the site topography, significant vegetation, and drainage.

(Ord. 1082, Add, 09/28/2006)

EXHIBIT C

Multnomah County
Department of Business and Community Services

MULTNOMAH COUNTY ROAD RULES

Prepared By:

Land Use and Transportation Program

January 5, 2004

MULTNOMAH CONTY ROAD RULES

Table of Contents

1.000 Legal Authority

These rules are promulgated under the Director's authority contained in Multnomah County Code 29.500. et seq.

2.000 Purpose statement

The purpose of these rules is to govern the administration of roads under the jurisdiction of Multnomah County in accordance with MCC 29.500 through 29.999 and in keeping with Policies 32, 33, 34, 35, 36, 37 and 38 of the County Comprehensive Framework Plan.

These rules provide the link between the County Code provisions of MCC 29.500, et seq and the Design and Construction Manual adopted under the provisions of these rules pursuant to MCC 29.571. In addition, these rules are the "Street Standards Rules" referenced in the Land Division Code parts of the Multnomah County Zoning Code Chapters and are therefore one of the implementation tools for establishing standards for street design and improvements.

3.000 Glossary of Terms

AASHTO: American Association of State Highway and Transportation Officials.

ADA: Americans with Disabilities Act.

Access: Any point of permitted ingress or egress from a site to a public road.

Accessway: A private road or way, which is not a part of a lot or parcel and which provides access to more than one lot or parcel. The standards for an Accessway are set in the Multnomah County publication "Permit Requirements for Accessway Construction" first adopted in May 1979 and including all subsequent amendments.

Access Spacing: The measured distance between the center of one driveway and the center of the next adjacent driveway on the same street. The next adjacent driveway can be on the opposite side of the street.

Arterial: Arterials are County Roads that comprise the regional transportation network and provide for travel between communities within the County as well as between counties. Arterials are typically three to five lanes in width and serve a high volume of through traffic. Minor, Major, Principal and Rural are sub-categories of the Arterial Classification.

Banner: For the purposes of these rules, a "banner" means a decoration or public notice of any kind placed within the public right-of-way of a County Road including but not limited to notices or other flyers attached to posts or other structures; or posters or other banners that span across or hang, within the right-of way.

Board: Board of County Commissioners of Multnomah County, Oregon.

Boulevard: A design overlay of a County Road that can include amenities such as wide sidewalks, street trees, on-street parking pedestrian scale lighting and landscaped medians

Collector: Collectors are County Roads that distribute traffic between local streets and the Arterial network. Collectors are typically two to three lanes in width, and serve more local trips and fewer through trips than Arterials. Neighborhood, Major, and Rural are sub-categories of the Collector classification.

County Engineer: Multnomah County Engineer, or designee. The County Engineer serves as the County Road Official, in accordance with ORS 368.046.

County Road: A public road under the jurisdiction of Multnomah County, that is maintained by the County and has been designated as a county road.

County Road Official: See County Engineer.

Design and Construction Manual (DCM): Multnomah County Design and Construction Manual, includes the engineering standards and specifications to be followed for new and improved roadways under Multnomah County jurisdiction.

Director: Director of the Multnomah County Department of Business and Community Services (and all successor Departments), or designee.

Extended Temporary Closure: A temporary closure of the road for authorized roadwork purposes for a period of thirty (30) days or longer.

Functional Classification: Hierarchy of County roads based upon the traffic volumes and land uses that they serve, as adopted in Multnomah County Comprehensive Framework Policy 34.

Half-Street Improvement: Improvements to the right–of-way along the entire length of a property's frontage necessitated by Transportation Impact from development or as otherwise required in the County Design and Construction Manual based upon the functional classification of the road, usually limited to improvements constructed to the centerline from the abutting property.

Green Street: A right-of-way design that incorporates storm water management and treatment within the right-of-way, using natural elements such as swales, trees and other vegetation.

Land Division: A subdivision or partition.

Local Access Road: A public road under Multnomah County jurisdiction that is outside a city and is not a county road, state highway or federal road. The County is not responsible to maintain, repair or improve a local access road unless the Board finds an emergency or public need as required under ORS 368.031.

MUTCD: Manual of Uniform Traffic Control Devices, produced by the Federal Highway Administration.

Off-Site Improvements: Any required public improvements not within or directly adjacent to a development site necessitated by of the Transportation Impact of a development.

Private Driveway: A private means of access, connecting one or more properties to the local public road system. A private driveway may be a private access easement that connects properties to the local public road system.

Private Road A private road is a private accessway built on a separate lot from the lots it serves, connecting more than one property to the local public road system and each lot using the private road for access has an undivided interest in the private road.

Pro-Rata Share: A proportional share of road improvements based upon road frontage and/or transportation impact.

Public road: A road over which the public has a right of use that is a matter of public record. County roads, city streets, state highways, federal roads and local access roads are all public roads.

Regional Transportation Plan: The Metro region's 20 year capital improvement plan.

Right of Way: Property that the public has a right to use for transportation and transportation related purposes.

Road: Any public or private way that provides ingress to or egress from property or that provides for travel between properties. "Road" includes, but is not limited to:
(a) Ways described as streets, highways, throughways or alleys;

(b) Road related structures that are in the right of way such as tunnels, culverts or similar structures; and
(c) Structures that provide for continuity of the right of way such as bridges.

Rural: The unincorporated area outside the urban growth boundary as designated on the most current map maintained by Metro, the regional government with responsibility for the boundary.

Special Event: Any sponsored activity held on a County road or bridge, which significantly interrupts the normal operation and maintenance of the facility or the normal vehicular or pedestrian traffic; or any such activity, which employs a road or bridge in a use outside of its primary use.

Transportation Impact: The affect of any new construction or alteration which will increase the number of trips generated by a site by more than 20 percent, by more than 100 trips per day or by more than 10 trips in the peak hour shall be found to have a *Transportation Impact*. A minimum increase of 10 new trips per day is required to find a transportation impact.

Trip: A one-way vehicular movement. A vehicle entering a property and later exiting that property has made two trips. "Trip" can also be applied to bicycle or pedestrian movements in the same way.

Urban: The area inside the urban growth boundary as designated on the most current map maintained by Metro, the regional government with responsibility for the boundary.

4.000 Access to County Roads

4.100 *Required Information:* Applicants for a new or reconfigured access onto a road under County Jurisdiction **may** be required to provide all of the following:

A. Site Plan;
B. Traffic Study-completed by a registered traffic engineer;
C. Access Analysis-completed by a registered traffic engineer;
D. Sight Distance Certification from a registered traffic engineer; and
E. Other site-specific information requested by the County Engineer

4.200 *Number:* Reducing the number of existing and proposed access points on Arterials and Collectors and improving traffic flow and safety on all County roads will be the primary consideration when reviewing access proposals for approval. One driveway access per property will be the standard for approval. Double frontage lots will be limited to access from the lower classification street. Shared access may be required in situations where spacing standards cannot be met or where there is a benefit to the transportation system.

4.300 *Location:* All new access points shall be located so as to meet the access spacing standards laid out in the Design and Construction Manual.

4.400 *Width:* Driveway and Accessway widths shall conform to the dimensions laid out in the Design and Construction Manual.

4.500 *Sight Distance:* All new access points to roads under the County's jurisdiction must have a minimum sight distance equal to the standards in the Design and Construction Manual and AASHTO's A Policy on Geometric Design of Highways and Streets.

4.600 *County Road Projects:* When the County conducts a public works project that includes frontage or other improvements to a County road as part of a Capital Improvement Project, the following conditions are applicable:

A. Driveway drops will be in their existing location, or in an alternative location that can be constructed to meet the standards of the Design and Construction Manual unless the permit specifies a non-standard improvement.
B. Only one driveway drop per frontage will be constructed by the County unless permits for multiple driveways exist or a Variance Request for an additional driveway is granted by the County Engineer. The location of consolidated access points will be determined by the County Engineer. Undeveloped parcels will not have any driveway drops constructed by the County unless an access is already permitted or a Variance Request for a driveway is granted by the County Engineer.
C. Driveway drops will be constructed to meet the standards of the Design and Construction Manual unless the permit specifies a non-standard improvement.

5.000 Transportation Impact

5.100 To determine if a Transportation Impact is caused by a proposed development, the County Engineer will determine the number of new trips generated by a site by one of the following methods:

A. Calculations from the most recent edition of the Institute of Transportation Engineers' Trip Generation (ITE); or

B. A site development transportation impact study conducted by a professional engineer registered in the State of Oregon and accepted by the County.

5.200 The County Engineer will use the information obtained pursuant to sub-section 5.100 and/or the frontage length of the subject property to determine the pro-rata share of the requirements set forth in Section 6.000.

5.300 Except where special circumstances require the County Engineer to make an alternate determination, any new construction or alteration which will increase the

number of trips generated by a site by more than 20 percent, by more than 100 trips per day or by more than 10 trips in the peak hour shall be found to have a *Transportation Impact*. A minimum increase of 10 new trips per day is required to find a transportation impact.

6.000 Improvement Requirements

6.100 *Site Development:* The owner of the site or the applicant for a proposed development, which is found to cause a *Transportation Impact* will be responsible for improvements to the right-of-way as follows:

A. *Dedication Requirement*: The owner is responsible for a pro-rata share, as determined by the County Engineer, of right-of-way and easement dedications necessary to bring the affected, existing, created or planned public streets and other facilities within and abutting the development to the current County standard. The dedication of the required easements and right-of-way may be conditions of approval of Design Review or any other development permit related to the proposal.

B. *Frontage Improvement Requirements*: In addition to easement and right-of-way dedication requirements, a pro-rata share may include half-street improvements along all of the site's County Road frontage(s). Improvements shall satisfy the standards of the County Design and Construction Manual based upon the functional classification of the road(s). The commitment to improve the affected streets or other facilities to the required standards shall be conditions of approval of Design Review or any other development permit related to the proposal. Half-street improvements can include all of the following:

1. Street widening/improvement
2. Utility cut restoration
3. Curb and sidewalk
4. Driveway relocation/replacement/removal
5. Traffic controls
6. Drainage facilities
7. Lighting facilities
8. Bicycle facilities
9. ADA ramp construction/reconstruction
10. Signal conduit facilities
11. Street trees
12. Other appropriate facility requirements

6.200 *Land Division:* Right-of-way and easement dedications needed to meet County standards may be required as a condition of all land divisions. Improvements will be required when there will be no further opportunity for County comment on the development of the subject property through a mechanism such as design review.

Land Divisions that create flag lots will be required to make frontage improvements along the entire length of the parent lot. The County Engineer may allow deferral of this improvement requirement until development of the flag lot(s) occurs. When further reviews or approvals will be necessary before development can occur, the County Engineer may allow deferral of those improvement requirements and not apply them to land division proposals.

6.250 *Lot-Line Adjustments:* Right-of-way and easement dedications needed to meet County standards may be required as a condition of a lot-line adjustment. Lot-line adjustments that would result in a reduction of the County road frontage of a lot planned for development or redevelopment may be conditioned to provide right-of-way and easement dedications, as well as deed restrictions committing the owner to improve the reconfigured lot's frontage to County standards.

6.300 *Zone Change:* A Transportation impact study over the 20-year planning horizon will be required for all zone changes that would allow more intensive use of a site than allowed by the site's existing zoning. Improvement requirements for zone changes will be based upon, but not bound by, the needs identified in the transportation impact study.

6.400 *Exceptions:* Not withstanding 6.100 through 6.300, improvement requirements will not exceed the limits set by applicable state and federal law.

7.000 Transportation Impact Studies

7.100 The County Engineer may require that a transportation impact study be submitted to the County as a part of a land development proposal at the Engineer's discretion. The scope of the study will be set by the County Engineer and by the standards in the Design and Construction Manual. The County may develop conditions of approval based upon the findings of a traffic study, but the County is not bound by those findings.

8000 Off-site Improvement Requirements

8.100 It is County policy to require off-site improvements as a condition of a site development permit to satisfy safety requirements, development created capacity needs, County road maintenance requirements, Uniform Fire Code requirements, ADA requirements and other public service requirements, and to protect the public from the detrimental effects of a proposed development.

The most common applications of these requirements are:

A. Connecting street sections which do not abut the development

1. A land division creating a public road shall be responsible for the cost of constructing a continuous, standard County road to a connection with the nearest publicly maintained road.

2. Any development utilizing a local access road must provide a road that conforms to the requirements of the Design and Construction Manual from their frontage improvement to the nearest publicly maintained road.

3. Any land development which has been determined to be responsible for the dedication of a half-street right-of-way and is required to improve the street as a condition of approval, must acquire/provide additional right-of-way or easement, or an acceptable modified street design, in order to provide a two-way paved road, approved by the County and the fire district, across the frontage and to a connection with a publicly maintained road.

B. Multiple unit developments, subdivisions, and high pedestrian or traffic generators may be required to provide additional travel lanes, left auxiliary lanes, sidewalks or other pedestrian facilities, and/or signalization on off-site facilities. Improvement requirements will be based upon the additional traffic generated by the development that result in conditions that exceed the design capacity of the facility, create a safety hazard or create an on-going maintenance problem.

9.000 Compliance Method

9.100 Once frontage or off-site improvement requirements have been established, one or any combination of the following methods must be used to satisfy those requirements:

9.200 *Construction Permit:* Property owner/developer must obtain a County Permit under Section 18 to construct any of the required improvements.

9.300 *Payment in-lieu-of Construction:* County may at its discretion authorize payment in lieu rather than construction of improvements if the County determines that there is a benefit to the public in delaying the construction of the development-related improvements or combining the improvements with a larger County project. In lieu of construction by the property owner, the County Engineer may require a cash payment in order to satisfy improvement requirements established as a condition of a development permit. Payment will be administered through a Payment in-Lieu-of Construction Agreement, as described in section 18.225 of these rules.

9.400 *Non-Remonstrance Agreement:* This agreement shall be recorded in the County's Deed Records against the affected property and "runs with the land", thereby obligating the property owner and any successors in interest to share in the cost of

the necessary improvements and to not remonstrate (object) against a petition or resolution for necessary improvements. In approving this method, the County Engineer may require a temporary improvement appropriate to the circumstances.

9.500 *Project Agreement:* The County, the developer and the property owner execute a written agreement to share the costs of design and construction of a road project consistent with any applicable laws and regulations. The agreement shall identify the roles and responsibilities of the parties and must be signed by both the County Engineer and the developer and all property owners.

10.000 Corridor Specific Cross-Section Overlay

10.100 In addition to a set of standard cross-sections set forth in the Design and Construction Manual at Section 2.2 (2000), the County may develop a corridor specific cross-section overlay design for all or a portion of a County road, but only in the following circumstances:

A. A topographical, environmental or other constraint makes it unfeasible or undesirable to construct a typical cross-section within the corridor;
B. The set of land uses within the corridor will be best served by a non-standard cross-section;
C. The corridor is identified as a suitable location for a cross-section pilot project, such as a Green Street design;
D. The corridor is identified as a Boulevard in the Regional Transportation Plan; or
E. The corridor is identified as a freight route in the Regional Transportation Plan or other adopted plan, or the route serves industrial or manufacturing uses that generate a high percentage of freight traffic.

10.200 A corridor specific cross-section overlay design as allowed under this Section for a County road, must be developed in cooperation with any cities through which the road passes and adopted by the Board. Once a cross-section overlay has been adopted, it will be used for all future improvements within the corridor, including developer-initiated improvements.

11.000 Local Access Roads

11.100 *Improvement Requirements:* Any new development where access is to be to a Local Access Road and the development is found to have a transportation impact will require the developer to improve the Local Access Road. The developer shall make appropriate improvements along the frontage of the developed property or a greater distance if the transportation impact warrants additional road improvements. Such additional improvements shall not extend beyond the nearest intersection with a publicly maintained road. Improvements will be constructed in a manner consistent with the standards provided in the Design and Construction Manual.

11.200 *Naming:* Naming or renaming of local access roads shall be done pursuant to MCC 11.05.500 through 11.05.575 or its successor.

12.000 Private Roads

12.100 *Authority*: Private roads are not subject to the authority of the County Transportation regulations and rules. Authority over private roads belongs to the land use and planning jurisdiction where the private road is located.

13.000 Temporary Road Closures

13.100 *When Applicable:* A road is considered closed under this Section when all of its lanes are closed to through traffic for any extended period of time not less than one hour for the purposes of authorized road work as provided under these Rules. Temporary road closures for Special Events are not subject to this Section and are regulated under Section 21 of these Rules.

13.200 *Road Closure:* The County Engineer may initiate a proposal for a temporary closure upon the Engineer's own volition, or upon receiving a request in writing from a citizen, an elected County official, a contractor performing work in the right-of-way or an official of a city in which the road is located. If the proposed roadwork is authorized under these Rules, the County Engineer will review any request for temporary closure subject to the following considerations:

A. Traffic safety during the closure, which may be satisfied by a traffic control plan accepted by the County Engineer;
B. Access and circulation for impacted properties in the area during the closure
C. Maintenance considerations during the closure;
D. Undesirable effects on impacted properties and any other circumstances that can be documented resulting from the closure;
E. Availability of reasonable alternatives to complete closure, if the closure would cause undue interference or hardship with the public's use of the road;
F. Receipt of a sufficient deposit to cover the County's administrative costs and costs of posting or publishing notice as required under these Rules; and
G. Emergency road repair.

13.250 *Notice of Intent to Close:*

A. The method of public notice required as a condition of a temporary road closure will be determined by the County Engineer based upon the length of closure, the traffic volume of the road to be closed, the availability of alternate routes and the anticipated impact of the closure on the surrounding transportation system. Possible public notice methods may include one or all of the following:

1. Notice of temporary closure signs at each end of the road or road segment to be closed;
2. Advertisement(s) in a newspaper of general circulation; and
3. Individual notices to abutting property owners.

B. Both posted and published notices shall contain the following information:

1. Description of the proposed action
2. Date(s) of the proposed closure
3. Request for comments to the County Engineer
4. Address of the County Engineer
5. Last date for accepting comments
6. If applicable, the date the matter is to be heard by the County Board of Commissioners, if required under Section 13.211.
7. If applicable, the time limit, location, format, and contact person for requesting a public hearing on closure other than under Section 13.211.

13.300 *Request for Public Hearing:* If a request for public hearing is received during the comment period as described in MCC 29.537, the County shall announce and conduct a public hearing on the closure as set forth in MCC 29.538 through 29.540, dealing with a closure instead of a rule adoption.

13.350 *Physical Barriers:* Shall be selected by the County Engineer to affect the closure giving consideration to aesthetics, safety, maintenance and economics.

13.400 *Traffic Control Plan Required:* The applicant or permitee shall submit a traffic control plan that conforms to the requirements set forth in the Design and Construction Manual for approval by the County Engineer. The street may not be closed until approval has been granted.

13.450 *Requests for Closures:* Requests for closure of twenty-four (24) hours or more must be submitted at least 14 days before the proposed closure. Public notice will be required for closures of more than twenty-four (24) hours. Requests for closures of twenty-four (24) hours or less may be authorized by the County Engineer without public notice.

13.500 *Access to Property During Closures:* To the extent feasible, access to property adjacent or abutting any temporary road closure must be maintained for occupants, patrons and emergency services.

13.600 *Extended Temporary Closures, Mandatory County Board Review; Procedures:*

A. An extended temporary closure is a road closure of thirty (30) days or more. Any request for an extended temporary closure of a County Arterial or Collector is subject to the following procedures:

1. The applicant /permittee must submit a written request 60 days before the proposed extended closure to the County Engineer;
2. The applicant/ permittee must post a deposit to cover the cost of the County's administrative costs and required public notice for submittal to the Board;
3. The County Engineer will review the request and associated traffic control plan for compliance with County standards;
4. If after completion of the County Engineer's review the County Engineer deems the closure reasonable, the County Engineer will submit the proposed closure to the Board of County Commissioners for consideration;
5. The Board's review is denovo and the Board shall review and consider the request according to the same criteria as set forth in Section 13.200; and
6. The Board retains full discretion to approve, amend, postpone, remand to the County Engineer or reject the request.

B. Any request for an extended temporary closure on any road that the County Engineer determines will cause an undue interference or hardship, such as the closure of a high volume road or a road with limited alternate routes, will be submitted to the Board for final determination in the same manner as provided in sub-section A of this Section.

13.700 *Emergency Road Closures:* Notwithstanding any other provisions of these Rules, the County Engineer may close a road without notice if a hazardous condition develops on or along a road that threatens public safety, private property or the road itself. An emergency closure may last as long as necessary to rectify the hazardous condition that led to closure.

14.000 Vacation of Right-of-Way

14.100 Except as provided herein all Vacation of Right-of-Way proceedings shall be conducted in a manner consistent with ORS 368.126, ORS 368.326 to 365.366 and the Multnomah County Code.

14.200 *Preliminary Feasibility Study:* An abutting property owner may request the County Transportation Division prepare a Preliminary Feasibility Study (PFS) to evaluate a proposal for the vacation of County controlled right-of-way.

14.300 *Fees, Timeline and Scope:* A request for a PFS shall require a non-refundable fee as established by County Resolution. The County's timeline to prepare the PFS shall be flexible, dependent upon staff availability and resources to perform the task, but shall be produced no later than 45 days from the receipt of the required fee. The focus and scope of the PFS will be to assess whether the vacation serves the public interest and is consistent with all applicable State, Regional and Local plans for the County's planning and transportation needs. The PFS shall contain findings sufficient to support the conclusion to recommend, recommend as

modified or reject the proposed vacation and shall be signed by the County Engineer. The County Engineer will not make a supportive recommendation if the PFS establishes that any of the following circumstances apply:

A. The existing right-of-way currently serves a road purpose or other public purpose;
B. The existing right-of-way will serve a road purpose or other public purpose in the foreseeable future; or
C. A Land Use code violation exists on the property owned by the petitioner.

14.400 *Formal Vacation Request:* After the completion of a Preliminary Feasibility Study for the vacation of a County right-of-way, a Vacation Petition may be submitted to the County pursuant to ORS 368.341(1)(c), and must include:

A. Legal description of the property to be vacated, including all easements
B. Statement of reason for the vacation;
C. Names and addresses of all persons holding any recorded interest in the property to be vacated;
D. Petitioner shall procure a comprehensive title report and provide a complete copy of the report to the County;
E. Names and addresses of all persons owning any improvements constructed in, under or above the area proposed to be vacated and shall include written responses from such persons (includes written responses from utility companies stating existence of utilities and any easement requirements if utilities exist.);
F. Names and addresses of all persons owning real property abutting public property proposed to be vacated;
G. Notarized signatures of either owners of record of at least 60 percent of the land abutting the property proposed to be vacated or at least 60 percent of the owners of land abutting the property proposed to be vacated evidencing their consent to the proposed vacation.
H. A subdivision plan or partitioning plan showing the proposed re-division. If the petition is for vacation of property that will be re-divided in any manner; and
I. Notarized signatures of persons with the authority to bind any impacted party identified under C or E above evidencing their consent to the proposed vacation.

Once the Vacation Petition is deemed complete, the County Engineer shall submit the petition for vacation and a supplementary staff report with a final staff recommendation to the Board.

14.500 *Vacation Request Fees:*

A. All costs associated with preparing a Vacation Petition are the responsibility of the petitioner.

B. Each filing of a County right-of-way vacation application shall be accompanied by a deposit of 120% of estimated costs based on the projected hours or materials required to investigate and process the petition. An additional fee for the County Surveyor to post the street vacation as required by ORS 271.230 (2) will be required. This deposit does not include any recording fees collected by the County Clerk.

C. The final fee will be determined at completion of the project based on actual costs incurred by the County, including overhead and other related costs. The difference between the actual costs and the deposit amount will be billed or refunded to the applicant. An approved County right-of-way vacation will not be recorded until all outstanding fees are paid.

14.600 *Joint Jurisdiction:* Any vacation proceeding over public right-of-way subject to the joint jurisdiction of the County and another governmental body shall be conducted in a manner consistent with the requirements and procedures set forth under Oregon law.

15.000 Truck and Transit Restrictions

15.100 *Local Roads Restrictions:* Through trucks of any size and transit vehicles are prohibited on local roads within the County's jurisdiction that are not arterials or collectors.

15.200 *Truck/Transit Size Restrictions:* The County Engineer may prohibit or regulate truck or transit movements as authorized under State and Federal law on all roads established as arterial and collectors.

15.300 *Truck Routes:* Consistent with State and Federal law, the County Engineer may designate through truck routes for movement of trucks in the County road system.

16.000 Variance from County Standards and Requirements

16.100 *Variance Requirements:*

A. Multnomah County Code 29.507 provides for a variance by the County Engineer from County standards and requirements when written documentation substantiates that the requested variance is in keeping with the intent and purpose of County Code and adopted rules, and the requested variance will not adversely affect the intended function of the County road system or related facilities. A variance approval may include mitigation measures as conditions of approval.

B. All requests for a variance to these Road Rules that are part of a development that requires approval of that development as a "land use decision" or "limited

land use decision," as defined in ORS 197.015, shall be submitted to the County Engineer at the time that application for the land use review is submitted to the applicable planning office having land use jurisdiction. The County Engineer' decision on the variance to these Road Rules shall not become effective until the date that the associated land use decision becomes effective.

C. For properties within unincorporated areas of Multnomah County for which Multnomah County has not contracted for planning and zoning services, the Hearings Officer shall be the final County decision maker for all applications for variances to these Rules that are in conjunction with applications for development classified as a "Type III" or an appeal of a "Type II" land use permit application under MCC Chapter 37 or the corresponding code parts in MCC Chapter 38, as applicable.

16.200 *General Variance Criteria:* In order to be granted a variance, the applicant must demonstrate that:

A. Special circumstances or conditions apply to the property or intended use that do not apply to other property in the same area. The circumstances or conditions may relate to the size, shape, natural features and topography of the property or the location or size of physical improvements on the site or the nature of the use compared to surrounding uses;

B. The variance is necessary for the preservation and enjoyment of a substantial property right of the applicant and extraordinary hardship would result from strict compliance with the standards;

C. The authorization of the variance will not be materially detrimental to the public welfare or injurious to other property in the vicinity, or adversely affect the appropriate development of adjoining properties;

D. The circumstances of any hardship are not of the applicant's making.

16.225 *Access Variance Standards:* Exceptions to access standards may be made by the County Engineer when spacing or other safety considerations make non-standard access acceptable. In addition to the variance requirements of Section 16.200 of these Rules, the applicant will be required to demonstrate that the proposed variance will not negatively impact the safety or capacity of the transportation system for a variance to be granted. The following are examples of variances that may be considered along with specific criteria that must be addressed before such a variance can be granted.

A. *Multiple Access Points:* The County Engineer may allow multiple access points when all spacing standards can be met, or when the additional access(es) will not negatively impact the safety or functionality of the

transportation system and a single access point cannot reasonably serve a site. Movement restrictions, such as right-in, right-out, may be placed on accesses to protect the safety and/or functionality of the transportation system.

B. *Access Spacing:* If it is not feasible to access a site and meet the access spacing standards, access may be located so as to provide the best access spacing possible. The County Engineer may require additional measures to mitigate sub-standard access spacing, such as a median or other restrictions.

C. *Sight Distance:* If it is not feasible to provide enough sight distance to meet County/AASHTO standards, the site's access must be located so as to provide the most sight distance possible. The County Engineer may require additional measures to mitigate sub-standard sight distance.

16.250 *Local Access Roads Variance Standards:* The County Engineer will consider a variance from the improvement standards for a Local Access Road in the Design and Construction Manual if the topography or other features of the site make compliance with the improvement standards infeasible. Any variance issued under this Section must meet the criteria of section 16.200 of these rules as well as the minimum requirements of the local police, fire and emergency service providers, any applicable Building Code Requirements, any applicable Land Use Code requirements and meet any other applicable environmental requirements.

16.300 *Variance Request Procedure:* For the County Engineer to consider a variance request, it must be submitted in writing with the appropriate fee to the County prior to the issuance of any development permit. The written variance request shall be signed by a person with the authority to bind the applicant and shall include the following information as applicable:

A. Applicant name, telephone/fax number(s), email address, mailing address,
B. Property location and zoning;
C. Current or intended use of the property;
D. The nature and a full description of the requested variance;
E. Site plan, sight distance, pedestrian traffic, intersection alignment, traffic generation, vehicle mix, traffic circulation including impact on through traffic, and other similar traffic safety considerations;
F. Existing right-of-way or improvement limitations, and utility considerations;
G. Adjacent land uses, their types, access requirements, and impact of traffic on them;
H. Topography, grade, side hill conditions, and soil characteristics;
I. Drainage characteristics and problems;
J. Fire Department access requirements within a public right-of-way and their written approval of the proposed modification;
K. Natural and historic features including but not limited to trees, shrubs or other significant vegetation, water courses, wetlands, rock outcroppings, development limitation, areas of significant environmental concern, etc;

L. Multnomah County Comprehensive Plan policies applicable to the particular parcel or location.

16.310 *Completeness, Timelines, Public Notice, Decision:*

A. Once a variance request application has been submitted to the County, the County Engineer will review the variance request application to determine if it contains all of the information necessary to make a decision on the variance request. If the County Engineer is satisfied that all of the needed information is included in the application, it will be deemed complete. If the County Engineer requires more information in order to make his or her decision, the application will be deemed incomplete. The County Engineer will determine completeness within 30 calendar days of receiving a variance request application.

B. If an application is deemed incomplete, a letter will be sent to the applicant with a list of the items that must be included in the application for it to be deemed complete. Upon receipt of the completeness letter, the applicant will have 180 calendar days from the original application submittal date within which to submit the missing information or the application shall be rejected and all materials returned to the applicant.

C. Within 30 days of the mailing of the initial completeness letter, the applicant shall submit to the County Engineer a statement accepting the 180 day time period to complete the application. Failure of an applicant to accept the time to complete the application within that 30 day time period will constitute a refusal to complete the application.

D. Once an application is deemed complete by the County Engineer, or the applicant refuses to submit more information, the County shall take final action, pursuant to 16.100(B) and (C), within 120 days within an urban growth boundary or 150 days outside an urban growth boundary unless the applicant waives or extends the 120 or 150 day time period. However, these time periods do not apply to any application that depends upon a comprehensive plan or land use amendment. The final decision maker, the County Engineer or County Hearings Officer, as applicable, will provide a written decision to the variance request, with either approval, approval with modification, or denial. The decision shall contain specific findings supporting the conclusion reached.

E. Public notice of an application for a variance to these Road Rules shall be as follows:

1. For variance applications not in conjunction with a proposed development requiring a land use decision:

a. Notice of the application and invitation to comment shall be mailed to the applicant, the applicable recognized neighborhood association, and all property owners within 100 feet within the urban growth boundary or within 750 feet outside of the urban growth boundary. The County Engineer will accept comments for 14 days after the notice of application is mailed.

b. Notice of a decision of the County Engineer and information regarding an opportunity to appeal shall be mailed to all parties that were previously mailed the invitation to comment. If no appeal is filed, the County Engineer's decision shall become final at the close of business on the 14th day after the date on the decision. If an appeal is received, notice requirements are the same as those for appeal of a Type II Land Use Permit to the County Hearing's Officer, whose decision is the County's final decision. All subsequent appeal shall be to the Land Use Board of Appeals.

2. For variance applications in conjunction with a proposed development requiring a land use decision the notice requirements shall be the same in scope and timing as those used in the land use application process of the respective jurisdiction.

16.400 *County Engineer Initiated Variance:* The County Engineer may initiate and establish a variance which is in keeping with the intent and purpose of the Code and adopted Rules and meets all the criteria of this section. The nature of the variance and written justification for the action will be included as a part of the County's records.

17.000 Appeals

17.100 *Dual Jurisdiction Situations:* All appeals of County Transportation conditions imposed under these Rules where the county road in question is either within the boundaries of a duly incorporated city or other jurisdiction; or is subject to a jurisdiction transfer agreement between the County and a City, shall be considered Dual Jurisdiction Appeals. A County decision on the transportation elements of a development application is not deemed final until a final decision on the application is issued by the City or other jurisdiction exercising jurisdiction over the application. Any appeal of such a condition shall be through the appeals process of the City or other jurisdiction, typically the land use authority.

17.200 *Sole Multnomah County Jurisdiction:* All appeals of County Transportation conditions imposed under these Rules in unincorporated areas other than as provided in section 17.100 shall be conducted pursuant to the appeal procedures contained in Multnomah County Code Chapter 37 or Chapter 38 if the subject area is within the Columbia River Gorge National Scenic Area.

18.000 Right-of-Way Use Permits

18.100 *County Consent And Or Permit Required:* Except where stipulated by an Intergovernmental Agreement between the County and a local jurisdiction, the prior consent of the County Engineer and/or a permit shall be required for any construction, installation, or the placement of any object or fixture; or the planting or placement of any vegetation within the public right-of-way or for any modification of existing construction or use in the right-of-way except as provided in this Section. A Permit shall not be required for any short-term use of 8 hours or less if the County Engineer determines such use is not a hazard to the public and will have no detrimental impact to the right-of-way.

18.110 *Exceptions:* Prior County Consent and or a Permit under this Section are not required for:

A. Any vehicle lawfully parked in the right-of-way,
B. A Banner Permit as provided under Section 19,
C. A Memorial Sign as provided for under Section 20,
D. A Special Event conducted pursuant to a permit issued under Section 21, or
E. Any other lawful public event held in the right of way as provided under Section 21.

18.120 *Permit Issuance:* Permits are issued subject to the approval of city, state, or other governmental bodies having either joint jurisdiction over the permitted facility, or authority to regulate land use by means of zoning and/or building regulations. It is the applicant's responsibility to obtain any approvals required by other governmental bodies.

18.130 *Permit Revocation:* A permit may be revoked at any time by mutual consent; for failure of the applicant to abide by the terms and conditions of the permit as determined in the sole discretion of the County Engineer; to protect public safety as determined by the County Engineer; or by the operation of law.

18.135 *Permit Expiration/ Extension:* A permit shall expire at the time stated on the permit. A permit may be extended at the discretion of the County Engineer for good cause shown and the payment of any applicable extension fee as established by the Board of County Commissioners.

18.140 *Utilities:* The applicant shall be responsible for accommodating any utility facilities located in the road right-of-way impacted by the permitted activity. If the project requires relocation or other affects to existing utilities the applicant shall be responsible for coordinating with the affected utilities to comply with Section 18.275 herein and for the performance of any utility relocation or alteration at no cost to the County and in compliance with applicable State law.

18.150 *Dedications:* All required right-of-way interests necessary to allow for the proposed development project as determined by the County Engineer must be dedicated to the County before a permit will be issued.

18.160 *Restoration Requirements:* Granting of permits is conditioned upon replacement or restoration of the road right-of-way by the applicant to an equal or better condition than existed prior to permit issuance.

18.170 *Trench Cutting Concrete Roads:* All panels affected by a trench cut for the placement of utilities within a concrete road must be removed and replaced. Trench cut patching will not be allowed.

18.180 *Special Provisions:* Right-of-way permits may include specific requirements based upon the impacts of the permitted activity on the right-of-way and the traveling public. These special provisions will be included as conditions of a permit.

18.200 *Construction Permit:*

A. A Construction Permit is required for any activity in the right of way that involves the construction of a facility, structure or otherwise permanently alters any physical aspect of the right of way, except for those activities covered under subsection 18.250 through an Access/Encroachment Permit.
B. The County Engineer shall not issue a Construction permit unless and until the permit fully addresses each of the following:

    1. Complete statement and description of the work to be performed in the County right-of-way, with all applicable documentation including but not limited to any specifications, drawing, plans to be used in construction of the work;
    2. Clear statement of the responsibilities of the property owner, developer and contractor(s) including but not limited to: proof of adequate liability insurance, identity, address, phone, fax and or email address of a qualified contact person for each party involved with the project;
    3. Required fee and deposit amounts are established and or paid as appropriate,
    4. Clear statement of the time period for completion of the work or project,
    5. Any special provisions as authorized and applicable under this Section have been included in the permit; and
    6. A performance guarantee for the work in the right-of-way and a maintenance guarantee for a 2-year period following the completion of the work.

C. Administrative fees to cover the County's cost of issuing and administering the permit shall be charged to the permittee. The fee amounts shall be established by Resolution of the County Board of Commissioners.

D. Both the performance guarantee and the maintenance guarantee required under this Section shall be surety bonds executed by a surety company authorized to transact business in the State of Oregon, or certified checks or other assurance approved by the County Attorney, guaranteeing complete performance. The amount of the performance guarantee will be a sum equal to 110 percent of the actual costs of the improvements, as estimated by the County Engineer. The maintenance agreement will be equal to 10 percent of the performance guarantee amount.

18.250 *Access/Encroachment Permit:*

A. An Access/ Encroachment Permit (A/E Permit) may be required for the following activities within the right-of-way:

1. New or altered access to roads under County jurisdiction. An access is considered altered when a change in the development that it serves has a Transportation Impact as defined in section 6.000 of these rules;
2. New or reconstructed driveway approaches, private road approaches, curb cuts, or sidewalks;
3. Structures in the right-of-way, such as signs, posts, fences, flags, non-standard mailboxes, etc.; or
4. Any other minor physical alteration of the County right-of-way, including but not limited to any altered landscape design, vegetation planting or placement.

B. Unless otherwise provided in the special provisions of the permit, any work authorized pursuant to an access/encroachment permit shall be initiated within ninety days from the date the permit issued and completed within a reasonable time thereafter as determined by the County Engineer.

18.275 *Utility Permit:*

A. The utility permit under this Sub-section governs the construction, installation, removal, relocation or repair, etc., of utilities and related facilities in the public right-of-way as authorized under State law. This permit must be obtained by the owner of the utility or facility for which the work is authorized.

B. Unless otherwise provided in the special provisions of the permit, any work authorized pursuant to a utility permit shall be initiated within ninety days from the date the permit is issued and completed within a reasonable time thereafter as determined by the County Engineer.

C. The utility permit shall comply with all applicable terms and conditions provided under Section 18 of these Rules and may be incorporated or

attached to a general permit issued under Sub-section 18. 200 or 18.250 if the general permittee is not the owner of the utility.

D. A utility permit is necessary if:
   1. The County has received a written request from the owner of a utility authorized to be located in the right-of-way to construct, install, remove relocate or repair an existing or proposed utility as applicable in the County controlled right-of –way.
   2. The County Engineer determines or is otherwise advised that any proposed activity in the right-of–way by a party other than the utility owner will cause the relocation or other impact to any existing utility known to the County at the time the permit is reviewed.

18. 280 *Recent Street Improvement Policy, Exceptions:*

A. After completion of a County Capital Improvement Project, the County's policy is to discourage cutting or digging up right-of-way for a period of 2 years. The County Engineer may grant an exception to this policy if such a delay would cause undue hardships for a utility, property owner, or other person or corporation. The County Engineer may impose one or more of the following requirements as a condition of an exception:

   1. The applicant must pay for a full width overlay of the entire street from curb to curb for the length of the subject property.

   2. The applicant must pay for a portion of the cost of a future overlay in addition to making all repairs as directed by the County.

   3. The applicant must pay for a share of the cost of road repair equal to the amount the County Engineer estimates it costs in reduced road life and future repair costs in addition to making all repairs as directed by the County.

18.300 *Payment in-Lieu-of Construction Agreement:*

A. In lieu of a standard construction improvement, the Director may require a cash payment in order to satisfy the improvement requirements established as a condition of a development permit.

B. The Payment in-Lieu-of Construction improvement method may be applied where there is a benefit to the public in delaying the construction of improvements or combining the improvements with a larger County project.

C. The payment amount will be equal to 110 percent of the actual project costs, as estimated by the County Engineer.

D. The agreement will specify the amount of the payment and the improvements that the payment will be used to construct.

E. Once the County has approved and received a payment under this sub-section, it shall:

1. Deposit the payment into a trust account for that project.
2. Schedule the subject improvements in its 5-year Capital Improvement Program.
3 Budget the project and demonstrate that the conditions of the relevant Payment In-Lieu-of-Construction Agreement will be met in order to release the funds.

F. If the County fails to meet any one of the requirements set forth in Section 18.300(E) within ten (10) years of payment, the payment amount and any interest earned on that amount while held by the County will be returned to the party that made the payment. Unless the party who made the payment gives written authorization to the County to retain the funds for an expanded period of time to construct the original improvements.

G. The County may choose to create a single project which satisfies several agreements. The County may oversize or extend the limits of a project, provided that the County bears the additional cost.

18.400 *Additional Permit Standards and Conditions:* Additional conditions and standards for the specific activities and facilities subject to Section 18 may be required under the County's Design and Construction Manual.

18.425 *Permit Implementation:*

A. The applicant or the applicant's contractor shall advise the County at least twenty-four (24) hours in advance of commencing construction of the facility or other work authorized by a permit. The County may require adjustment of the construction schedule to allow for inspection by the County.

B. The road approach or other facility shall be constructed in conformance with the special provisions and exhibits contained in and attached to the permit. The applicant shall notify the County when construction of the driveway approach or other facility has been completed. The County will then inspect the completed work and advise the applicant whether the work has been completed in a satisfactory manner. If not, the applicant shall promptly correct any deficiencies outlined by the County.

18.450 *Non-Compliance:* The obligation to perform all work and authorized activity under the permit in compliance with all applicable terms and conditions of the

permit is binding on the applicant and all successors and assignees of the applicant.

A. Failure of the applicant to comply with any of the terms and conditions of a permit shall be sufficient cause for immediate revocation of the permit and may result in removal of the utilities, driveway approach or other facility by the County at the applicant's expense, as provided under ORS 374.320.

B. If the applicant fails to complete construction of the facility or other work covered in a permit within the period specified in the permit, the permit shall be deemed null and void and all privileges and fees forfeited unless a written extension is obtained from the County Engineer.

C. The Applicant shall be responsible for all costs incurred by the County to remedy, replace or repair any non-complying work or damage done to any County controlled right-of way as provided under these Rules or other applicable law or regulation.

18.475 *Allocation of Costs:*

A. The entire cost of installing, maintaining, repairing, operating or using the installation or facility, performing miscellaneous operations, or any other expense whatsoever incident to the facilities or operations authorized by a permit shall be paid by the applicant.

B. The applicant shall reimburse the County for any reasonable and necessary expense that the County incurs in connection with the facilities or operation authorized by a permit. The reimbursement to the County shall be made by the applicant within ten days of receiving a bill from the County Engineer. These expenses may include but are not limited to:

1. Emergency repairs by persons other than the applicant when authorized by the County Engineer.

2. Emergency traffic control by persons other than the applicant when authorized by the County Engineer.

3. Quality testing as required under the terms of the permit, or when ordered by the County Engineer to establish permit compliance and the test determined the applicant's work to be noncompliant.

4. Repair of non-conforming installation (non-emergency) thirty (30) days after notification by the County Engineer of a non-conforming use.

18.500 *Liability and Control:*

A. The permittee shall defend, indemnify and hold harmless Multnomah County, its officers, employees and agents against any and all damages, claims, suits, demands, actions, causes of action, costs and expenses of any nature which any of them may sustain by reasons of the acts or omissions of the applicant, its employees, agents, representatives and invitees in connection with any work or other activity performed under the permit including but not limited to construction, maintenance, repair, operation or use of the permitted installation or facility.

B. Multnomah County, its officers, employees and agents shall not be liable for any personal injury or damages to any permitted installation or facility or any connection thereto caused by or resulting from the performance of reasonable road maintenance and construction operations, or a County contractor or permitted operations, or resulting from or caused by motorists or road user operation.

C. The applicant shall employ any and all methods in performing the operation authorized by a permit, which the County Engineer may require in order to properly protect the public, the right-of-way and private property from injury or damage.

D. During the initial installation or construction of the facility authorized by a permit, or during any failure repair, removal, or relocation thereof, or during any miscellaneous operations, the applicant shall at all times maintain such flaggers, signs, lights, flares, barricades and other safety devices as required or recommended by the MUTCD with Oregon Supplements. A traffic control plan or additional traffic control measures may be required prior to permit issuance by the County Engineer if deemed to be reasonably necessary to properly protect traffic upon the road, and to warn and safeguard the public against injury or damage. The applicant shall maintain a watchperson as required to maintain said signs, lights, flares, barricades and other safety devices during non-work hours. The County Engineer may request and be furnished the telephone number and/or address of the watchperson.

E. In the event of an emergency repair the applicant shall so conduct the operation that there will be a minimum of interruption of traffic until a plan for the satisfactory handling of traffic has been approved by the County Engineer. In emergencies, the applicant shall notify the County Engineer as soon as practicable.

F. To ensure compliance with the terms and conditions of the permit, the County Engineer reserves the right to inspect the job whenever the County Engineer deems necessary, to check compliance with the terms of the permit by the

applicant and to require the applicant to correct all deviations from those terms and conditions.

G. Any supervision and/or control exercised by the County Engineer shall in no way relieve the applicant of any duty or responsibility to the general public nor shall such supervision and/or control relieve the applicant from any liability for loss, damage or injury to persons or property.

H. The decision of the County Engineer shall be final with respect to any of the conditions, terms, stipulations, and the provisions of the permit.

18.600 *Insurance:* The applicant/permittee shall obtain and carry a liability and property damage insurance policy or policies as provided herein unless this requirement is altered or waived at the sole discretion of the County Engineer

18.610 *Duration:* Insurance must be carried for the period of time required to construct the facilities authorized by the permit, including the repair and restoration of the road facilities, as well as future periods when operations are performed involving the repair, relocation or removal of the facilities authorized by the permit.

18.620 *Covered Parties:* The insurance policy or policies shall name Multnomah County, its officers, agents and employees as additional insureds and provide coverage against any claim, expense, cost, demand, suit or action for property damage, personal injury, or death resulting from any activities of the applicant, his or her officers, employees, agents or contractor in connection with the permit, except as to claims against the applicant.

18.630 *Coverage Amount:* The insurance policy or policies shall provide coverage not less than $200,000 for personal injury to each person, $500,000 for each occurrence and $500,000 for each occurrence involving property damage; or a single limit policy of not less than $1,000,000 covering all claims per occurrence. The County Engineer reserves the authority to require larger amounts of insurance protection if he or she reasonably concludes that such greater insurance protection is warranted.

18.640 *Insurance Provider:* The insurance policy or policies shall be with an insurance company duly authorized and licensed to conduct business in the State of Oregon. A copy of the policy or policies, or some other such evidence shall be submitted to and approved by the County Engineer before any work is commenced under a permit.

18.700 *Bond:* A permit applicant shall furnish a bond in the amount specified in the Special Provision of a permit for a period of two years. The Bond shall cover the repair and restoration of the road facilities, as well as future repair, relocation or removal of facilities authorized by a permit. The bond must be written by a surety company duly qualified and licensed to do business in the state of Oregon and in a

form satisfactory to the County Engineer. No work shall commence under a permit until the bond has been submitted to and approved by the County Engineer.

18.750 *Disturbance of Existing Conditions:*

A. *Road Surface:* The permittee shall take all reasonable precautions to ensure that the road surface and other improvements are not damaged. The permittee shall repair or replace any damage resulting from the applicant's operations to a level equal to or greater than the previous condition.

B. *Existing Utilities:* All authorized, existing underground utilities shall be protected and kept in operation to the extent possible. If it is necessary to interrupt service of any existing utility, the applicant shall be responsible for proceeding as required under subsection 18.275.

C. *Traffic Signal Detector Loops:* Verification of the existence and location of signal detector loops before excavating in a signalized intersection is the responsibility of the permittee and shall be obtained prior to beginning work. Verification of signal detector loop locations must be obtained from the County and shall be incorporated into the plans as required by the County Engineer.

D. *Protection of Survey Monuments:* The permittee is responsible for locating and protecting all survey monuments in the vicinity of a permitted project during construction. If it is necessary to disturb a monument or if a monument is inadvertently disturbed or destroyed during the course of the applicant's operation, the permittee shall immediately notify the County Surveyor. The applicant shall be responsible for all costs incurred in the restoration or perpetuation of any monuments that may be disturbed due to the permittee's operations.

E. *Drainage:* All road drainage facilities impacted as a result of the permittee's operations shall be repaired or replaced by the permittee to the satisfaction of and at such time as directed by the County Engineer.

F. *Signs and Mailboxes:* All existing streets signs and mailboxes in the way of operation allowed in a permit shall be removed and immediately reset temporarily in a location where they will be noticeable and serve their purpose. After the work is completed or at such time as directed by the County Engineer, the signs and mailboxes shall be permanently reset at their original location or at another location approved by the County Engineer.

G. *Vegetation:* It is strictly forbidden to spray with selective herbicides, or cut or trim trees or shrubs growing in the County right-of-way unless written permission is first obtained from the County Engineer.

18.800 *Maintenance Obligations, Encroachments, Emergency Enforcement:*

A. The owner of all utilities, facilities, structures, vegetation or other encroachments permitted in the County right-of-way shall at all times keep them in good repair. The owner must obtain written approval from the County Engineer prior to performing maintenance on a utility, facility, structure, vegetation or other encroachment in the County right-of-way that will significantly disrupt the normal flow of traffic or pose a safety hazard to the traveling public.

B. The County Engineer shall retain sole discretion as to the extent of the review necessary for any proposed maintenance work in the right-of-way. If the proposed maintenance work requires that the road surface be altered in any way or requires that traffic control be deployed the owner shall obtain written approval from the County, which shall be considered an amendment to the original permit and incorporate and subject to all the terms and conditions of the original.

C. If the County Engineer determines that the lack of maintenance to a permitted facility, utility, structure, vegetation or other encroachment has caused a nuisance or hazard, such lack of maintenance shall be deemed a violation of the terms and conditions of the original permit, and the County Engineer shall proceed as follows:

1. If the County Engineer determines the lack of maintenance creates a nuisance, hazard, a substantial risk of damage, injury or other emergency condition as provided under 368.271(1)(c), the County Engineer shall authorize the County Transportation Division to immediately abate the nuisance or hazard by any means reasonably necessary.

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2. If the situation is not deemed an emergency, notify the owner to perform the repair providing an appropriate time period within which to complete the repair or other work necessary to mitigate the hazard or nuisance. If the owner cannot or will not make the repair within the timeframe set by the County Engineer, the County Engineer may authorize the work to be performed by the County Transportation Division.

D. In either situation identified in subsection 18.800 (C) (1) and (2) the owner of the utility or facility shall bear the full cost of the work. This may include all County costs and shall be paid to the County within 30 days of the receipt of written notice of the costs incurred by the County and a request for payment. If the owner or other responsible parties do not make payment as provided herein the County reserves all rights as authorized pursuant to ORS Chapters 368.374 or other lawful means to procure collection and enforcement of the debt.

E. Any non-permitted utilities, facilities, structures, vegetation or other encroachment in the right-of-way shall be deemed a public nuisance and a hazard and will be subject to applicable provisions of ORS Chapters 368 and 374 or other applicable State law.

18.850 *Removal or Relocation of Permitted Facilities:*

A. *County Authorization*: the County may require an applicant/permittee to remove or relocate the pole, pole line, buried cable, pipe line, sign, approach road or miscellaneous facility (hereinafter referred to collectively as "facility" or "facilities") covered by a permit, at the sole cost of the facility owner.

B. *Notice and Instructions*: Within 30 days of receiving written notice from the County Engineer to remove or relocate a facility, the facility owner/permittee shall make arrangements for removal or relocation at his or her sole cost in accordance with the written instructions from the County Engineer. Owners of utility poles with joint occupancy shall be responsible for the coordination of the removal/relocation of all other occupants of the pole(s) to be removed or relocated. Possible arrangements may include removal or relocation of the facility by the County with all County costs reimbursed by the facility owner/permittee. The facility owner/permittee shall furnish insurance and post a bond as required by the County Engineer before commencing removal or relocation.

C. *Cost Recovery*: Should the facility owner/permittee fail to remove or relocate the subject facility as instructed by the County Engineer or pay all costs incurred by the County for removal or relocation of the facility, the Board may commence an action or proceeding in a court of competent jurisdiction to recover all County costs. In addition, the Board shall be entitled to recover an additional sum that the court deems reasonable for attorney's fees incurred in the cost recovery proceeding.

19.000 Banners

19.100 Except where stipulated by an Intergovernmental Agreement between the County and a local jurisdiction, a permit will be required for all banners. All of the following criteria must be met before a permit may be issued:

A. The applicant/permittee for the banner is a governmental body, and the purpose of the banner is to promote a holiday, a public or civic event or other governmental purpose;
B. The banner(s) will be in place for a maximum of 30 days;
C. Banners may not include any advertising, commercial message, brand or product name, or other information about an event such as cost, directions, etc.;

D. The banner(s) must have a vertical clearance of at least 20 feet above the roadway;
E. The banner(s) may not be erected or maintained if they:

1. Interfere with, imitate, or resemble any official traffic control device or attempt or appear to attempt to direct the movement of traffic;
2. Prevent the driver of a motor vehicle from having a clear and unobstructed view of official traffic control devices or approaching or merging traffic;
3. Have any lighting, unless such lighting is shielded to prevent light from being directed at the highway or is of such low intensity or brilliance as not to cause glare or to impair the vision of the driver of a motor vehicle; or
4. Are otherwise a traffic hazard; and

F. Banner material and support must be made from a durable material and constructed to withstand wind pressure of 20 pounds per square foot of exposed surface.

19.200 Applications shall include the following:

A. A signed liability release and insurance certificate.
B. Date proposed for installation of the banner(s).
C. Date for removal of the banner(s).
D. Sketch showing banner layout, graphics, and wording.
E. If appropriate as determined by the County Engineer, provisions for traffic control during installation and removal.
F. If the proposed banner is to attach to a utility pole or other facility within right of way, the written consent of the facility owner(s) for the proposed attachment(s).

19.300 If the County Engineer approves the proposed permit for the banner, the permit shall specify:

A. Date of installation of the banner(s).
B. Date of removal of the banner(s).
C. Any special provisions for installation or removal of the banner(s).

19.400 The number and type of the banner(s) allowed will be at the discretion of the County Engineer.

20.000 Impaired Driving Victim Memorial Signing Program

20.100 *Application:* Upon the request of a member of the immediate family, legal guardian or the registered domestic partner of a fatal victim of an impaired driving motor vehicle crash and subject to the requirements set forth herein, a

temporary memorial sign may be installed within the County's right-of-way at the approximate site of a fatal crash.

20.200 *Guidelines:* The following guidelines apply to the County's Impaired Driving Victim Memorial Signing Program:

A. sign may be installed at the site of a fatal crash:

1 If it was caused by the operator of a motor vehicle who has been convicted of Negligent Homicide or Manslaughter in the first or second degree and was driving under the influence of intoxicants;
2 If it was caused by a vehicle operator, who was convicted of driving under the influence.); or
3 If it was caused by a deceased vehicle operator who had a blood alcohol level of .08 percent of greater.

B. Signs installed will be black on white, 36 inches by 48 inches (24 inches by 30 inches in urban areas) with a legend, which reads "DON'T DRINK AND DRIVE", below which will be a 36 inch by 12 inch (24 inch by 10 inch in urban areas) plaque with the message "IN MEMORY OF (Victim's Name)".

C. Each successful applicant will be entitled to a single sign as described above, mounted on one side of the post only (no back-to-back signs), facing oncoming traffic and only on the side of the road nearest the lane of oncoming traffic.

D. Signs will be installed only in locations where additional signing will not interfere or obstruct other traffic control signing or devices or contribute to sign clutter as determined by the County Engineer.

E. Signs will not be installed adjacent to single-family residences in urban areas.

F. A sign must be paid for by the party requesting the sign. Only one sign will be installed for any accident. The standard sign authorized under sub-section 20.200 (B) can name up to three individual victims. If a given accident event causes more than three fatalities, at the discretion of the County Engineer a larger sign may be installed to accommodate the additional names of the victims. Although only one sign will be allowed per accident, the County will accept joint applications as provided herein by the eligible representatives of multiple victims authorized under Sub-section 20.100. If the victims are not related the County will require that the application submitted is either done on behalf of all the victims or accompanied with written consent by the other eligible parties declining to participate.

G. The cost to install the sign shall cover all expenses incurred by the County to investigate installation locations and necessary materials and labor to construct and place the sign.

H. County staff will investigate all proposed installation sites and make a recommendation to the County Engineer regarding sign placement. If the investigation determines that a location other that the one requested in the application is more appropriate, a distance of as much as one-half mile away will be acceptable, with variations as approved by the County Engineer. In no case will the alternate location be on a road other than the one on which the crash occurred.

I. The County Engineer will approve or deny request based on the criteria set forth herein. If the request is approved the County Engineer will issue to the applicant(s) a Memorial Sign Authorization Permit setting forth the terms and conditions of the sign installation and establishing the cost to install the sign. The County will install the sign within 60 days of the date of receipt of the requisite funds.

J. Not withstanding Sub-section 20.200(K), at any time the County Engineer may order the removal of a sign if it is found to cause safety or operational problems for the traveling public.

K. Signs will remain in place until they are weathered (usually seven to ten years). At that time, they will be removed. If a sign that is still in serviceable condition is stolen, vandalized, or other wise significantly damaged, it will be replaced in the course of regular operations at the County's expense.

20.300 *Application Procedures:* In order to sponsor a memorial sign, a person must submit an application to the County that includes the following:

A. Name, address, and telephone number of applicant and relationship to victim.
B. A brief description of the crash;
C. Date and location of the accident including the road name, direction and distance in feet from the nearest green milepost paddle and distance and direction from any nearby landmarks (such as an intersecting road, or a bridge over a named stream;
D. If available, copies of the local police agency accident or DMV report relating to the crash;
E. Names of all parties involved in the crash;
F. Proof of conviction (unless driver is deceased) and blood alcohol or drug level of driver (from court, police or Medical Examiner's records);
G. Name or names, as they should appear on the sign; and
H. Commitment to provide the installation fee for the sign – payment will be required once a sign is approved.

21.000 Special Events

21.100 *Purpose:*

A. The purpose of this section is to provide regulation of special events requiring the use of County streets, non-Willamette River bridges, rights-of-way, and/or services in order to maximize the safety of participants, reduce inconvenience to the general public, and provide the least disruption to public services.

B. The County's Special Event Permits Program under this Section shall be conducted in a manner consistent with Multnomah County Code (MCC) 29.701 et.seq. relating to Bridge Special Events. Except to the extent that the Sub-sections of MCC 29.701 et.seq. are particularly and solely applicable to the Willamette River Bridges, any event permit issued pursuant to this section shall be issued in general compliance with and subject to all the requirements, terms and conditions of that Chapter.

21.200 *Permit Required:*

A. A permit to hold a special event is required when the County services, rights-of-way, or public streets, as defined in ORS 368.001, are used to stage a special event.

B. No special event shall be allowed on any public street until a permit has been obtained from the County. Failure to obtain a permit is punishable by a fine, as set forth in MCC 29.999.

C. Exception: If the Event is conducted in compliance with all applicable traffic and pedestrian safety laws, requires no County services, and does not exceed 200 participants, no permit shall be required.

21.300 *Obtaining a Permit:* In order to obtain a permit to conduct a special event, the event sponsor must submit the following in writing to the County:

A. A Special Events permit application that describes the type of event, the event date, beginning and ending times, the expected number of participants, the name, address and phone number of the event sponsor, a contact person, and past experience in special events.
B. A map showing the direction and roadways/bridges on which the special event is to be held.
C. Written support from any city or other public agency or chamber of commerce that has regulatory authority over, or that is sponsoring, promoting or endorsing the special event.
D. Exception: If the Event is conducted in compliance with all applicable traffic and pedestrian safety laws and requires no County services, a notice

requirement may be substituted for written support at the discretion of the County Engineer.

21.400 *Event Types:*

21.410 *March:* An organized procession conducted or staged in the vehicle travel lane that interferes with the regular flow of vehicle traffic.

21.420 *Block Party:* A temporary road closure (8 hours or less) agreed to by 100 percent of the abutting property owners and allows access to all other residents without undue inconvenience.

21.430 *Parade:* a procession of people, animals, or vehicles or any combination thereof, conducted or staged in the vehicle travel lane that interferes with the regular flow of vehicle traffic

21.440 *Athletic Event:* a competition or fund raising event involving athletic activity by the participants, such as a road run, marathon, or bicycle race.

21.450 *Filming Use:* An event, which uses the County right-of-way for the production of a film, video, or any other visual or audio recording use.

21.460 *Other:* Any Event over 1000 participants

21.500 *Special Event Fees:* Fees for special events are set by Board resolution.

22.000 Property Owner Maintenance Requirements

22.100 As stated in ORS 368.910, the maintenance and repair of sidewalks and curbs is the responsibility of the owner of abutting real property. If any such sidewalk or curb is out of repair, the County may send notice by mail to the owner of the abutting property to repair the sidewalk or curb, setting forth the nature and extent of repairs and the time, not less than thirty (30) days, within which the repairs must be completed. If the owner does not make the repairs within the time allowed, the County may complete the repairs and assess the total cost against the abutting property, in accordance with ORS 368.915 and 368.920.

EXHIBIT D

Department of Community Services
MULTNOMAH COUNTY OREGON

Land Use and Transportation Program
1600 SE 190th Avenue
Portland, Oregon 97233-5910
PH. (503) 988-3043 Fax (503) 988-3389
www.multco.us/landuse

FIRE SERVICE AGENCY REVIEW

TO THE APPLICANT: Take this form to the Structural Fire Service Provider* that serves your property, along with the following:

- ❑ A site plan drawn to scale showing the subject property, its improvements, location of fire hydrants and driveway information;
- ❑ A floor plan of the proposed development; and
- ❑ A fire flow report from your water purveyor (if applicable) [Not Applicable for Properties served by MCRFD#14 customers]

After the fire official signs this form, include it with your application material. See Fire Code Application Guide for fire-related access standards and fire flow information.

*If your property is not served by a structural fire service provider, your project is to be reviewed by the appropriate building official serving your property.

Address of Site: _____

Map & Tax Lot: _____ R number:_____

Description of Proposed Use:_____

Total Square Footage of Building (including roof projections, eaves, & attached structures): _____ _

Applicant Name: _____ Phone: _____

Mailing Address: _____

City: _____ State: _____ Zip Code: _____

STRUCTURAL FIRE SERVICE AGENCY REVIEW

Fire Agency completing this form: _____Date of Review_____

❑ The subject property is located within our service boundaries or is under contract.

❑ The subject property is outside of our service boundaries and we will not be providing fire protection services via contract. (Additional review is not needed)

** Access Review by Structural Fire Service Agency Providing Service **

❑ The proposed development is in compliance with the fire apparatus access standards of the Oregon Fire Code standards as implemented by our agency.

❑ The following access improvements must be completed prior to issuance of the building permit and be re-inspected by our agency before flammable materials are placed on the property.

_____

_____

_____

❑ The proposed development is **not** in compliance with the adopted Fire Service Agency's access standards. The proposed building/structure is required to have a fire sprinkler system installed in compliance with Section 903.1.3 (NFPA 13D) of the Oregon Fire Code.

Fire Official: Please sign or stamp the presented site plan & floor plan and attach it to this form.

_____
Signature & Title of Fire Official

See Other Side

STRUCTURAL FIRE SERVICE AGENCY REVIEW, CONTINUED.

** Fire Flow by Structural Fire Service Agency Providing Service **

❒ The structure, building or addition is exempt from the fire flow standards of the OFC B-105.2.

❒ The proposed non-commercial structure **is less** than **3,600 sq. ft.** (including the horizontal projections of the roof) and there **is** 1,000 gallons per minute of fire-flow available at 20 psi from public water lines. No mitigation measures are necessary.

❒ The proposed non-commercial structure **is more** than **3,600 sq. ft.** (including the horizontal projections of the roof) and the fire-flow & flow duration at 20 psi is available from public water lines or private well and is in compliance with minimums specified in Appendix B, Table B105.1 of the Oregon Fire Code. No mitigation measures are necessary.

❒ The existing fire-flow & flow duration available from public water lines or private well is not adequate to serve the proposed non-commercial structure in compliance with Appendix B of the Oregon Fire Code. The following mitigation measures are necessary* and must be installed prior to occupancy or use of the structure.

- ❍ A monitored fire alarm must be installed
- ❍ A Class A or non-combustible roof materials must be installed.
- ❍ Defensible space of 30 feet around the structure/building/addition.
- ❍ A defensible space of 100 feet around the structure/building/addition due to slopes greater than 20 %.
- ❍ A fire sprinkler system meeting Section 903.1.3 (NFPA13D) of the Oregon Fire Code shall be installed.
- ❍ Other _____

_____

*The above required structural features are required by the Oregon Fire Code and shall be shown clearly on all building plans.

Commercial/Industrial Buildings & Uses.

❒ The minimum fire flow and flow duration is available from public water lines or private well as specified in Appendix B, Table B105.1. No mitigation measures are required.

❒ The minimum fire flow & flow duration is not available from public water lines or private well as specified in Appendix B, Table B105.1. The following mitigation measures are required:

_____

_____

_____

_____

Signature & Title of Fire Official

To the Fire Official:

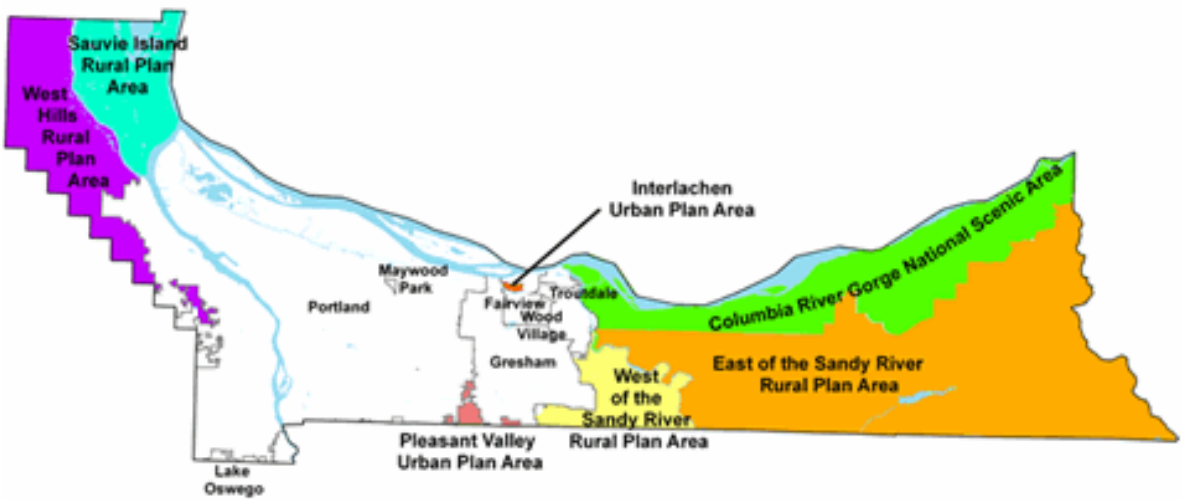
❍ Land Use Planning has determined that the proposed building will qualify as an Exempt Farm Structure and the property owner has indicated that the building will be used solely for farm purposes and they intend on using the provision under ORS 455.315 and will not be obtaining a building permit for its construction.

_____

Multnomah County Land Use Planning

EXHIBIT E

FIRE CODE APPLICATION GUIDE
FOR DEVELOPMENT IN UNINCORPORATED MULTNOMAH COUNTY



This guide is intended to provide assistance in the application of the fire code in Unincorporated Multnomah County.
October 2011

Final 11.14.2011

FIRE SERVICE PROVIDERS

Gresham Fire & Emergency Services
(Gresham east to Sandy River)
1333 NW Eastman Pkway
Gresham, OR 97030
503-618-2355

Multnomah Co. RFPD #14
P.O. Box 1 | 36930 E Hist Col Rvr Hwy
Corbett OR 97019
503-695-2272

Sauvie Island Fire District #30
18342 NW Sauvie Island Rd.
Portland OR 97231
503-621-1242

Scappoose Fire District
PO Box 625 | 52751 Columbia River Hwy
Scappoose, OR 97056-3029
503-543-5026

Tualatin Valley Fire & Rescue
North Operating Center
20665 SW Blanton
Aloha OR 97007-1042
503-259-1423

Portland Fire & Rescue
55 SW Ash St.
Portland, Oregon 97204
503-823-3700

Cascade Locks Fire & EMS
505 Wa-Na-Pa / P.O.BOX 308
Cascade Locks, Oregon 97014
541-374-8510

FIRE APPARATUS ACCESS.

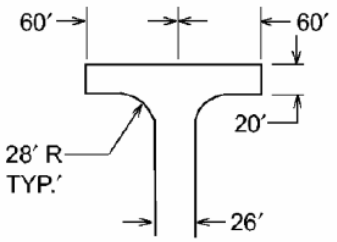
All proposed dwellings, facilities, buildings or portions of buildings hereafter constructed shall be accessible to the appropriate structural fire service agency's apparatus by way of an approved fire apparatus access road. The fire apparatus access road shall meet the following standards or as authorized by the fire official.

WIDTH AND VERTICAL CLEARANCE: The width of the fire apparatus access road serving your development is dependent on the number of existing and proposed structures and buildings served by the access road.

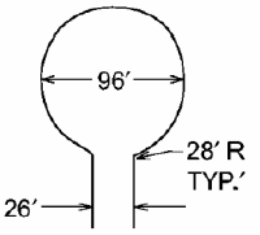
Two or Less Dwelling Units and Accessory Buildings – The fire apparatus access road shall have an unobstructed width of 20 feet with a 12 foot wide uniform driving surface. The access road shall have an unobstructed vertical clearance of not less than 13 feet, 6 inches.

Three or More Dwelling Units and Accessory Buildings - Fire apparatus access roads shall have an unobstructed, uniform driving surface width of not less than 20 feet and an unobstructed vertical clearance of not less than 13 feet, 6 inches.
(OFC 503.2.1 & D103.1)

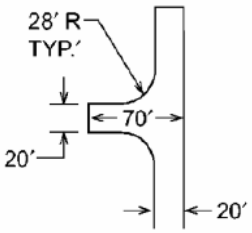
DEAD END ROADS & TURNAROUNDS: Dead end fire apparatus access roads in excess of 150 feet in length shall be provided with an approved turnaround. Diagrams of approved turnarounds are shown below.
(OFC 503.2.5)



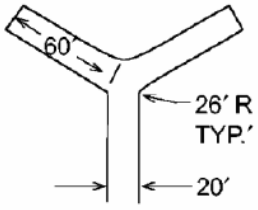
120′ HAMMERHEAD



96′ DIAMETER
CUL-DE-SAC



ACCEPTABLE ALTERNATIVE
TO 120′ HAMMERHEAD



ACCEPTABLE ALTERNATIVE
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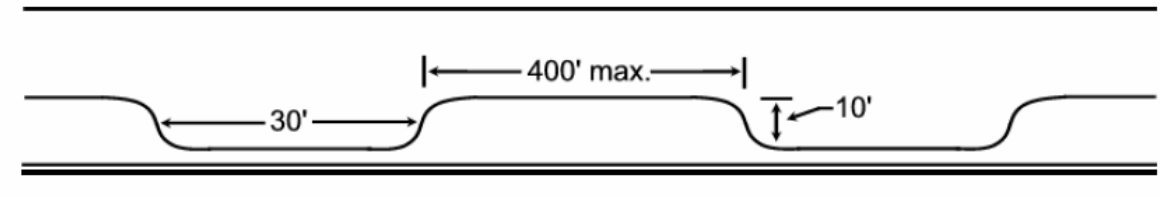
TURNING RADIUS: The inside turning radius and outside turning radius of curves in the access road shall be not less than 28 feet and 48 feet respectively, measured from the same center point.
(OFC 503.2.4 & 103.3)

TURNOUTS: When a fire apparatus access road exceeds 400 feet in length, turnouts 10 feet wide by 30 feet long shall be provided in addition to the required road width and shall be placed no more than 400 feet apart, unless otherwise approved by the fire code official. These distances may be adjusted based on visibility and sight distances. Multnomah County RFPD #14 requires that turnouts be 20 feet wide by 40 feet long. (OFC 503.2.2)

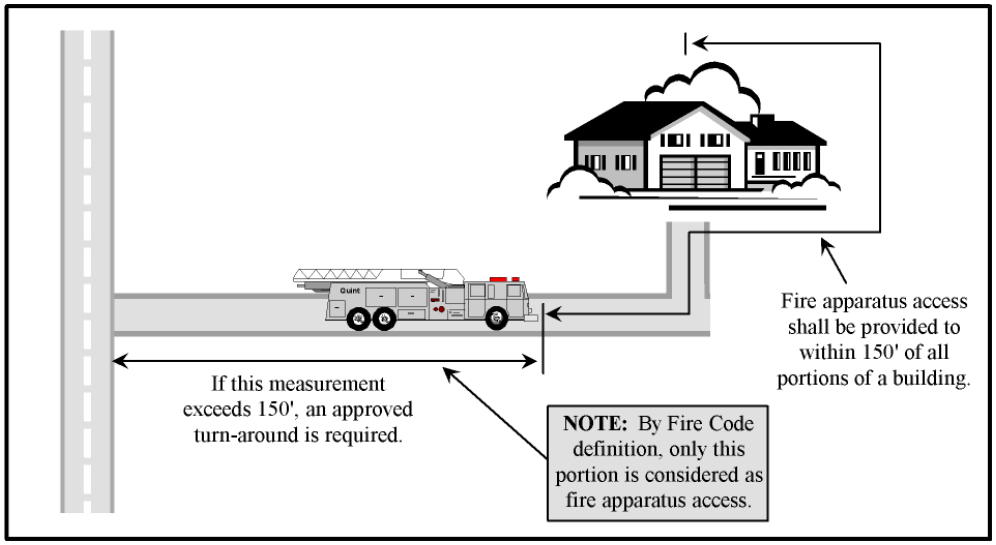


GRADE: Fire apparatus access roadway grades shall not exceed 10 percent. Intersections and turnarounds shall be level (maximum 5%) with the exception of crowning for water run-off. Approval of grades steeper than 10% and fire sprinklers as an alternative shall be at the discretion of the fire code official. The approval of fire sprinklers as an alternate shall be accomplished in accordance with the provisions of ORS 455.610(5) and OAR 918-480-0100. (OFC 503.2.7 & D103.D)

SURFACE AND LOAD CAPACITIES: Fire apparatus access roads shall be on an all-weather surface that is easily distinguishable from the surrounding area and is capable of supporting not less than 12,500 pounds point load (wheel load) and 60,000 pounds live load (gross vehicle weight). Gresham Fire & Emergency Services and Multnomah County RFPD #14 require that the all-weather surface support an imposed load of fire apparatus weighing 75,000 pounds. Documentation from a registered engineer that the final construction is in accordance with approved plans or the requirements of the Fire Code may be requested. (OFC D102.1)

BRIDGES: Private bridges shall be designed and constructed in accordance with the State of Oregon Department of Transportation and American Association of State Highway and Transportation Officials Standards "*Standard Specification for Highway Bridges – AASHTO – HB-17*". A building permit shall be obtained for the construction of the bridge if required by the building official of the jurisdiction where the bridge is to be built. The design engineer shall prepare a special inspection and structural observation program for approval by the building official. The design engineer shall give in writing final approval of the bridge to the Fire Service Provider after construction is completed. Maintenance of the bridge shall be the responsibility of the party or parties that use the bridge for access to their property. The Fire Service Provider may at any time, for due cause, ask that a registered engineer inspect the bridge for structural stability and soundness at the expense of the property owner(s) the bridge serves. Culverts may be treated the same as bridges. Vehicle load limits shall be posted at both entrances to bridges when required by the fire code official. Please contact your local fire code official for information. (OFC 503.2.6 & D.102.1)

FIRE APPARATUS ACCESS ROAD DISTANCE FROM BUILDING & TURNAROUNDS: Access roads shall be within 150 feet of all portions of the exterior wall of the first story of the building as measured by an approved route around the exterior of the building. An approved turnaround is required if the remaining distance to an approved intersecting roadway, as measured along the fire apparatus access road, is greater than 150 feet. (OFC 503.1.1)



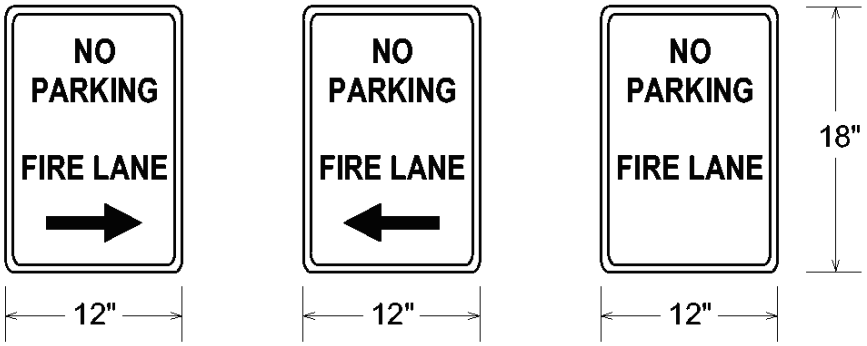
GATES: Gates securing fire apparatus roads shall comply with all of the following:

- Minimum unobstructed width shall be not less than the required roadway surface width, or two 10 foot sections with a center post or island.
- Gates serving three or less single-family dwellings shall be a minimum of 12 feet in width.
- Gates shall be set back at minimum of 30 feet from the intersecting roadway.
- Gates shall be of the swinging or sliding type.
- Manual operation shall be capable by one person.
- Locking devices shall be approved.
- Electric automatic gates shall comply with ASTM 220-5 and UL 325.
- Electric gates shall be equipped with a means for operation by the fire department personnel.
- Contact the local fire code official for lock box requirements. (OFC D103.6)

FIRE APPARATUS ACCESS ROADS WITH FIRE HYDRANTS: Where a fire hydrant is located on a fire apparatus access road, the minimum road width shall be 26 feet. (OFC D103.1)

NO PARKING SIGNS: Where fire apparatus roadways are not of sufficient width to accommodate parked vehicles and 20 feet of unobstructed driving surface, "No Parking" signs shall be installed on one or both sides of the roadway and in turnarounds as needed. Roads 26 feet wide or less shall be posted on both sides as a fire lane. Roads more than 26 feet wide to 32 feet wide shall be posted on one side as a fire lane.

Signs shall read "No Parking – Fire Lane" and shall be installed with a clear space above grade level of 7 feet. Signs shall be 12 inches wide by 18 inches high and shall have red letters on a white reflective background. (OFC D103.6)



PAINTED CURBS: Where required, fire apparatus access roadway curbs shall be painted red and marked "NO PARKING FIRE LANE" at approved intervals. Lettering shall have a stroke of not less than one inch wide by six inches high. Lettering shall be white on red background. (OFC 503.3)

FIRE APPARATUS ACCESS ROAD EXCEPTIONS: The requirements for fire apparatus access may be modified as approved by the fire official where any of the following apply:

(1) Buildings are equipped throughout with an approved automatic fire sprinkler system (the approval of this alternate method of construction shall be accomplished in accordance with the provisions of ORS 455.610(5)).

FIREFIGHTING WATER SUPPLIES

Fire Fighting Water Supply Exceptions: The requirements for firefighting water supplies may be modified as approved by the fire official where any of the following apply:

(1) Buildings are equipped throughout with an approved automatic fire sprinkler system (the approval of this alternate method of construction shall be accomplished in accordance with the provisions of ORS 455.610(5)).
(2) There are not more than two Group R-3 or Group U occupancies.

COMMERCIAL BUILDINGS – REQUIRED FIRE FLOW: The minimum fire flow and flow duration for buildings other than one-and two-family dwellings shall be determined according to OFC Appendix B. The required fire flow for a building shall not exceed the available GPM in the water delivery system at 20 psi.

NOTE: Appendix B, Section B106, Limiting Fire-Flow is also enforced, save and except for the following:

- In areas where the water system is already developed, the maximum needed fire flow shall be either 3,000 GPM or the available flow in the system at 20 psi, whichever is greater.
- In developed areas, the maximum needed fire flow shall be 3,000 GPM at 20 psi.

SINGLE FAMILY DWELLINGS – REQUIRED FIRE FLOW: The minimum available fire flow for one and two-family dwellings served by a municipal water supply shall be 1,000 gallons per minute. If the structure(s) is (are) 3,600 square feet or larger, the required fire flow shall be determined according to OFC Appendix B. (OFC B.105.2)

RURAL BUILDINGS – REQUIRED FIRE FLOW: Required fire flow for rural and suburban areas in which adequate and reliable water supply systems do not exist shall be calculated in accordance with the National Fire Protection Association Standard 1142, 2007 Edition (OFC B107)

- Water supply is still required but alternative sources/means are allowed as approved by the fire code official.

NOTE: Structures protected by an automatic fire sprinkler system are not required to have a water supply other than that required to supply the fire sprinkler system.

ACCESS AND FIRE FIGHTING WATER SUPPLY DURING CONSTRUCTION: Approved fire apparatus access roadways and fire fighting water supplies shall be installed and operational prior to any combustible construction or storage of combustible materials on the site. (OFC 1410.1 & 1412.1)

PREMISE IDENTIFICATION: New and existing buildings shall have approved address numbers; building numbers or approved building identification placed in a position that is plainly legible and visible form the street or road fronting the property. These numbers shall contrast with their background. Address numbers shall be Arabic numerals or alphabet letters. Numbers shall be a minimum of 4 inches high with a minimum stroke width of 0.5 inch. In the Gresham Fire & Emergency Services' area, commercial buildings shall have a minimum lettering size of 6 inches tall. Commercial Warehouses shall have a minimum lettering size of 10 inches tall. Residential buildings shall have a minimum lettering size of 4 inches tall. (OFC 505.1)

EXHIBIT F

White Deer Creek Road
Dust Suppressant Testing

By
Michael Silsbee and Steven Bloser
With contributions by

Barry Scheetz
Kevin Abbey
Woody Colbert
David Creamer
Phillip Dux
James Lipko
Kathy Moir

PENN STATE UNIVERSITY
CENTER FOR DIRT AND GRAVEL ROAD STUDIES

and
PA DCNR - BUREAU OF FORESTRYBALD EAGLE STATE FOREST DISTRICT

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Bruce Vandergrift of DEP's Air Quality provided valuable guidance based on his years of field experience in air quality monitoring. Ken Murin from DEP provided timely advice. Robert Klotz from PennDOT provided engineering insight.

We would be remiss of we did not acknowledge those individuals whose efforts provided the impetus for the Commonwealth to establish its Dirt and Gravel Road Program. Collectively they were known as the Dirt and Gravel Road Task Force. It is not possible to list all who contributed but a few individuals deserve to be singled out. Among these special people are "Bud" Byron, Ed Bellis, Woody Colbert and Sen. Doyle Corman. Their tireless efforts provide an example for us all.

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EXECUTIVE SUMMARY

The White Deer Creek Road project described here is a joint effort between the Pennsylvania State University's Center for Dirt and Gravel Road Studies, and the PA Bureau of Forestry's Bald Eagle State Forest District. The purpose of this study is to perform a side-by-side comparison of several dust palliatives and application methods in order to test and monitor their performance and longevity. Ten sections of dust suppressants were applied to White Deer Creek Road in western Union County, Pennsylvania. Each treated section of road was approximately 1,500 feet long, with untreated buffer sections of at least 1000 feet in length between all application sites.

Dust collection jars were used to sample the amount of dust generated on all treated and buffer sections of the road over a period of several months after application. The dust collection jars are placed just off of the roadway to collect any dust that is generated by passing cars for a period of 30 days. In an effort to further compare the application sections and develop a simpler method of predicting dust generation, sweep samples were taken on each section monthly. Sweep samples involved the collection of all loose material present on the road surface in a one square foot section in the wheel track.

BACKGROUND

Air quality is an environmental topic of increasing concern. Airborne particulates, or dust, is one of the major contributors to air pollution in less developed areas. The Environmental Protection Agency (EPA) has identified airborne particulates as one of six principal air pollutants. While some atmospheric dust is a natural result of wind and other erosive forces, there are many man-made sources that are contributing excess amounts of dust into the atmosphere. This excess dust generation can adversely affect nearby plants, animals, and even people. EPA estimates show that up to 40% of fugitive dust originates from unpaved roads (*Figure 1*).

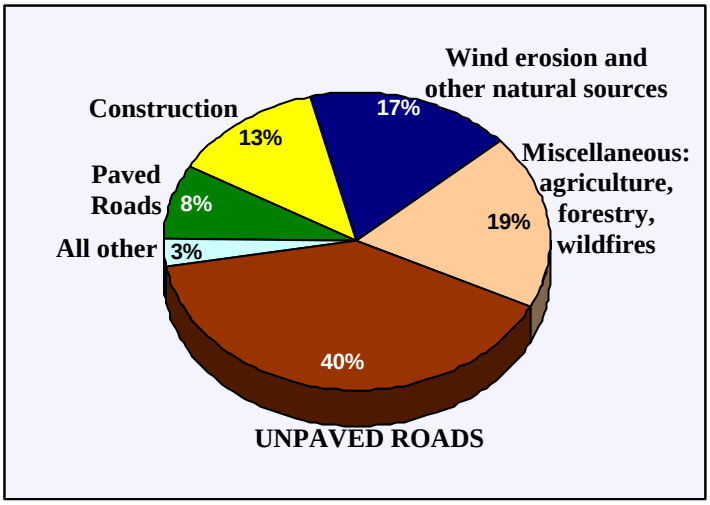


Figure 1. Sources of fugitive dust in the atmosphere.[1] The EPA estimates total fugitive dust emissions at 25 million tons per year. Source: EPA, National Air Quality and Emissions Trends Report, 1997.

The total particulate emissions from stationary sources in 1999 amounted to 1.1 million tons nationally. These stationary particulate sources like boilers, kilns, industrial processes, etc. are the kinds of sources that are principally addressed by the Pennsylvania Department of Environmental Protection's (DEP) Bureau of Air Quality. These stationary sources represent roughly 4% of the 26 million tons per year of total particulates. Unpaved road particulate emissions are estimated to be ten times more by weight than emissions from classic stationary sources of particulates.

An extensive network of unpaved roads throughout the Commonwealth of Pennsylvania provides access for the State's four largest industries of tourism, agriculture, mining, and logging. Pennsylvania has in excess of 21,000 miles of unpaved public roads. Local municipalities and Pennsylvania's Bureau of Forestry own the majority of these roads. In addition to those public roads, thousands more miles of privately owned unpaved roads exist in the form of driveways, field accesses, haul roads, and trails.

There are a number of possible control strategies that are traditionally used to help minimize dust emissions from unpaved roads. The cheapest short-term solution used in many locations is to apply water to the road surface. While inexpensive, results will typically last only a few hours. Traditional oils have been used for dust control in the past with varying degrees of effectiveness and little regard for environmental implications. Another popular variety of dust suppressants are salts such as magnesium chloride and calcium chloride. Salts have the ability to extract moisture out of the air to keep the surface of the road moist. In today's environmentally conscious world, new products are being developed to safely control dust using petroleum emulsions, plastic resins, naturally occurring oils, and other sources while minimizing or eliminating environmental impact. There are several outstanding problems with the use of dust suppressants: 1) The use of dust suppressants is often beyond the financial resources of the responsible parties. 2) The temporary nature of most suppressants requires periodic re-

application. 3) Many of the materials traditionally used as dust suppressants are detrimental to the environment.

Financial costs associated with dust generation cannot be ignored. Not only does the application of dust suppressants cost money, but the road aggregate loss associated with not using dust control costs money as well. Sanders, et al.[4] reports that cost of aggregate replacement necessitated by loss of fine particles to dust can exceed $15,000 per mile per year

Dust control is becoming an increasingly important part of unpaved road maintenance. Excessive dust emissions can be more than a nuisance. Dust can cover roadside plants inhibiting the amount of sunlight they can use. Excessive dust can also lead to health concerns for people who are exposed on a regular basis.

ROAD TREATMENT

Figure 2. White Deer Creek Road

SITE SELECTION

White Deer Creek Road is located on the border of Center and Union Counties in the Bald Eagle State Forest in Central Pennsylvania. White Deer Creek Road was chosen for this project for its length and overall uniformity (*Figure 2*). The entire length of road has relatively consistent slope, canopy cover, side slope position, surface material, and drainage characteristics. This overall uniformity was essential to reduce natural variations to measure the effects of each dust suppressant. Approximately eight miles of White Deer Creek Road were used for this project.

SITE LAYOUT

Ten dust suppressant application sites were identified on White Deer Creek Road. Each application site was approximately 1,500 feet in length. Between each application site was a buffer area of at least 1,500 feet where nothing was applied to the road (*Figure 3*). The dust suppressant application sites were located away from access roads to avoid any possible dust contamination from those roads. Since White Deer Creek is an Exceptional Value waterway and is used as a reference reach for impaired streams in the area, products that had received approval from Pennsylvania's Dirt and Gravel Road Program were used closest to the stream. Products that may have detrimental effects on the environment were placed far from any stream to avoid any possible discharge into the stream. The rest of the products were randomly placed on an application site. (*see Appendix 1 for detailed site map*)

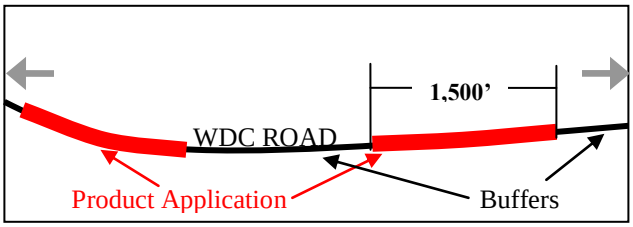


Figure 3. Sample site layout.

ROAD PREPARATION

The Bureau of Forestry grades White Deer Creek Road on an annual basis. The road had been graded earlier in the spring and was in excellent condition prior to the activity described here. The grading technique that is employed in this section of this Forest District is as follows:

1. A single grader pass in each direction pulls the material from the edges of the travel lanes toward the middle of the road forming a windrow.
2. The grader then passes down the center of the road to "spread" the accumulated material.
3. A stone rake is then used to smooth out both travel lanes.

This technique typically develops in areas where native shale or bank run gravel is used as road material. The rake acts as a tool to "groom off" coarse material that naturally comes to the surface during grading operations on these materials. Roads graded with this technique are typically very smooth and have a rounded crown with a fairly flat center. The Bald Eagle road maintenance crew is accomplished with this technique, and produces a very smooth and uniform road.

Figure 4. Spray application of topical dust suppressants.

Several of the vendors expressed a concern about the condition of the road prior to product application. They were concerned that the road was not graded enough. Failure to loosen enough material during the grading operation causes products that are topically applied to be less effective. Many of these products depend on penetration for long-term effectiveness. Several vendors stated that their product was not designed to hold loose unconsolidated material in place. The same grading technique was used on all sections of the road.

Figure 5. Toothed grader blade used on section 6 to incorporate suppressant into road.

SUPPRESSANT APPLICATION

Dust suppressant applications took place on July 9th and 10th of 2001. The dust suppressants were applied as shown in *Table 1*. The dust suppressants were topically applied on sites 1-5, and 8-10. A topical application simply means that the dust suppressant was distributed on the surface of the road according to the manufacturer's standard procedures and application rates (*Figure 3*). Topical applications rely on their ability to penetrate into the road surface.

Sites 6 and 7 were unique in that an attempt was made to mechanically incorporate the dust suppressant into the road material. A "mini-stabilization" was done with Ultrabond 2000 on site 6. This mini-stabilization involved using a grader to incorporate the Ultrabond into the road material (*Figure 5*). Prior to product application and between each of the 2 application passes, the road was turned using a toothed road grader to mix the dust suppressant into the road. A "full-depth stabilization"

Figure 6. – Bomag Road reclaimer used on section 7 to incorporate suppressant into road.

was done on Site 7. The full-depth stabilization utilizes a road reclaimer to grind road material to a depth of 8 inches (*Figure 6*). The road reclaimer functions as a large roto-tiller as it cuts into the road and mixes the material. The road reclaimer was used before product application and between each of the 3 application passes to mix the dust suppressant into the road.

In all cases, the manufacturer was instructed to follow their standard procedures in regards to product application variables such as vehicle speed, application rate, number of passes, etc.

SITE	PRODUCT	TYPE	APPLICATION METHOD	APPLICATION RATE
1	**PETROTAC**	Petroleum Emulsion	topical*	0.57 gal/yd^2 in 3 passes
2	**MAGNESIUM CHLORIDE**	$MgCl_2$	topical	0.50 gal/yd^2 in 2 passes
3	**TECH SUPPRESS**	Resin emulsion	topical	0.65 gal/yd^2 in 3 passes
4	**DUSTKILL**	Soybean Oil	topical	0.25 gal/yd^2 in 1 pass
5	**COHEREX**	Petroleum emulsion	topical	0.75 gal/yd^2 in 3 passes
6	**ULTRABOND 2000**	Paraffin emulsion	mini-stabilization**	1.00 gal/yd^2 in 2 passes
7	**ULTRABOND 2000**	Paraffin emulsion	full-depth stabilization***	1.50 gal/yd^2 in 3 passes
8	**ULTRABOND 2000**	Paraffin emulsion	topical	1.25 gal/yd^2 in 2 passes
9	**SAND AND GRAVEL BINDER**	Paraffin emulsion	topical	0.50 gal/yd^2 in 2 passes
10	**DUSTDOWN**	artificial polymer	topical	0.50 gal/yd^2 in 2 passes

Table 1. Guide to dust suppressant application sites on White Deer Creek Road.

**topical treatments were simply applied to the road surface*.

*** mini-stabilization involves using a grader to incorporate dust suppressant into the road between passes.*

**** Full-depth stabilization uses a road reclaimer to incorporate dust suppressant into the road between passes.*

MONITORING PROCEDURES

DUSTFALL JARS

Figure 7. Typical dust fall jar placement.

BACKGROUND: In order to measure the effectiveness and longevity of each dust suppressant, it was necessary to quantify the volume of dust that was produced on each section of road. The standard method of measuring dust is with "dust fall jars" (ASTM D 1739-98). Each dustfall jar measures five inches in diameter and is seven inches deep. The jars are made of high density polyethylene and coated so dust will not stick to the walls of the jar. A small amount of distilled water (½ inch to 1 inch) is placed in the jars so that strong winds do not blow dust out of the jar. A very small amount of algaecide is included in the water to prevent the growth of algae in the bottles. The water level is periodically checked and refilled if necessary.

The dustfall jars were then mounted about three feet off of the ground and thirty feet from the center of the road. They were allowed to collect dust for a period of thirty days before being collected and replaced. By comparing the amount of dust collected by jars on each section over the same period of time, a comparative analysis can be performed between locations. The photograph in *Figure 7* is an example of a typical dust jar mounted in place.

ASTM standards recommend that jars have a minimum setback of 90 feet from any large objects such as trees or poles. It was not possible to meet these guidelines since White Deer Creek Road is surrounded by forest. Jars were placed in a relatively open area as far away from low hanging trees as possible. A relatively open canopy consisting of about 50% cover over the road was used as a general rule for placing each jar to insure that the section of road being measured by each jar received a similar amount of sunlight. Bank slope was also a factor in jar placement locations. Jars were placed at a location where bank elevation was as close to the road elevation as possible. These factors were all considered in placing the jars to insure equal dust collection opportunity.

PLACEMENT: In order to obtain data for a comparative analysis, two dustfall jars were placed on each of the 10 product application sections and each of the buffer areas in between. One jar was placed on each side of the road to account for variation in wind direction. All jars were mounted approximately three feet off of the ground and thirty feet from the centerline of the road. The jars were placed near the center of each application and buffer site. Actual jar placement varied slightly (less than 200') from the center of the site in some cases in order to place them in an area with relatively consistent canopy cover, vegetation density, and bank slope. *Figure 8* shows the typical placement of dust jars on a section of road.

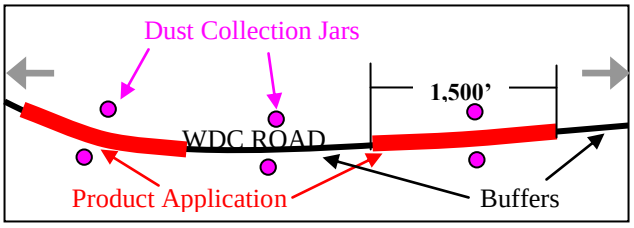


Figure 8. Sample Dustfall jar layout.

In order to measure the amount of background dust that should be expected, three "ambient" dustfall jars were used. These three "ambient" jars were placed in the forest at least 1,500 feet from any road,

and were used to measure the general level of dust that is in the area that does not come directly from White Deer Creek Road. Please see the map in Appendix 1 for all jar locations.

The comparative analysis of the 10 dust control products was the main purpose of the dust collection jars. There were, however, other experiments set up at the same time. One experiment was to measure how far dust travels away from the road. The other experiment was to measure the extent to which dust from untreated control sections of road may drift onto treated sections. A brief description of each follows:

Dust Fall Perpendicular to Road

The purpose of this experiment was to determine the extent to which dust traveled away from the road. This experiment was set up on the untreated buffer site between application sites 2 and 3 because that location was generally more open and had a much flatter expanse than any other buffer site. Five different distances were used for this experiment. All jars were placed on the south side of the road to take advantage of the prevailing winds. The five jars were placed at a height of three feet at 30 feet intervals from the center of the road. Jars were located at a distance of 30, 60, 90, 120, and 150 feet from the center of the road (*Figure 9*). By comparing the amount of dust each of these jars collect, we hope to learn details about how far dust travels from the road. See inset on map (*Appendix 1*) for jar locations.

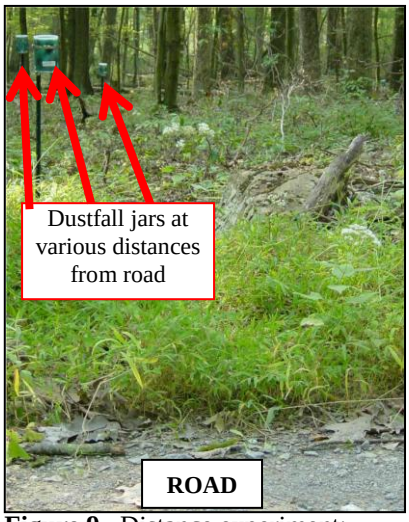


Figure 9. Distance experiment; dust fall jars on buffer site 2-3.

Dust Fall Parallel to Road

The purpose of this experiment was to determine the extent to which dust is carried along the roadway, parallel to the direction of travel. For this experiment, product application site 6, Ultrabond 2000 mini-stabilization was chosen for its uniformity in jar placement opportunities. Five jars were placed at the same height and distance from the road at equal intervals along the western half of site 6. The first jar was placed at the western edge of site 6 at the border between the application and buffer site. The remaining 4 jars were placed at 200' intervals the whole way the center of the application site. By measuring the variations in dust collected by these jars, it can be determined how far dust from the untreated buffer section is drifting onto the jars located on application site 6. This information may be useful for future studies in determining the most economical length of site that can be used without risking contamination from neighboring sites.

SAMPLE COLLECTION:

The dust fall jars were collected on a monthly basis during the fall of 2001 and spring of 2002. During collection, the jars were briefly removed from their stands in the field. Any large organic matter such as insect and leaves was picked out with forceps and rinsed off with distilled water to remove any dust (*Figure 10*). The contents of each dustfall jar were then carefully washed to 500 mL Nalagene™ bottles. Distilled water was used to clean any residue left in the dustfall jars and rinse it into the sample

Figure 10. Contents of a dust fall jar as it was collected in the field.

bottle for return to the lab. The dustfall jars themselves were then thoroughly cleaned and returned to their station in the field.

SAMPLE ANALYSIS: After returning from the field, the sample jars were stored in a refrigerator to further inhibit the growth of algae until testing was complete. The main function of the analysis performed on all samples was to determine the amount of dust that they contained. Total solids were determined as specified in ASTM D1735. The first step in this process was to run the sample through a filter. The material caught on the filter paper (watchman No. 40 ashless) was then dried at 105˚C and weighed.

Since much of the material caught in the jars was organic, a Loss on Ignition (LOI) was performed on all of the samples. This process involves slowly heating each sample to over 700˚C to burn off any organic matter. The resulting mass was then weighed. In addition to the mass of inorganic material caught on the filter, the ionic conductivity of the solution that passed through the filter was determined and the amount of totally dissolved solids it contained was calculated. The mass of the dissolved solids added to the mass of the filtered sample after LOI makes up the total weight of inorganic matter collected in the jar. In addition to the weight determination described above, the pH and ionic conductivity of the each solution was measured.

Several other tests were conducted on selected samples in an attempt to further understand and characterize the material that was collected in the dustfall jars. To determine the mineral composition of the samples, selected samples were characterized by powder x-ray diffraction analysis. For the analysis the samples were mounted on a zero background slide and then scanned over the range of 5 to 60º2Θ at 2º2Θ/minute.

To determine the size and morphology of the particles collected, some samples were examined using scanning electron microscopy (SEM). One set of samples was examined in a Hitachi S-3500N SEM using secondary electron imaging and energy dispersive x-ray (EDS), providing a qualitative correlation between the bulk chemistry of the particles and their size and shape. A second set of samples was characterized using an automated particle counting and analysis system. The characterization of the second set of samples was performed by the RJ Lee Group[1], Inc. of Monroeville, PA at no charge to the project.

A Thermo-gravimetric Analysis (TGA) was also performed on several samples. The TGA measures the change in weight of a material as the temperature is slowly increased to over 700˚C. By examining the mass change at specific temperatures and comparing that to know curves, it is possible to determine what materials are present in the sample. In this case TGA was used to characterize the presence of organic compounds samples collected by dust fall jar.

SWEEP SAMPLES

BACKGROUND: Dust emissions from unpaved roads have been found to vary linearly with the fraction of fines (<75 μm, or passing 200 mesh) particles in the road surface material. *Table 2* gives typical fines contents for a variety of road types. The more material that is loose on the surface of the road, the more potential the road has for generating dust. Large loose stones dig and grind into the road surface under the weight of traffic. Large and medium sized particles eventually ravel of to the sides of the road while the fine material leaves the road as dust. By sampling the loose material directly from the road surface, we hope to be able to characterize the potential of each section of road to generate dust to further compare the effectiveness of the

[1] For more information, contact Steve Schlaegle at (724) 387-1843 or sschlaegle@rjlg.com

various dust suppressants used on White Deer Creek Road. We can also compare the finding of the sweep samples with the findings of the dustfall jars and field observations to compare the two methods of estimating dust generation.

Industry	Road Use	Plant Sites	# of Samples	Fines Content	
				Range	Mean
Copper smelting	Plant road	1	3	16 – 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	1	1	-	7.1
Stone quarrying and processing	Plant road	2	10	2.4-16	10
	Haul road to/form pit	4	20	5.0-15	8.3
Taconite mining and Processing	Service road	1	8	2.4-7.1	4.35
	Haul road to/form pit	1	12	3.9-9.7	5.8
Western Surface coal mining	Haul road to/form pit	3	21	2.8-18	8.4
	Plant road	2	2	4.9-5.3	5.1
	Scraper route	3	10	7.2-25	17
	Haul road (freshly graded)	2	5	18-29	24
Construction sites	Scarper routes	7	20	0.56-23	8.5
Lumber sawmills	Log yards	2	2	4.8-12	8.4
Municipal Solid waste landfills	Disposal routes	4	20	2.2-21	6.4
Publicly accessible roads	**Gravel/crushed limestone**	**9**	**46**	**0.1-15**	**6.4**
	Dirt	**8**	**24**	**0.83-68**	**11**

Table 2. Typical silt content values of surface materials on industrial and rural unpaved roads[1].

SAMPLE COLLECTION: Sweep samples were taken monthly on each application and buffer site. Sweep samples were collected by carefully measuring out a 1 square foot area, then sweeping the area using a dustpan and whiskbroom (*Figure 11*). A sweep was done en each wheel track and combined to make the sample for each site. The sample locations were selected randomly each time they were taken. The samples were stored in sealed containers for transport back to the laboratory.

Figure 11. Example of 1 foot square used to obtain a sweep sample

SAMPLE ANALYSIS: After returning to the laboratory the samples were first weighed and then dried and weighed again. This provided information about the moisture content of the samples, which is important because some of the dust suppressants function by drawing moisture to the road. The dried samples were then passed through a series of sieves ranging from 3/8" to 200 mesh. The results were recorded as percent remaining. The total material collected and the percentage fines of each sample can be used for further comparative analysis of the dust suppressant application sites.

TRAFFIC COUNTERS

One of the main variables that will affect the amount of dust generated on each section of road is the amount of traffic the road receives. The quantity of dust emissions from a given section of road will vary directly with the volume of traffic. The section of White Deer Creek Road used in this study is about 8 miles long. Traffic can enter from both ends and from one point in the middle via Cooper Mills Road (located on the buffer site between site 4 and 5). To insure that traffic volumes are taken into account, two traffic counters were used on White Deer Creek Road. The traffic counters were placed on either side of Cooper's Mill Road in the center of the project (see map *Appendix 1*). Any differences in traffic volume between the two sections of road will result in a variation in the dust that is generated and will need to be taken into account when analyzing the dustfall jars. One of the traffic counters used was a pneumatic counter that simply counted the number of cars and reported the total. The other traffic counter was a more advanced model that had the capability to keep track of daily traffic totals. This model used a buried electric wire to count vehicles and is shown in *Figure 12*.

Figure 12. Installation of a buried wire traffic counter.

DIRECT OBSERVATION

While clearly subjective, direct observation of the dust suppressant performance over time provides a crucial perspective on their performance. Photo-documentation was used to record the status of the various dust suppressant applications. Pictures of each site were taken before any work was done. Additional photographs were taken monthly when the dust jars were collected. The condition of White Deer during each site visit to collect dust samples was also recorded photographically. *Figure 13* shows the condition of each site on the day after dust suppressant application. For a complete photographic record, see *Appendix 2*.

Figure 13a. Photographs of sites 1 day after dust suppressant application.

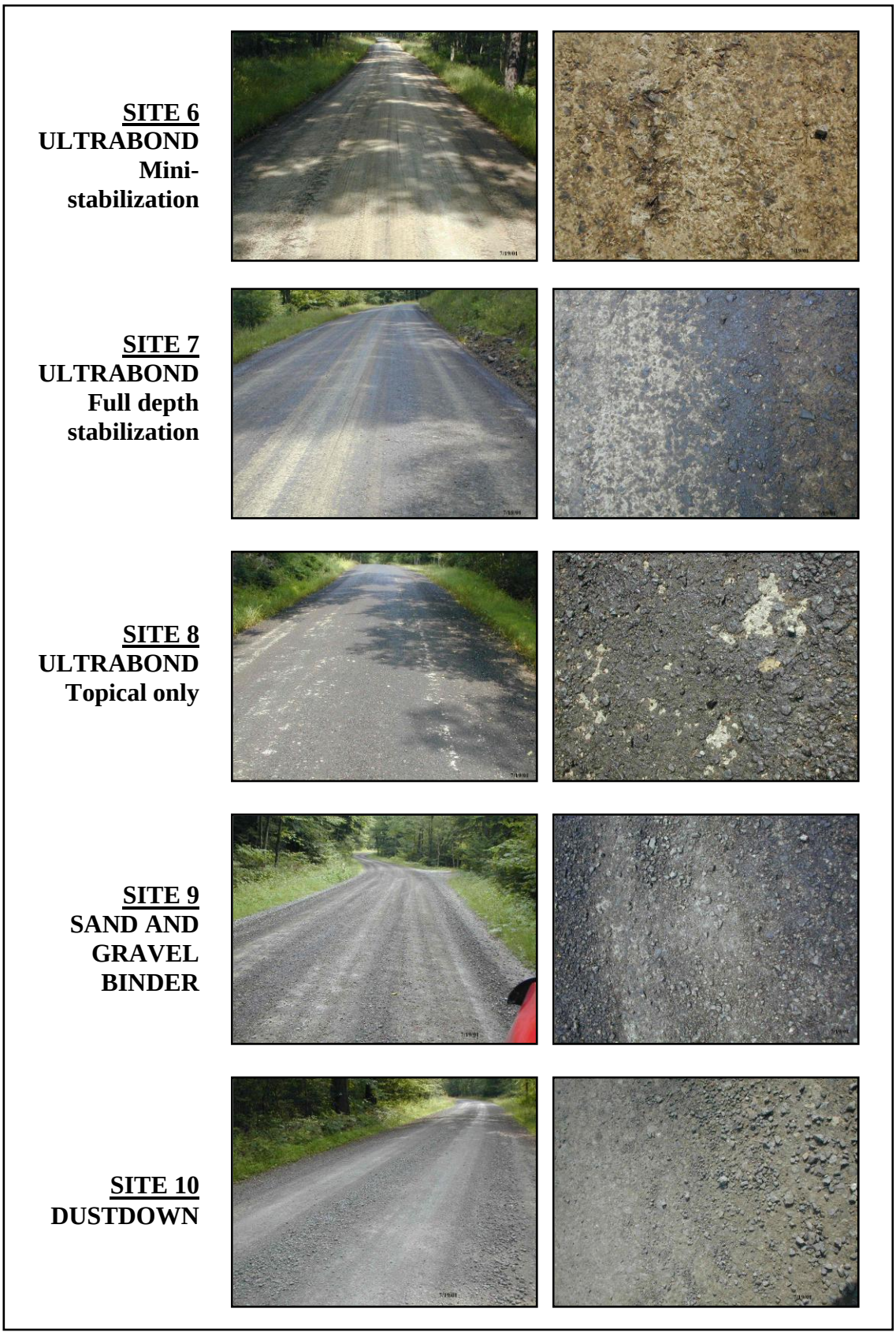


Figure 13a. Photographs of sites 1 day after dust suppressant application.

RESULTS

DUSTFALL JARS

TOTAL RESIDUE: Dustfall jars were placed in the field and allowed to collect dust continuously for a period of one month. A total of four samples were collected in the following time periods:

Sample Period 1	July 19 – August 17, 2001
Sample Period 2	August 17 – September 17, 2001
Sample Period 3	September 19 – October 19, 2001
Sample Period 4	October 19 – November 19, 2001

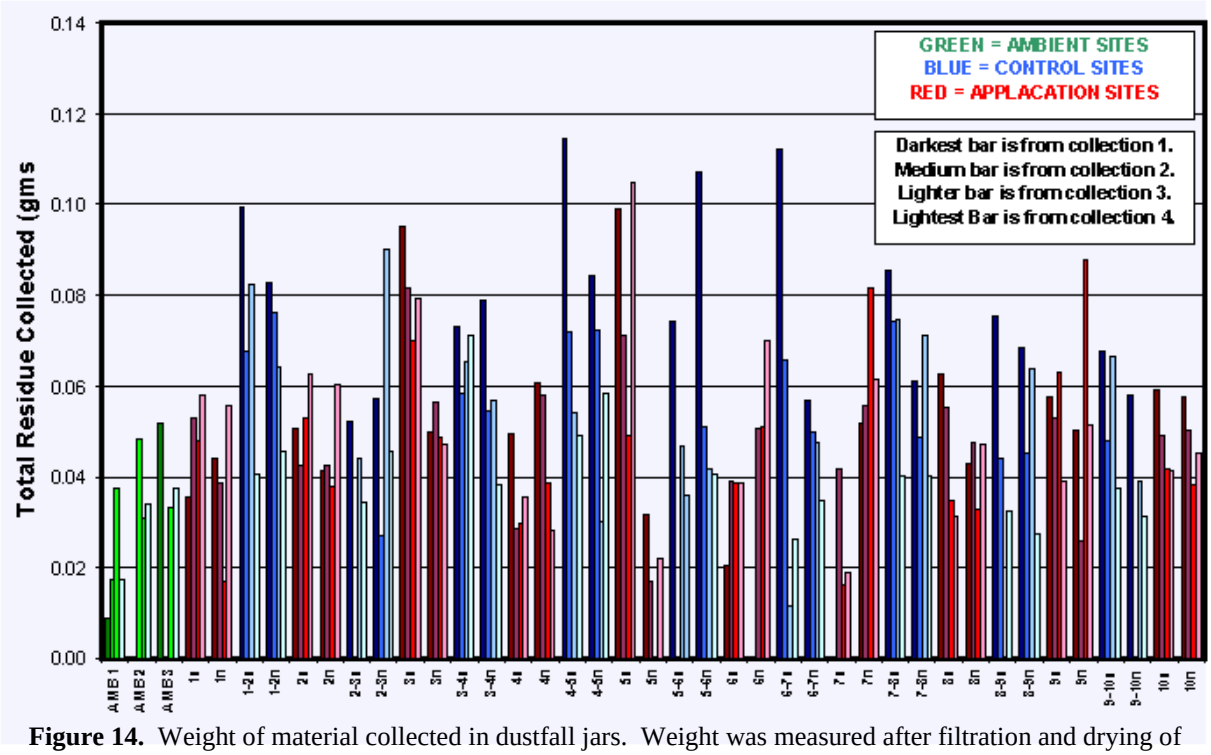


Figure 14. Weight of material collected in dustfall jars. Weight was measured after filtration and drying of residue at 105°C. Total dissolved solids in solution in each sample is also included in the total residue.

The complete data for all dust jar samples can be found in *Appendix 3*. At least one jar from each sample period was not usable due to vandalism or curious wildlife. These samples are noted with "lost" in the data table and are blank in the accompanying graphs. *Figure 14* illustrates the total residue accumulated in the dustfall jars during each sampling period. Included in the total residue accumulated is the weight of residue after filtration and drying, and the weight of the total dissolved solids in solution.

Because of the high and inconsistent organic content in the jars, a clear trend is difficult to identify. The Loss on Ignition test was run on all jars to determine the amount of inorganic material in ease sample.

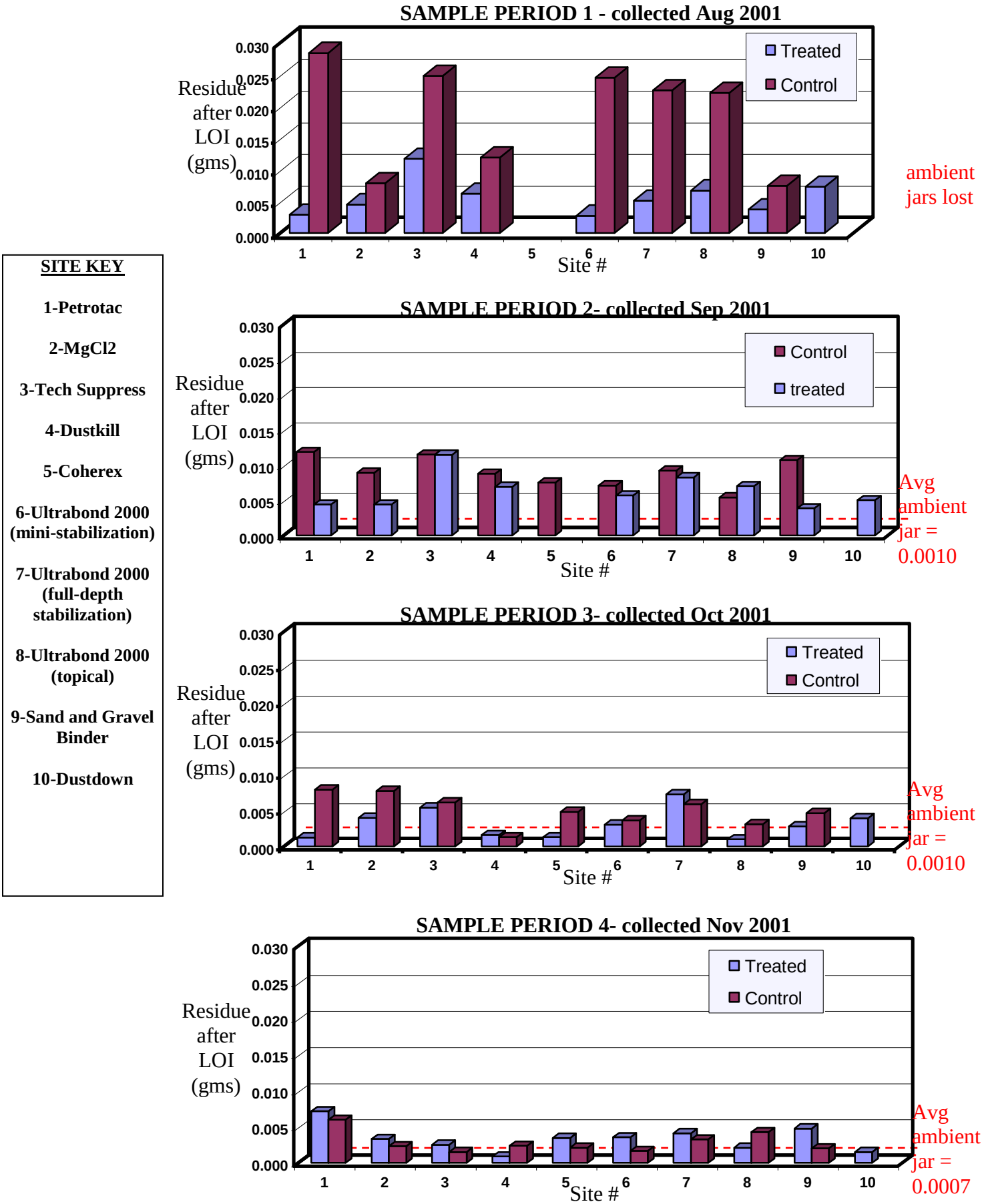


Figure 15. Total residue of sample after Loss on Ignition procedure. Sample from North and South Side of road were averaged for each site.

TOTAL RESIDUE AFTER LOSS ON IGNITION: After the initial filtration, drying, and weighing, each sample underwent further analysis using Loss on Ignition (LOI) procedures. LOI was used to insure that all organic material in the residue was burned off, so only inorganic material remained. *Figure 15* illustrates the total residue left in each sample after the LOI procedure.

The results reveal that from 50-90% of the collected residue was organic material. During the first month (collection 1), the average amount of inorganic material collected on treated sections of road using dust fall jars was approximately 70% less than that collected on the untreated sections. However, by the second month (collection 2), the average reduction was only 24%. During the third month (collection 3), the treated sections produced 37% less emissions than the control. *Appendix 6* contains the full results of the LOI testing. Sample periods 3 and 4 experienced a much higher amount of rainfall than sample periods 1 and 2, which could account for the lower dust collection totals.

Dust Fall Perpendicular to Road

The five dustfall jars used in this study were located on the control site (no treatment) between dust suppressant application sites 2 and 3. Jars were placed perpendicular to the road at intervals of 30 feet and allowed to collect dust for one month at a time. See (*Appendix 1, inset map 1*) for jar locations. The total amount of residue remaining after LOI procedures is shown for each sample distance in *Figure 16*.

Dust Fall Parallel to Road

The five dustfall jars used in this study were located on application site 6 (Ultrabond 2000: mini-stabilization). The jars were placed every 200 feet beginning at the western border of application site 6, and stretching to the center of the site. See (*Appendix 1, inset map 2*) for jar locations. During all sampling periods loss of jars from this experiment occurred. The remaining results were not useful.

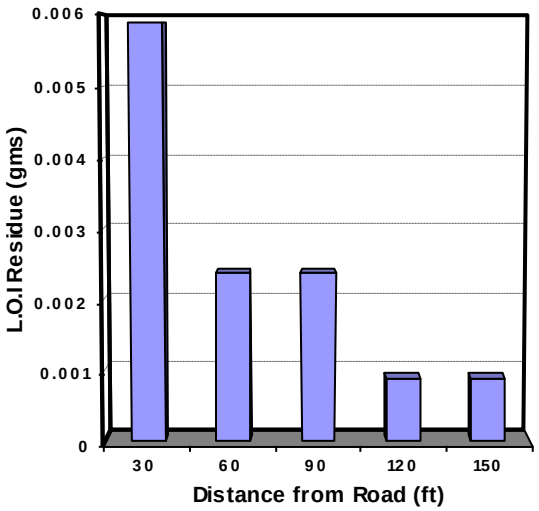


Figure 16. Total residue after LOI procedure for jars placed at 30 foot intervals from the road.

ADVANCED SAMPLE ANALYSIS:

Thermo-gravimetric Analysis

A Thermo-gravimetric Analysis (TGA) of several typical samples was performed to determine the amount of organic materials present in the samples. In the TGA procedure, the weight of the sample is continuously monitored as the temperature is slowly increased from room temperature to over 700°C. The result is a plot of a sample's weight change vs. temperature. The TGA plot reveals three distinct areas of weight loss at 301, 361 and 414 ºC. These temperature ranges are typical of organic burn-off. The plot also reveals that only a small amount of weight loss occurs after 700ºC. The results of a sample TGA are given in *Figure 17.*

The TGA testing confirmed the suspected abundance of organic matter in the samples. As a result of the high organic content of the samples, the Loss on Ignition (LOI) procedure was used on all samples to eliminate any organic materials.

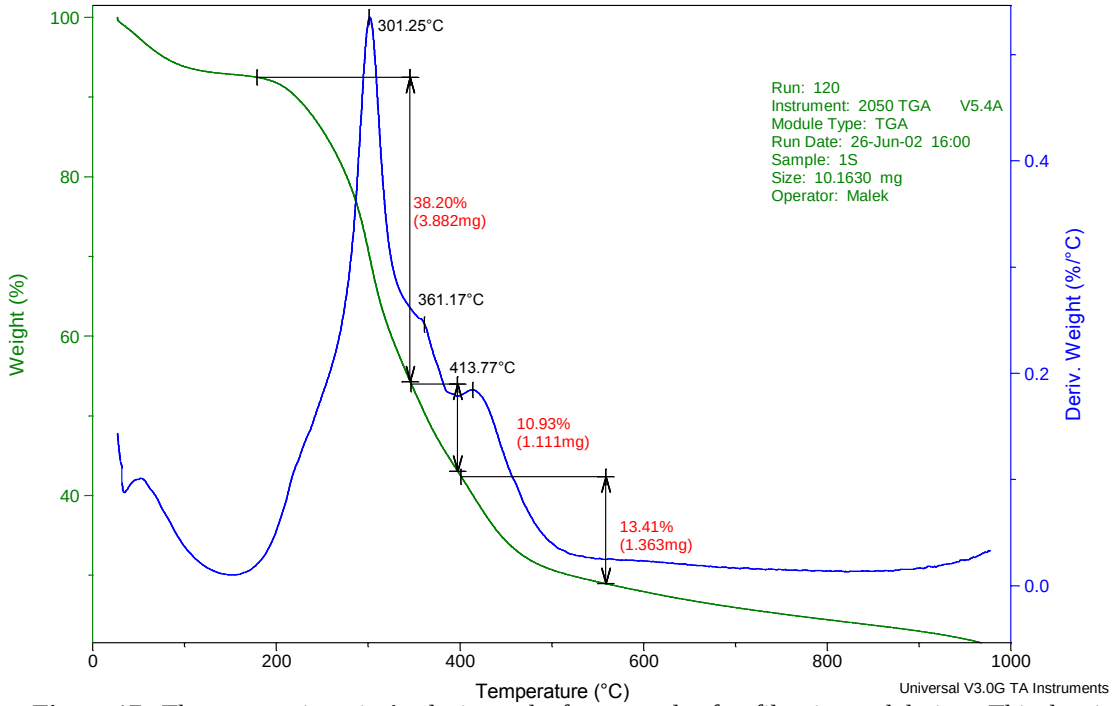


Figure 17. Thermo-gravimetric Analysis results for a sample after filtration and drying. This data is from the dustfall jar located on the southern side of site 1 (Petrotac™) from collection period #1.

Dust particle characterization

In order to characterize the size and composition of any dust particles present in the samples, it is necessary to isolate individual particles. *Figure 18* shows a scanning electron microscope (SEM) image of a section of filter paper after filtering. As can be seen from the image, a film is formed on the filter during filtering. The film makes distinguishing individual particles very difficult. *Figure 19* shows an image of a similar area at a higher magnification. One method used to isolate individual particles is to wash the particles off from the filter paper and then redistribute them onto a support grid. *Figure 20* shows a series of SEM images of individual dust particles after redispersal on a support grid.

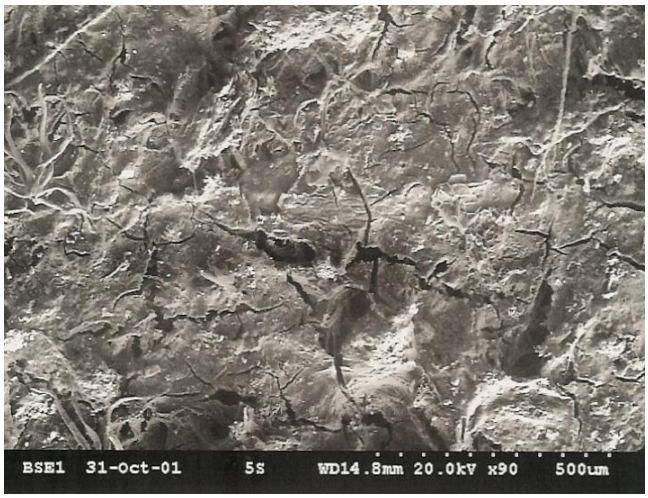


Figure 18. A scanning electron microscope (SEM) image of a section of filter paper after filtering. (90 X magnification)

Figure 19. A scanning electron microscope (SEM) image of a section of filter paper after filtering. .(150X magnification)

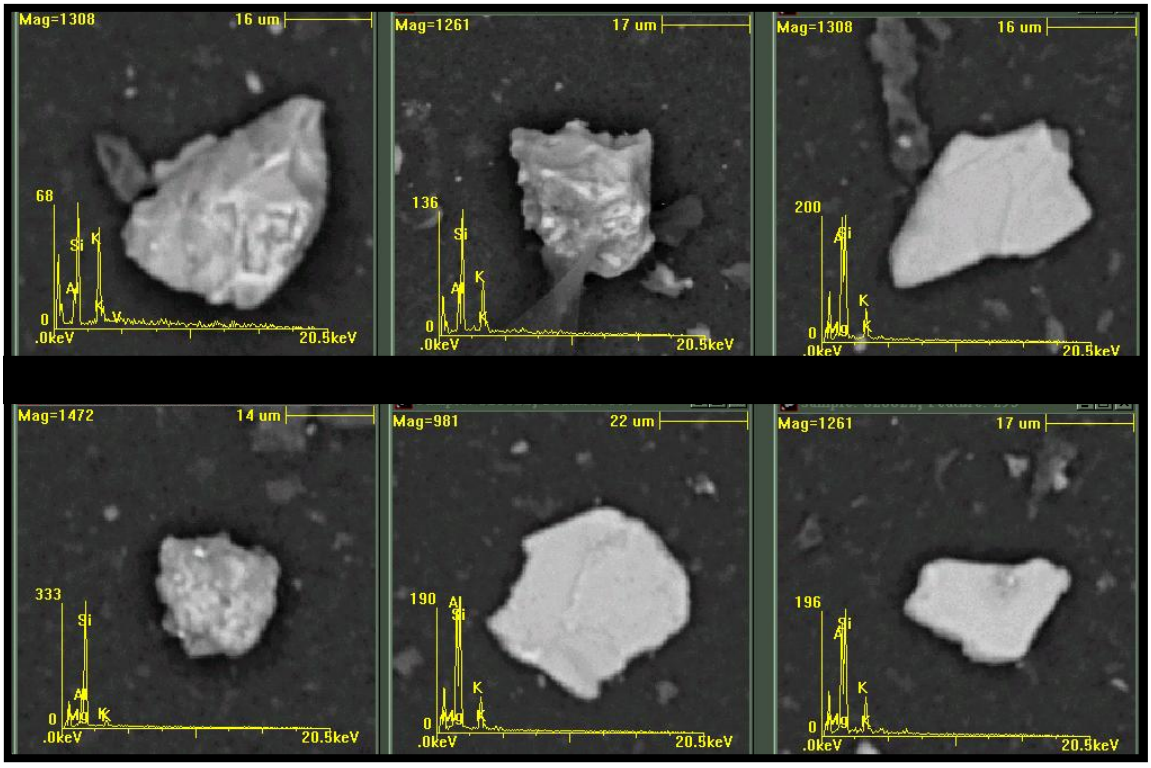


Figure 20. SEM images of dust fall particles after redispersal on a support grid. Overlaid on the images is an EDS scan revealing that the particles are primarily potassium alumino-silicates, most likely clays of some type. (courtesy of RJ Lee Group Inc., Monroeville, PA)

A scanning electron microscope uses a focused beam of electrons to generate an image. As some of the electrons that hit the sample may knock electrons out of the sample. Higher energy electrons then drop down to fill the vacancies, giving off electrons in the form of x-rays. The energy of the x-rays generated is characteristic of the element from which they are coming. An energy dispersive spectroscopy (EDS) detector placed in a SEM allows one to perform chemical analysis. Overlaid on the images in *Figure 20* are EDS scans revealing that the particles are primarily potassium alumino-silicates, most likely clays of some type. An

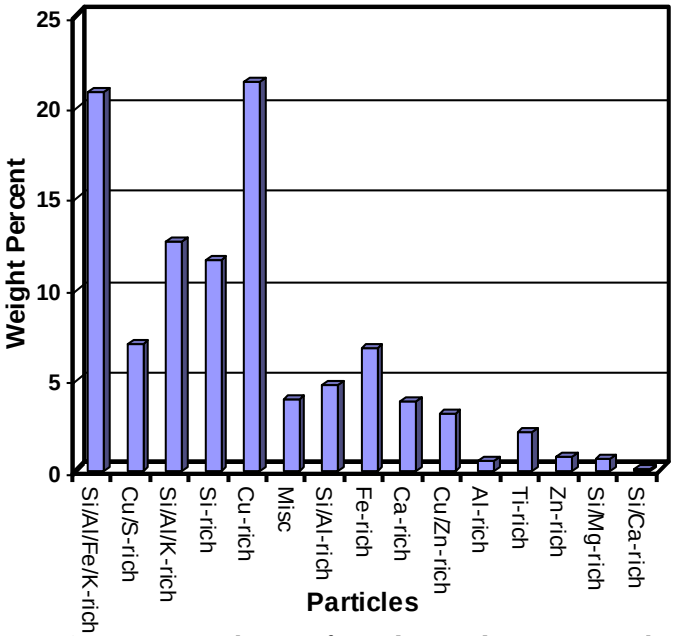


Figure 21. Distribution of sample particle composition by percent weight using energy dispersive spectroscopy.

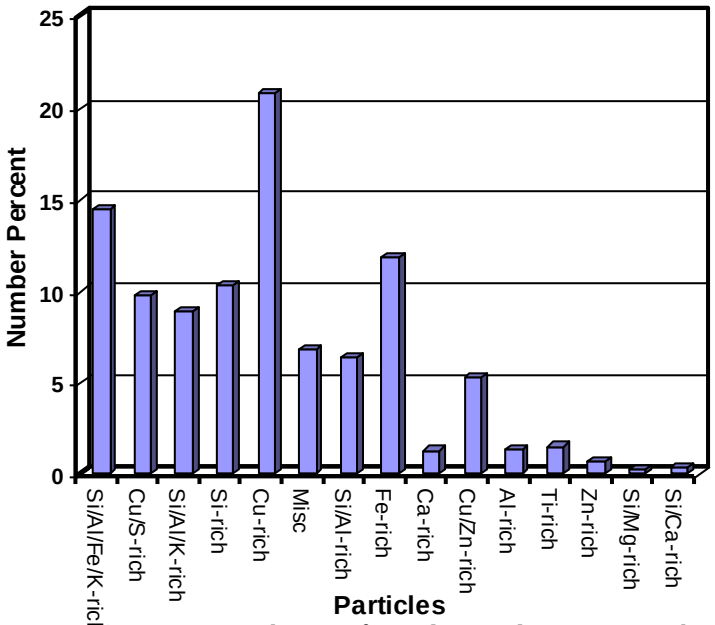


Figure 22. Distribution of sample particle composition by number percent using energy dispersive spectroscopy.

automated particle counting and measuring routine was employed to characterize these particles (*Appendix 3*).

Figures 21 and 22 summarize some of the results of the particle measuring and counting by both weight percent and number percent. The results show that the dust particles are predominately composed of silica containing particles with compositions typical of clays and shales. Bulk chemical analysis reveals that the samples were composed primarily of calcium, potassium, iron and silica. A significant fraction of copper containing particles was also found. *Table 3 and Figure 23* give a breakdown of the number of particles by size. The results reveal that the majority of the particles fall in the 0.5 to 5 μm range. The largest number of particles were around 1 μm.

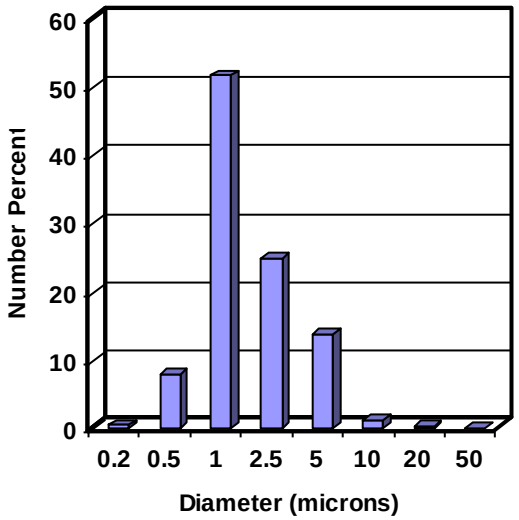
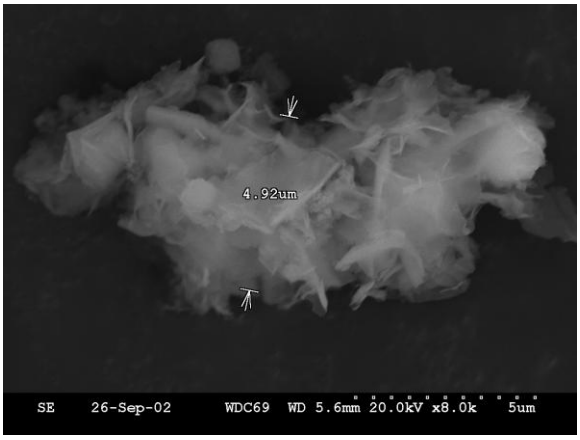


Figure 23. Particle size distributing by average diameter (μm). (courtesy of RJ Lee Group Inc., Monroeville, Pa).

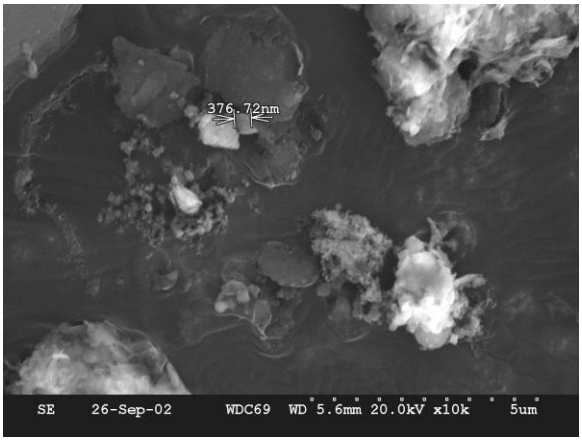
		Particle Diameter (μm)						
Classes	**Number %**	**0.5**	**1.0**	**2.5**	**5.0**	**10.0**	**20.0**	**50.0**
Si/Al/Fe/K-rich	14.5	0.0	2.1	31.1	43.5	20.4	2.5	0.4
Cu/S-rich	9.7	0.0	1.5	21.5	36.4	40.5	0.0	0.0
Si/Al/K-rich	8.9	0.0	0.0	38.9	42.2	16.7	1.7	0.5
Si-rich	10.4	0.0	0.0	66.6	17.1	13.3	2.5	0.5
Cu-rich	20.8	1.7	23.8	59.9	11.4	2.4	0.6	0.2
Misc	6.8	0.0	2.2	39.7	29.0	29.0	0.0	0.0
Si/Al-rich	6.4	0.0	0.0	54.2	34.1	10.8	0.5	0.3
Fe-rich	11.8	0.0	12.7	78.7	6.7	0.8	1.0	0.1
Ca-rich	1.3	0.0	0.0	46.0	30.2	15.1	8.0	0.6
Cu/Zn-rich	5.3	2.8	5.7	70.8	18.6	1.9	0.1	0.1
Al-rich	1.4	0.0	0.0	64.5	14.1	21.2	0.1	0.0
Ti-rich	1.5	0.0	29.8	49.6	19.6	0.0	0.5	0.5
Zn-rich	0.6	0.0	23.1	46.2	15.2	15.2	0.2	0.2
Si/Mg-rich	0.3	0.0	0.0	59.3	39.0	0.0	0.5	1.1
Si/Ca-rich	0.4	0.0	0.0	74.7	24.6	0.0	0.7	0.0
Totals	**100.0**	**0.5**	**7.9**	**51.6**	**24.8**	**13.7**	**1.2**	**0.3**

Table 3. Particle size distributing of each component by average diameter (μm). (courtesy of RJ Lee Group Inc., Monroeville, Pa).

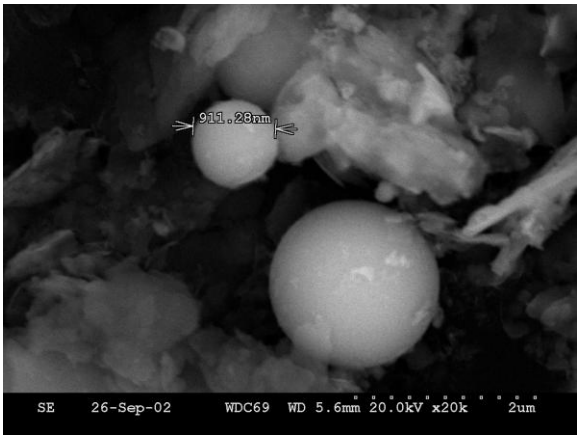
Samples of the material collected in the dust fall jars that had been through the L.O.I. process were examined in the SEM and subjected to characterization by EDS. In *Figure 24(a)* we see an agglomerate approximately 5 μm in cross section. The agglomerate is apparently made up of many fine particles (< 1 μm). *Figure 24(b)*, shows some of the finer particles observed. These particles have a cross section of less than 0.5 μm. *Figure 24(c)*, shows an image of what looks appears to be coal fly ash particles. The round spheres have diameters in the micrometer range. One could speculate that these particles are perhaps residual anti skid material or that they were carried in on the undercarriage of vehicles. *Figure 25* shows an EDS scan characteristic of the particles in *Figure 24*, *parts a-c*. The scan reveals that the particles are primarily potassium-alumino-silicates. A small amount of copper is also noted. One can speculate that since copper is commonly used as an algaecide that it has found its way onto the roadway via this route.



(a)



(b)



(c)

Figure 24 (a-c). SEM images of dust particles after L.O.I procedure.

SWEEP SAMPLE ANALYSIS

Sweep samples were collected form each treated and buffer section of the road monthly. The full results of this testing are shown in *Appendix 7*. While there was a wide variance, the average amount of loose material found on the treated sections of road was about ½ the amount found on the control sections. *Figure 25* illustrates the typical composition of particles collected during sweep samples. *Figure 26* shows the various amounts of loose material collected by sweep samples two months after product applications. *Figures 27-28* show the size distribution of the loose material collected during sweep samples. *Figures 29-30* illustrate the amount of fine material(less than 140 mesh) collected during the sweep samples. On average, the material from the treated sections of roadway had 35% less material finer than 140 mesh when compared to the control sections. Even after one year (*Figure 30*) there was 14% % less material finer than 140 mesh on the treated sections when compared to the control sections.

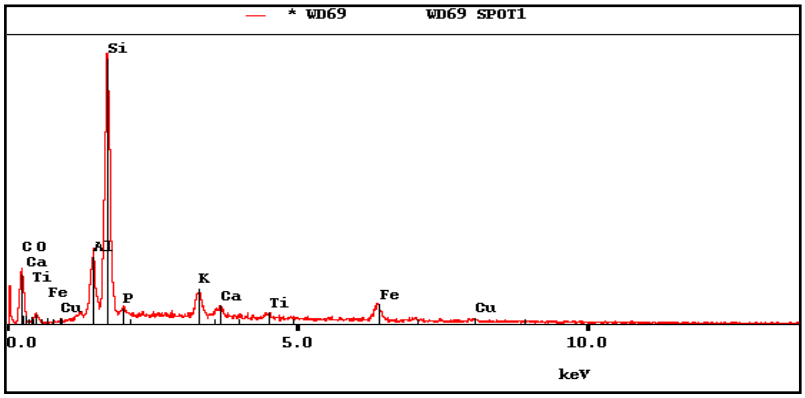


Figure 25. EDS scan typical of the particles collected in the sweep samples.

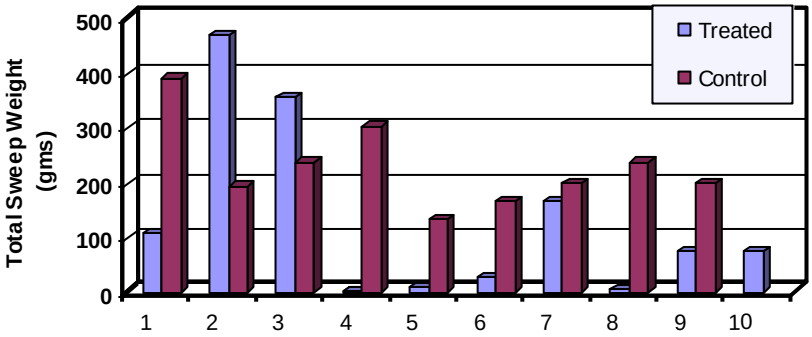


Figure 26. The amount of loose material collected by sweeping a one square foot section of the roadway, two months after the application of the suppressants.

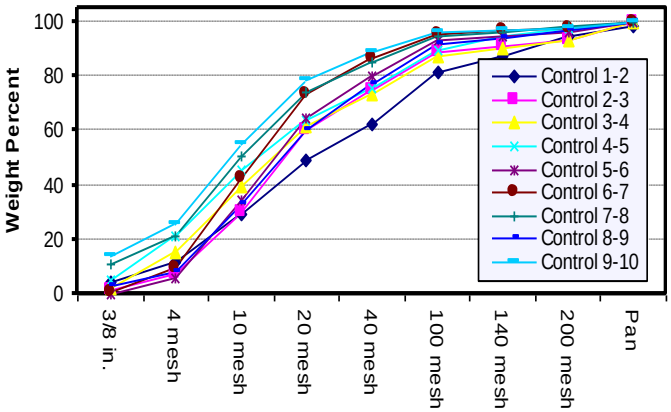


Figure 27. The size distribution of the loose material collected by sweeping a one square foot section of control roadway, two months after the application of the suppressants.

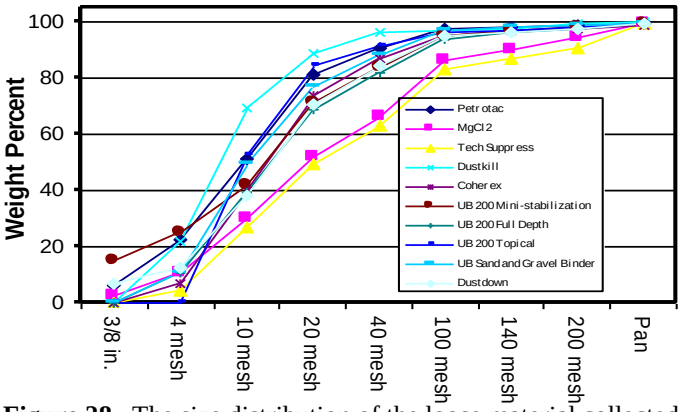


Figure 28. The size distribution of the loose material collected by sweeping a one square foot section of treated roadway, two months after the application of the suppressants.

SITE KEY: 1-Petrotac; 2-MgCl2; 3-Tech Suppress: 4-Dustkill: 5-Coherex; 6-Ultrabond 2000 (mini-stabilization): 7-Ultrabond 2000 (full-depth stabilization); 8-Ultrabond 2000 (topical); 9-Sand and Gravel Binder; 10-Dustdown

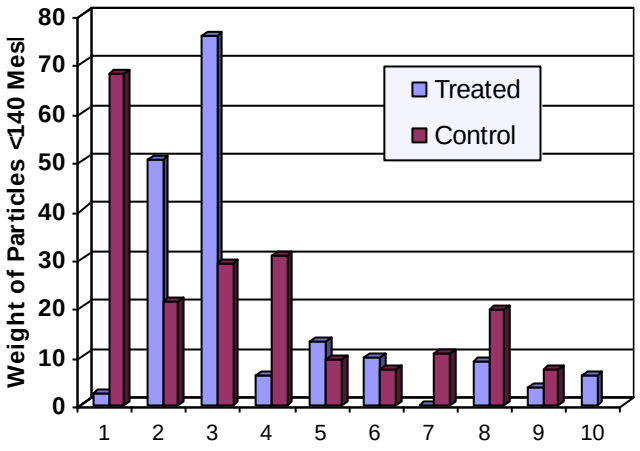


Figure 29. The total weight of loose material that passes a 140-mesh sieve collected by sweeping a one square foot section of roadway, one month after the application of the suppressants.

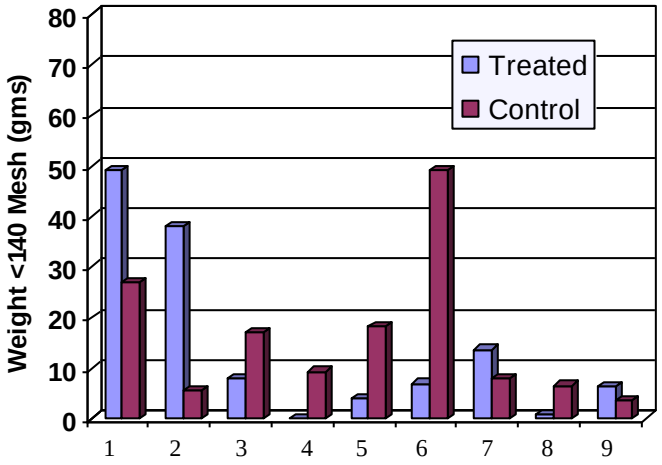


Figure 30. The total weight of loose material that passes a 140-mesh sieve collected by sweeping a one square foot section of roadway, one year after the application of the suppressants.

TRAFFIC COUNTS

When comparing the performance of different sections of roadway, the number of vehicles using a particular section of road is important. During the period July 20 to September 16, 2001, 1003 vehicles traveled the western end of the road and 1263 traveled the eastern end. *Figure 31* summarizes the traffic pattern observed on the east section of the test area. On average, 41 vehicles passed the traffic counter on a typical weekday and 60 on an average weekend day. The traffic ranged from a low of 7 to high of 143 vehicles per day. The detailed traffic count data is given in *Appendix 8*. See map in *Appendix 1* for traffic counter locations.

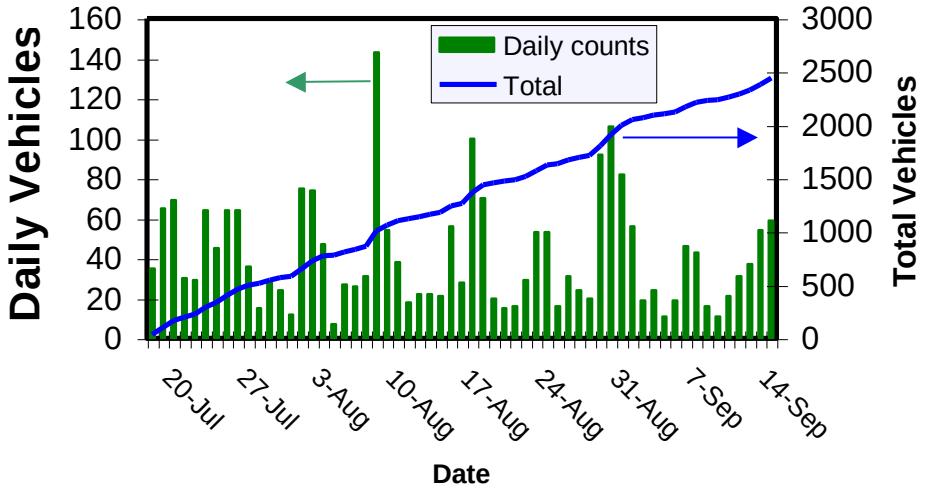


Figure 31. Summary of traffic on the eastern end of White Deer Creek Road for the period July 20, to September 16, 2001.

Summary

The following observations can be made from this study:

- The results show that the dust particles are predominately composed of silica containing particles with compositions typical of clays and shales.
- **50 to 90% of the matter collected in the dust fall jars was organic.**
- While there was a wide variance, the average amount of loose material found on the treated sections of road was about ½ the amount found on the control sections.
- On average, the material swept from the treated sections of roadway had 35% less material finer than 140 mesh when compared to the control sections.
- After one year there was 14% less material finer than 140 mesh on the treated sections when compared to the control sections. sweep
- The size of the dust particles ranged from 0.5 to 50 µm. The largest numbers of particles were observed in the 1-µm size range.
- While traffic on White Deer Creek Road varied from day to day, on average 41 vehicles passed the traffic counter on a typical weekday and 60 on an average weekend day. The traffic ranged from a low of 7 to a high of 143 vehicles per day.
- During the first summer of testing there was an average reduction of approximately 50% of the emission from the treated sections compare to the control.
- The average moisture content found in treated sections of road was about 20 percent higher than in the control sections.
- There did not seem to be any appreciable advantage to the mini-stabilization or full depth stabilization for dust control. However, these techniques may be useful for other applications.
- It was impossible to place all the dust fall collection jars in areas that were free from influences of the surrounding vegetation. This resulted in a high sample to sample variation for the samples collected from the dust fall jars. As a result of the high standard of deviation in the amounts collected it is impossible to draw any statistically significant conclusions about the performance of the individual suppressants.

In summary, the use of new generation dust suppressants can be an effective tool for controlling visible dust. This study does have a limitation in the concentrations of suspended dust which has not been measured. This is of concern since the small particles likely to remain suspended are in the size range most likely to cause health problems.

EXHIBIT G

Good practice guide for assessing and managing the environmental effects of dust emissions

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Ministerial Foreword

The effects of dust emissions from sources such as quarrying, aggregate crushing, abrasive blasting, unsealed surfaces and material stockpiles can cause widespread public concern.

This guide has been developed to provide guidance on how to assess and reduce the environmental impacts of dust emissions. It looks at where dust comes from, its effects on the environment and how we can better monitor and manage dust emissions.

This guide is the result of more than a year of consultation and development with councils, industry, practitioners and communities. It is based on best practice evolved under New Zealand's Resource Management Act.

This guide will be a valuable resource to those involved with dust issues, from those managing the emissions through to those affected by dust. It will help councils prepare regional and district plans and with resource consent decisions. Industry will be able to use the guide to prepare environmental effects assessments and to manage and control their dust emissions.

While a local approach to dust nuisance management is recommended to take account of local conditions and factors, this guide provides practical information and tools that can be tailored to particular situations and communities.

As a result of this work I hope we will see a reduction in the levels of dust emissions caused by human activity and a more consistent approach to dust management nationally.

Hon Marian L Hobbs
MINISTER FOR THE ENVIRONMENT

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1 Introduction

1.1 Purpose

This Good Practice Guide aims to provide useful information and recommendations for councils, communities and industry on how to assess and manage the environmental effects of particle or dust emissions from sources such as quarrying, aggregate crushing, abrasive blasting, unsealed surfaces and material stockpiles.

The guide should assist in:

- assessing environmental effects of dust emissions and ways to mitigate them
- developing regional air plans
- considering resource consent applications to discharge contaminants to air
- preparing district plans
- compliance monitoring
- state of the environment monitoring.

The Guide focuses on what is typically referred to as "dust nuisance" effects and impacts on amenity values, such as the soiling of clean surfaces and visual impacts. It does not go into significant detail on potential human health effects of fine particulate (particles less than 10 microns in size – PM_{10}). This is covered in other guidance documents from the Ministry.

The term "dust nuisance" has been chosen quite deliberately, to distinguish it from the very similar "nuisance dust". In other words, the information given here is directed at the management of an effect of dust (i.e. nuisance), rather than managing the specific class of dusts referred to as "nuisance dust" or "nuisance particulates".

The nuisance effects of dust can be subjective and are difficult to measure in any quantitative or objective way. They are also very dependent on the sensitivity of the receiving environment. As a result, the effects cannot be controlled or managed easily through the use of air quality guidelines, which is the approach taken with most other air contaminants.

The recommendations in the guide aim to provide a practical and reasonable approach to the management of dust nuisance problems.

The information provided is complementary to the advice on planning provisions offered by the Ministry's report on *Managing the Amenity Conflicts Arising from Rural Activities* (MfE, 2000).

1.2 Content and scope

The remainder of section 1 discusses the importance of dust as an environmental issue and introduces the reader to the potential sources and environmental impacts of dust emissions.

Section 2 of the guide contains information on the sources of fugitive dust and a discussion of the potential environmental effects of dust emissions. These include effects on human health, soiling of clean surfaces, visibility loss and effects on plants.

Section 3 reviews current and historical legislation relevant to the control of dust emissions and their environmental effects. This includes a discussion of the key requirements under the Resource Management Act (RMA), along with a review of relevant case law.

Section 4 contains a discussion on various management options under the RMA. These include land use planning, regional and district plans, and resource consents (discharge permits). All of these instruments are appropriate for the management of dust nuisance, although they need to take into account the subjective nature of the environmental effects of dust emissions.

Section 5 describes the variety of different methods that can be used to assess dust emissions and their effects, including cumulative effects.

Section 6 then reviews methods for monitoring dust effects and contains recommended methods for different circumstances. These include complaint monitoring, source testing and environmental monitoring. More specific information on the methods used for dust monitoring and related assessment criteria is given in Section 7.

Section 8 reviews the engineering methods available for dust control. For diffuse sources such as housing developments and construction sites, these can be as simple as regular watering of exposed surfaces and on-site speed limits for trucks and other vehicles. Control methods for industrial sources include the use of dust collectors, such as cyclones or bag filters, and total or partial enclosure of potential dust sources, such as conveyors.

The series of Appendices provide further information on dust properties, complaint records, assessment criteria, dust monitoring methods, and dust management plans. Case studies are provided at the end of the guide that highlight the practical issues associated with managing the effects of dust emissions.

This Guide does not cover occupational health issues for workers involved in dusty activities. The Occupational Safety and Health Division of the Department of Labour, relevant legislation and specific guidance information deal with these issues.

1.3 Why is guidance on dust assessment and management important?

The environmental impacts of dust emissions can cause widespread public concern about environmental degradation and/or a decline in amenity. The nature and extent of the problem and significance of the effects usually depend on the nature of the source, sensitivity of the receiving environment and on individual perceptions. For example, the level of tolerance to dust deposition can vary enormously between individuals. However, individual responses can also be affected by the perceived value of the activity producing the dust. For example, people living in rural areas may have a high level of tolerance for the dust produced by activities such as ploughing or top-dressing, but a much lower tolerance level for dust from unsealed roads.

The importance of community perception was clearly demonstrated in the results of a public opinion survey carried out by the (then) New South Wales State Pollution Control Commission and the New South Wales Coal Association (Dean *et al*, 1990). Population surveys and deposition measurements were carried out over a period of three years in areas where dust problems were known to occur. The results showed that individual perceptions were affected by the existing background dust levels, and by the rate of change. The study found that the environmental character of an area (i.e. whether it is predominantly natural, rural, semi-rural, suburban or urban/industrial) and the social nature of an area (particularly the degree of community stability preceding a period of development and associated environmental change) were important determinants of the degree of community response.

The study also found that there was no particular threshold at which people were able to clearly perceive a decline in amenity. This conclusion has important implications for setting loss of amenity criteria or guideline values because any goal, criteria or value based on a universal threshold may be inappropriate.

Given the above, dust nuisance is best dealt with at a local level using management programmes tailored to the local conditions and local community concerns. This can lead to different controls between regions, based on varying receiving environment sensitivities and community perceptions of dust nuisance. It is therefore important to promote sound decision-making and a consistent approach to the management of dust issues throughout New Zealand.

Without a consistent approach founded on good practice there is a risk that certain regions may become "easy targets" for dusty activities because they have a less stringent approach to regulation than other regions (e.g. through rules in regional air quality plans). Industries have also expressed concerns about inconsistent requirements being imposed throughout New Zealand. Different requirements can also be particularly frustrating for trans-regional activities, such as mobile abrasive blasting.

National guidance aimed at achieving sound, reasonable and consistent decisions on dust management should also assist in handling overlapping responsibilities between local and regional authorities. These overlaps have the potential to occur in relation to dusty activities because of a degree of duplication of council functions. This guide provides advice intended to minimise the duplication of functions. The Ministry's report *Managing the Amenity Conflicts Arising from Rural Activities* (MfE, 2000) also provides useful information in this respect.

1.4 Issues

There are a number of key issues associated with dust management, which will be addressed by this guide. These are as follows:

- Subjective effects. The main problem with the environmental effects of dust is their subjective nature. People may be annoyed by dust fallout on their property, and some may find it objectionable or offensive. There are a number of practical and legal aspects that need to be considered in judging the severity and significance of these effects.
- Assessment methods. Many dust emissions come from diffuse sources, such as bare ground, unsealed roads, mines and quarries. As a result, it is difficult to quantify the emissions, and it is also very difficult to accurately predict the likely effects.
- Variability of the receiving environment. Measurable amounts of dust can be found in most urban and rural environments, but the levels can be highly variable. There are also extreme situations, such as drought-stricken rural areas or fallout from volcanic eruptions, where the natural dust levels can be well above the recognised nuisance levels.
- Land use planning. Dust nuisance problems are often associated with land use activities. This raises the issue of overlapping responsibilities between territorial local authorities and regional councils. There is also a need to recognise and provide ways to minimise the potentia l impacts of dust nuisance through land use planning.
- Understanding cumulative effects. In some areas there may already by relatively high background levels of dust and dust deposition. It is important to determine how these should be taken into account when carrying out an environmental assessment.
- Potential health effects. Although this document deals mainly with dust particles larger than PM_{10}, there needs to be some guidance on when potential health impacts should also be included in an assessment of the impacts of dust emissions.

2 Sources and Environmental Effects

2.1 Dust sources

Airborne dust can arise from a wide variety of anthropogenic sources, including the following:

- wind-blown dust from exposed surfaces such as bare land and construction sites
- wind-blown dust from stockpiles of dusty materials such as sawdust, coal, fertiliser, sand and other minerals
- dust caused by vehicle movements on sealed or unsealed roads
- agriculture and forestry activities
- mines and quarries
- road works and road construction
- housing developments
- municipal landfills and other waste handling facilities
- dry abrasive blasting
- numerous industrial operations, including grain drying and storage, timber mills, stonemasons, mineral processing, cement handling and batching, and fertiliser storage and processing.

Large quantities of dust can also be generated from natural sources, such as dry river beds, pollen from plants and volcanic eruptions.

2.2 Potential health effects

The potential health effects of dust are closely related to particle size. Particle sizes are normally measured in microns, and the size range of airborne particles is typically from less than 0.1 microns up to about 500 microns, or half a millimetre. Human health effects of airborne dust are mainly associated with particles less than about 10 microns in size (PM_{10}), which are small enough to be inhaled. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20 microns. Further discussion of the relationship between dust particle size and potential effects is given in Appendix 1.

The potential health effects of fine particles (less than 10 microns) are specifically covered under the New Zealand Ambient Air Quality Guidelines (MfE, 1994 and 1999), and will not be addressed further in this guide.

Many forms of dust are considered to be biologically inert, and hence the primary effects on people relate to our sense of aesthetics. There can also be minor health effects, such as eye irritation, when the dust is airborne. Indirect stress-related health effects could also arise, especially if dust problems are allowed to persist for an unreasonable length of time.

Some nuisance dust may have the potential to cause other types of health effects because of the presence of specific biologically active materials. For instance, some mineral dusts contain quantities of quartz, which can cause the lung disease known as silicosis when persistent at high concentrations. Other dusts may contain significant amounts of toxic metals such as mercury or lead.

The management procedures given in this guideline are applicable to all types of dust, regardless of their physical and chemical composition. However, those containing specific toxic components will generally require a much tighter level of control than simple nuisance dust. In some cases Workplace Exposure Standards have been developed for these materials to address occupational health issues (Department of Labour, 1994). Recommendations on the acceptable ambient air concentrations for some of these materials are given in a recent draft technical report prepared for MfE (1999). This Good Practice Guide is directed at the management of dust that causes nuisance or annoyance to people, rather than specific health effects.

2.3 Soiling and amenity value effects

The most common areas of concern include: the visual soiling of clean surfaces, such as cars, window ledges, and household washing; dust deposits on flowers, fruit or vegetables; and the potential for contamination of roof-collected water supplies. Dust deposits inside the house are often the impact of greatest concern in residential areas, followed by soiling of the outside of the house and the effects on paintwork.

Dusty conditions can also affect people's ability to enjoy their outdoor environment, making activities such as barbeques and sports unpleasant and unappealing.

For most people, a major effect of a dust nuisance problem is annoyance at the increased requirement for cleaning. However, this can also involve a financial aspect, through the increased use of cleaning materials, water, and possibly paid labour. This aspect of dust nuisance was addressed in a (by now rather dated) book by Ridker (1970) and in a paper by Narayan and Lancaster (1973). In the latter paper, the authors estimated that the cost differential for maintaining a house in an area of heavy dust deposition compared with a less polluted area of the Hunter Valley, New South Wales, was $90 per annum. An equivalent figure in today's terms could be about $500–$1000, which is significant.

Another related effect of dust nuisance is the potential impact on property values. This is a more difficult and often more emotive subject than soiling effects, but it is also a matter of common concern. Clearly, there is no simple method for quantifying this effect, and it would need to be assessed on a case-by-case basis.

2.4 Visibility

Airborne dust can have effects on visibility, although dust is usually less regionally significant than the effects of smoke from domestic fires and motor vehicles in urban areas. Visibility effects from dust are usually only a concern in the immediate vicinity of a specific source, whereas smoke effects can accumulate across a much wider area.

Visibility effects are largely a matter of aesthetics. However, it should also be recognised that visibility is one of the main ways by which people commonly judge air quality. Some people feel that the ultimate success of air quality management programmes in New Zealand will be measured against ensuring that we do not suffer the widespread degradation in visibility that has occurred elsewhere.

Loss of visibility is also a safety concern under extreme conditions, especially for road traffic or aircraft.

Guidance on atmospheric visibility degradation is being prepared under a separate MfE project and visibility has been adopted as a stage 2 (further development required) air quality indicator under the Environmental Performance Indicators Programme (MfE, 1998b).

2.5 Effects on plants

Dust deposits can have significant effects on plant life, though mainly at high dust loadings. This can include:

- reduced photosynthesis due to reduced light penetration through the leaves. This can cause reduced growth rates and plant vigour. It can be especially important for horticultural crops, through reductions in fruit setting, fruit size and sugar levels.
- increased incidence of plant pests and diseases. Dust deposits can act as a medium for the growth of fungal diseases. In addition, it appears that sucking and chewing insects are not affected by dust deposits to any great extent, whereas their natural predators are affected.
- reduced effectiveness of pesticide sprays due to reduced penetration.
- rejection and downgrading of produce. Once again, this is a particular issue for horticultural crops.

The effects of air pollutants on plants were recently reviewed in a report on ecosystem effects (ESR, 1998), although the coverage of dust effects is minimal. A much more detailed coverage of the effects of dust on plants is given in a report by the Agricultural Engineering Institute (McCrea, 1984). This report gives estimates of the potential losses in crop productivity for various rates of dust deposition. The main focus of the report is on horticultural crops grown alongside unsealed roads, and in this case the losses were shown to be significant within about 200 metres of the source.

Figure 1: Extraction processes and material stockpiles are common sources of wind-blown dust

3 The Legal Framework for Dust Management in New Zealand

3.1 Background legislation

Prior to 1991, the control of air pollution in New Zealand was under the common law doctrines of nuisance, and to a lesser extent trespass and negligence, and the statutory controls of the Health Act 1956 and the Clean Air Act 1972.

The Clean Air Act 1972

The Clean Air Act 1972 (CAA) imposed a general obligation to adopt the best practicable means to reduce air pollution. It limited the application of the Health Act to "nuisance" and "offensive trades" that were not included in the CAA Schedules. Common law remedies remained, particularly as there were no rights to object to licenses or rights to statutory compensation under the CAA.

The CAA was repealed by the Resource Management Act (RMA) in 1991, although transitional provisions continue to apply for some activities (section 418).

The Health Act 1956

Section 29 of the Health Act deems a nuisance to be created:

> *(h) Where any factory, workroom, shop, office, warehouse, or other place of trade or business is not provided with appliances so as to carry off in a harmless and inoffensive manner any fumes, gases, vapours, dust, or impurities generated therein:"*

Other more general nuisance provisions may also be wide enough to include a nuisance generated by dust where an accumulation or deposit is in such a state or situated so that it is offensive or likely to be injurious to health (section 29(b)).

The Health Act is administered by district and city councils. Every person who permits or causes a nuisance commits an offence under the Health Act. The Court may require an owner or occupier to abate a nuisance and may specify the works to be done. A local authority may also abate a nuisance and recover costs. The general penalty for offences is $500 and a further fine not exceeding $50 a day for a continuing offence.

The nuisance provisions of the Health Act 1956 have not been repealed by the Resource Management Act 1991 ("the RMA"). However a nuisance created under the Health Act 1956 is also likely to constitute an offence under the RMA. The offence provisions under the RMA provide for heavier penalties for similar offences as well as the possibility of abatement notices and enforcement orders requiring work to be done to avoid, remedy or mitigate any actual or likely adverse effect on the environment.

3.2 The Resource Management Act 1991

The purpose of the RMA as specified in section 5(1) is *"to promote the sustainable management of natural resources"*. Section 5(2)(c) provides for *"avoiding, remedying, or mitigating any adverse effects of activities on the environment"*. Section 2 of the Act defines "environment" as including:

> *"(a) Ecosystems and their constituent parts, including people and communities; and*
>
> *(b) All natural and physical resources; and*
>
> *(c) Amenity values; and*
>
> *(d) The social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters."*

The term "amenity values" is also defined in section 2 of the Act. It means:

> *"those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes."*

Clearly, dust nuisance is covered under the RMA because of its potential to cause adverse impacts on amenity values.

Section 9

Section 9 provides that a person may use land in whatever manner they like provided it does not contravene a rule in a plan. If the activity does contravene a rule then a resource consent is required, except when existing use rights apply. The production of dust from a land use will, therefore, not be controlled under a district plan unless the plan includes restrictions on the effects of the use of land that causes the dust emission.

Section 15

Dust is an air contaminant, and is therefore controlled under section 15 of the Act. Section 15(1) means that discharges from industrial or trade premises are only allowed if they are authorised by a rule in a regional plan, a resource consent, or regulations. If a discharge is not authorised in this manner, consent will be required unless a plan prohibits the activity.

Under 15(2) the opposite presumption applies to discharges from any other source. Unless these sources are controlled by a rule in a plan, discharges are allowed as of right and consent is not required.

Section 17

Section 17 of the Act imposes a general duty upon every person to avoid, remedy or mitigate any adverse effect on the environment arising from any activities the individual may conduct or have carried out on their behalf. This applies, regardless of whether the activity is carried out in accordance with any rule, plan or resource consent.

In section 3 of the RMA, "effect" is defined as including:

> *"(a) Any positive or adverse effect; and*
>
> *(b) Any temporary or permanent effects; and*
>
> *(c) Any past, present, or future effect; and*
>
> *(d) Any cumulative effect which arises over time or in combination with other effects – regardless of the scale, intensity, duration or frequency of the effect, and also includes –*
>
> *(e) Any potential effect of high probability; and*
>
> *(f) Any potential effect of low probability which has a high potential impact."*

Enforcement provisions

Section 17(3)(a) provides that an enforcement order or abatement notice may be made or served, requiring a person to cease doing something that is or is likely to be noxious, dangerous, offensive or objectionable to such an extent that it has or is likely to have an adverse effect on the environment (sections 314(1)(a)(ii) and 322(1)(a)(ii)). Only a few forms of dust would be classified as "noxious" or "dangerous", but most can be "offensive" or "objectionable" in sensitive areas.

3.3 Best Practicable Option (BPO)

Section 108(1)(e) of the RMA makes provision for requiring a consent holder to adopt the best practicable option to control any adverse effects caused by an activity. The BPO is also commonly included in the review clauses of consents; essentially as a "fall back" option should the other consent conditions prove ineffective in controlling the effects of an activity.

The best practicable option was dealt with in some detail in *The Medical Officer of Health* v *Canterbury Regional Council and Ravensdown Fertiliser Co-operative Limited* (W109/94). The Planning Tribunal (now called the Environment Court) stated that in its view the key word was "practicable":

> *"Practical effect is given to those requirements [the provisions of section 108] by ensuring that the contaminants discharged by the applicant are at a level which on the best scientific and technical information available constitute the best practicable option of minimising adverse effects on the environment" (p.26)*

The Planning Tribunal held that it would be wrong to impose conditions that the holder of the consent could not practically comply with.

In an earlier case, the Planning Tribunal considered it was important the best practicable option condition was the *"most efficient and effective means of preventing or minimising any actual or likely adverse effect on the environment"* (*Peninsula Watchdog Group Incorporated* v *Waikato Regional Council and Coeur Gold New Zealand Limited* (A52/94)). It therefore appears that, the best practicable option will need to be the one that is most efficient and effective, and practicable given the current scientific and technical information available to prevent or minimise any actual or likely adverse effect on the environment. It will be the *"optimum combination of all methods available ... to the greatest extent achievable"* (*Auckland Kart Club Incorporated* v *Auckland City Council* A124/92 at pp.22-23).

In the *Ravensdown Fertiliser* case (W109/94) the Planning Tribunal went on to consider the term "environment" in relation to section 108(1)(e). It held at p.26 that:

> *"... it is clearly more than just the receiving air which must be considered in the context of s.108. It is also relevant to the facts of this case that it is amenity values and the social, economic, aesthetic and cultural conditions of the people of the surrounding area which must be borne in mind."*

In that case odour from the factory was said to clearly be capable of adversely affecting the amenity values of the district and the social, economic, aesthetic and cultural activities that take place there.

The Planning Tribunal noted that there was nothing known to science and technology at the time of the case that meant odours from the factory could be completely eliminated. However it was satisfied that all that was practicable at the time was being done to minimise the adverse effects on the environment of the odour discharge. Accordingly, the best practicable option does not necessarily mean the complete elimination of any adverse effect on the environment.

In *Australasian Peat Limited* v *Southland Regional Council* (C44/96) the Planning Tribunal required certainty in relation to a condition of the best practicable option for the control of dust. It stated that the best practicable option for the control of dust must be specified before it would allow an appeal. The methods specified to control dust included covering storage heaps with mesh cloth, laying and maintaining a concrete pad, installing and maintaining sliding doors on the peat drying plant, sealing a common access way with limestone rock and watering all loose dry peat before and during high wind events.

3.4 Site management plans

Site management plans are commonly required for the management of dust nuisance (see section 8). It is possible for a condition requiring compliance with a management plan to be included in a resource consent under section 108. To be included as a condition, the management plan must meet the criteria for resource consent conditions which means it will need to:

> *"1. Be for a resource management purpose, not for an ulterior one; and*
>
> *2. Be fairly and reasonably related to the development authorised by the consent to which the condition is attached; and*
>
> *3. Not be so unreasonable that no reasonable planning authority duly appreciating its statutory duties could have approved it."* (*Coote* v *Marlborough District Council* (W96/94))

The Environment Court has stated that its preference is for management plans to be prepared in advance and form part of the terms of the consent (*New Zealand Rail* v *Marlborough District Council* (C36/93), *Bird* v *South Canterbury Car Club* (C27/94) and *Hicks and Ors* v *Canterbury Regional Council and Selwyn District Council* (C58/95)). It has been held specifically in relation to dust control that where management practices are to be adopted that:

> *"If the intention is to ensure not only that these steps are taken, but that certain air quality parameters are to be adhered to, then we think those parameters should be specified as conditions of consent ..."* (*New Zealand Rail* case at p.193)

It is not appropriate for a council to try and reserve the power to approve a management plan at a later date outside the formal resource consent procedure (*Macraes Mining Company* v *Waitaki District Council and the Otago Regional Council* (C14/94)). The applicant or requiring authority needs to know what is required when the decision is made.

4 Management of Dust Emissions under the RMA

Most regional and district councils have recognised the need for controls on dust nuisance, and attempt to do so through rules in regional and district plans, and through conditions in resource consents. This section discusses the functions of regional councils and territorial local authorities (TLAs) and describes how these relate to managing dust issues.

4.1 Regional air quality management plans

To assist them in achieving the purpose and principles of the RMA, regional councils and unitary authorities can prepare regional air quality management plans. The plans specify the methods that will be used in managing air quality within a region. They usually aim to achieve the objectives and policies set out in the Regional Policy Statement. Individual sources or groups of sources are typically controlled by rules in plans that specify whether the activities are permitted (with conditions), controlled, discretionary, non-complying or prohibited.

The plans may also include policies and methods for the management of identified issues such as dust nuisance, odour, smoke from domestic fires, and motor vehicle emissions. In addition to rules, non-regulatory mechanisms may be adopted, such as education and development of industry codes of practice. Regional air plans are developed through a process of public consultation and review, before the plan finally becomes "operational". The current status of specific plans should be checked with the relevant regional council.

4.2 District plans

In the case of territorial local authorities, air quality matters are usually covered in a general way in a district plan. District Councils do not have specific functions under the RMA to manage discharges to air, unless delegated to do so by the regional council. However, under section 31 they are responsible for controlling some activities that can cause impacts on air quality, in particular, the use and development of land.

The types of industries allowed in different areas or zones are indicated in the district rules, along with some basic performance criteria or conditions. In some cases these conditions include restrictions on emissions of dust or odour.

4.3 Integrated land use planning

Regional and district councils often have a shared responsibility for the management of activities with the potential to cause dust nuisance. This is because the activities often involve the use of land, which is controlled by the district council, but the resulting environmental effects are controlled at a regional level. A good level of interaction and good communication between the different authorities is therefore essential, especially in the development of regional and district plans. These plans should be developed to prevent duplication so that dust emissions are controlled by consent from only one authority.

At a district level, there is a need for greater emphasis on effects-based planning. The use of simple zoning systems (industrial, commercial, etc) will generally not be sufficient, because of the wide range of different activities that can fall into different land use categories. Encroachment of residences and sensitive commercial activities on existing "dusty" industries is also a significant problem in some areas. Conversely, regional councils need to give a clear direction on the desired environmental outcomes for the region, and the ways in which these will be achieved.

Land use planning measures

The use of buffer zones around activities is one approach to preventing environmental impacts of dust emissions. The role and application of buffer distances under the effects-based principles of the RMA needs to be examined carefully. In some cases implementation of good practice dust control measures can greatly reduce the distance to affected areas. However, there may be cases (such as establishment of district plan zones) where buffer distances provide an appropriate method by which to avoid, remedy or mitigate adverse effects on the environment.

Buffer distances are well recognised internationally. For example, the State of Victoria in Australia (Vic. EPA, 1990) recommends buffer distances for a wide range of industrial sources of dust, odour and other nuisance emissions. The recommended buffer distances typically range from about 200–500 metres. However, it should be noted that these distances are based on the assumption that good pollution control technologies are also being used. An industry with poor controls would require a larger buffer distance.

The use of buffer distances should not be seen as a primary means of control, but as a means of providing an additional safeguard in the case of unintended or accidental emissions. There can also be problems with erosion of the buffer over time where residential areas encroach on existing industries. Changes in industries or processes cannot always be predicted, and "protected' land is often lost through urban sprawl. These risks can be minimised if the industry owns the land in the buffer zone, thereby retaining control over encroachment from sensitive activities.

A useful discussion of the benefits and limitations of buffer zones for planning purposes is provided in the Ministry's report *Managing the Amenity Conflicts Arising from Rural Activities* (MfE, 2000).

4.4 Regional and district rules

Under section 68 of the RMA, councils can use rules to allow, regulate or prohibit activities. Activities can be classified as permitted, controlled, discretionary, non-complying or prohibited (section 88). Land use consents from city and district councils, and discharge permits from regional councils, are required for activities classified as controlled, discretionary or non-complying in the relevant plan.

Regional air plans contain rules relating to dusty activities that generally provide for activities with a low dust potential to be permitted, provided certain conditions are met. Such activities commonly include: wet abrasive blasting, stationary enclosed dry abrasive blasting, small scale quarrying and mineral extraction processes, and dust emissions from unsealed roads. Where the effects of dust emissions are potentially more than minor, consents are likely to be required.

Activities with a greater potential for dust emissions are often classed as controlled or discretionary, and require discharge permits. These can include:

- mobile abrasive blasting
- asphalt or bitumen manufacture or processing
- milk powder or milk based powder manufacture
- pulp, paper, cardboard or reconstituted wood panel manufacture
- steel mills
- synthetic fertiliser manufacture
- timber mills, including moulding manufacture and planing
- waste treatment and disposal, including landfills and commercial composting operations
- large quarries and mines.

Some air plans give guidance on how the council intends to assess dusty activities and how they will determine whether there are any significant adverse effects on the environment. This is a recommended approach as it enables applicants and communities to be clear on what is required and how the activity will be assessed. An example of assessment criteria that may be used in response to a complaint, for instance, is included in Appendix 3.

Requirements of district plans have often been similar to those of regional plans and in some cases have included prescriptive controls on the nature of the dust generating activity. To avoid unnecessary duplication of consent requirements in future the effects of dust emissions should primarily be controlled at the regional level, unless that function has been delegated to the district.

The types of activities that require resource consents vary between individual councils. As a general guide, activities that would have been licensed under the former Clean Air Act 1972 have often received much the same level of control under the RMA. This is not always the case however, and the only way to be sure is by checking with the relevant regional and district councils, or working through the appropriate plans.

4.5 Dust control conditions

Conditions specified in consents and the conditions applying to rules in a plan, often require that there be:

> *"no dust beyond the site boundary which causes an offensive or objectionable effect"*.

This approach is well recognised as a viable method for the control of subjective issues such as dust and odour nuisance. However, the following points should be taken into account when this approach is being used.

1. The assessment as to what constitutes an offensive or objectionable effect should be determined by trained persons, such as council officers, according to clear criteria (Appendix 3).

2. The assessment will need to take into account the frequency of nuisance events, the quantity of dust emissions/deposition and the sensitivity of the receiving environment. Refer to the assessment criteria in Appendix 3.

3. Single isolated incidents may on rare occasions be cause for punitive action. However, more commonly they are used as a signal for greater attention to dust control measures. In the event of recurrent complaints, the discharger should be required to keep a complaint register (if this is not already being done). The council should also record and investigate complaints.

4. Where regular complaints occur, the discharger should also be required to set up procedures for regular consultation and communication with the affected community. A dust monitoring programme with trigger levels for when actions are required should be considered. Implementation of effective dust control measures, as outlined in section 8, may eliminate the need for further action.

5. If the problem continues, then the council should consider taking some of the actions available to it under the RMA. This could include: an infringement fee of between $300 to $1000 to address minor matters, an abatement notice, which requires the discharger to cease or control specific activities, or an enforcement order that must be obtained from the Environment Court. The enforcement order would require the operator to implement proper corrective actions immediately.

6. If legal action is considered, then the council should ensure that a full range of evidence has been gathered (refer to the assessment guidance in Appendix 3) for the assessment of environmental effects. The council should attempt to collect visual evidence of the problem, such as photographs or videos and should record or investigate the meteorological conditions during the incident/s.

7. The results from an existing dust monitoring programme may also be used in support of any action. Alternatively, the council should consider carrying out short-term measurements during specific dust events.

Some councils have used the term "discernible dust" in preference to "offensive or objectionable". Obviously this places a much tighter level of control on activities, which may be appropriate in some urban areas. However, it may be unnecessarily restrictive in industrial and rural locations.

Suggested conditions

Some or all of the following conditions may be applied to air discharge permits for diffuse dust sources, such as quarries and stockpiles. Clearly the specific nature of conditions will depend on the scale and significance of the activity, having regard to the sensitivity of the receiving environment.

- A condition requiring that specific dust control measures, described in the application, are implemented. This requires that the consent holder undertake good practice measures, such as those detailed in section 8.
- Where an appropriate management plan has been presented with the application, a condition requiring that the plan be implemented. Note that the plan must meet the criteria for consent conditions, as detailed in section 3.4. If these criteria are not met, dust control methods should be specified by condition rather than relying on the management plan.
- A condition requiring the consent holder to record any complaints relating to the dust discharge. This record should include the location, date and time of complaint, a description of weather conditions (notably wind speed and direction), any identified cause of the complaint, and the corrective action taken.
- A condition requiring that the discharge does not cause airborne or deposited dust beyond the property boundary of the site that is determined to be noxious, objectionable or offensive. Alternatively, the condition could require that no discharges from any activity on the site give rise to visible emissions, other than water vapour and steam, beyond the boundary of the site that are determined to be offensive or objectionable.

A condition relating to objectionable or offensive dust has commonly been used as a "catch all" to prevent significant adverse effects beyond the site boundary. There is some debate as to whether compliance should be determined by a council officer (specifically referenced in a condition) or on the basis of all evidence gathered during a complaint investigation. Ultimately the courts will examine all available evidence (such as monitoring results, dust sample analyses, photographs, and evidence from officers and complainants) when determining whether an effect has been objectionable or offensive. Refer to the discussion of case law below.

Councils should develop clear criteria for determining and assessing nuisance effects, and this should include specific procedures for complaint investigation. Suggested assessment criteria are provided in Appendix 3. A format for investigating and recording complaint investigations is provided in Appendix 2.

Conditions requiring dust monitoring may be imposed where there is potential for significant adverse effects beyond the site boundary. It is important that the monitoring methods and programme are carefully selected to ensure that meaningful results are received, as discussed in chapters 6 and 7. For large point source dust discharges, in-stack monitoring may be appropriate. Selection of a suitable isokinetic monitoring method is critical, as detailed in the Ministry's compliance monitoring and emission testing guide (MfE, 1998a).

Case law relating to "noxious, offensive and objectionable"

A number of decisions of the Court of Appeal, the High Court and the Environment Court have focused on the meaning of "offensive", "objectionable" and "noxious" as used in sections 17(3)(a), 314(1)(a)(ii) and 322(1)(a)(ii).

The Court of Appeal in *Watercare Services Ltd* v *Minhinnick* [1998] NZRMA 113 dealt with the terms "offensive" and "objectionable' in relation to an activity on a site claimed to be waahi tapu. The Court of Appeal stated at the outset that:

"the assessment whether something is noxious, dangerous, offensive or objectionable is an objective one. The bona fide assertion of the person seeking an enforcement order that the matter in question is offensive or objectionable is not enough. There must be some external standard against which that assertion can be measured."

The case involved the construction of a major sewage pipeline across the Matukutura Stonefields to the Manukau Harbour. The Stonefields are an archaeological site in terms of the historic places legislation. The Historic Places Trust gave approval for the construction of the pipeline subject to various approvals in 1978. Mrs Minhinnick sought an enforcement order on the basis that Watercare Services Ltd was proposing to do something that was likely to be "noxious, dangerous, offensive or objectionable" to such an extent that it was likely to have an adverse effect on the environment (section 314(1)(a)(ii)). Mrs Minhinnick submitted that conveying sewage over and across waahi tapu and the works associated with the pipeline were in the circumstances "objectionable" and "offensive".

The Court of Appeal held that the legislation (i.e. section 314(1)(a)) required the Court to form its opinion on whether something is noxious, dangerous, offensive or objectionable to such an extent that it has or is likely to have an adverse effect on the environment. In forming its opinion, the Court is to act as the representative of the community at large in determining whether something is offensive or objectionable. It held at p.124 that four steps were involved:

"5. Whether the assertion of the applicant seeking the enforcement order that the subject matter is noxious, dangerous, offensive or objectionable is an assertion honestly made.

6. If so, whether in the opinion of the Court the subject matter is or is likely to be noxious, dangerous, offensive or objectionable.

7. If so, whether in the opinion of the Court any noxious, dangerous, offensive or objectionable aspect found to exist is of such an extent that it is likely to have an adverse effect on the environment.

8. If so, whether in all the circumstances the Court's discretion should be exercised in favour of making the enforcement order sought or otherwise."

The Court of Appeal stated that in the second and third steps the Court in forming its opinion is the representative of New Zealand society as a whole, the "community at large". It went on to hold at p.125 that:

"The views of individual members of society must always be sympathetically considered but the Resource Management Act does not require those views to prevail irrespective of the weight of other relevant considerations."

In assessing whether something was offensive or objectionable, the Court of Appeal stated that it is necessary for the Court to consider the relationship between the objector and the subject matter and all other features of the case that are said to justify or not to justify the objector's contention.

The *Watercare Services Ltd* case confirmed the approach of the High Court in *Zdrahal* v *Wellington City Council* [1995] NZRMA 289. Justice Grieg in that case highlighted the point that it was not just a case of whether something was noxious, dangerous, offensive or objectionable but it had to be to such an extent that it has or is likely to have an adverse effect on the environment. He stated that:

"If it is objectively offensive or objectionable, that is if reasonable ordinary persons would be offended or find it objectionable, then it does affect the environment of those people and of any other such people living in the vicinity who are likely to be so affected." (p.299)

The Environment Court in *Thompson* v *Davidson* C130/97 had to decide on whether the noise of barking dogs was "offensive" or "objectionable". The Environment Court adopted the approaches of the Court of Appeal and High Court as outlined above. In the *Thompson* case the Environment Court had difficulty finding the level of noise experienced as being offensive or objectionable but found that the Thompsons were annoyed and disturbed by the noise.

5 Assessment of Emissions and Environmental Effects

The information to be submitted in support of consent applications under the RMA is specified in section 88 and the Fourth Schedule of the Act. The extent to which various matters are addressed should be (section 88(6)(a)): *"in such detail as corresponds with the scale and significance of the actual or potential effects that the activity may have on the environment"*. In addition, consent applications must be accompanied by *"An assessment of any potential effects from the discharge, including effects on amenity values, human health, flora and fauna".*

In the case of discharges to air, assessments of environmental effects depend on whether the activity is existing or proposed. In general, an assessment usually involves the following steps:

- Identify and estimate the mass emissions from the process and activities causing dust to be discharged into the air, and the factors that influence them. This can be done using published emission factors, or measurements on an existing plant.
- Predict the way in which the emissions will disperse downwind of the site. This is usually done using atmospheric dispersion modelling or, in the case of an existing activity, by results from any monitoring.
- Assess the off-site environmental effects, by comparing the predicted or measured dust concentrations against appropriate guidelines and by discussing the potential or actual impacts of the activity with surrounding neighbours and the community. This should also involve investigating the potential cumulative effects of the discharge on the environment in combination with existing background levels and other discharges in the area.

5.1 Emission estimation

There are two ways of determining the air emissions from a process; direct measurement or estimation using published emission factors. Obviously, the first option is only possible with an existing process, although it may sometimes be possible to use test data from other similar plants in support of a proposed development. In addition, emission testing is not possible for many of the diffuse sources that can contribute to fugitive dust emissions.

Emission testing is a specialised activity and the measurements should be carried out using standard methodologies. Recommended test methods for emissions testing in stacks have been summarised in the Ministry for the Environment's Guide to Compliance Monitoring and Emissions Testing (1998a). However this does not include test methods for fugitive dust emissions. There are no recognised standard methods for measuring such emissions. Refer to Chapter 6 for further discussion of ambient dust monitoring.

Emission estimation using published emission factors is the more common approach for most applications for an air discharge permit. Emission factors have been published by a variety of agencies. The most widely used and extensive compilation is that published by the US Environmental Protection Agency in the document known as AP-42 (US EPA, 1996). Some of the dust sources covered in AP-42 include paved and unpaved roads, heavy construction activities, aggregate handling and storage piles, industrial wind erosion, surface coal mining, sand and gravel processing, abrasive blasting, and various forms of mineral processing.

The emission factors given in AP-42 are based on measurements on a limited number of different sources under varying operating conditions. The factors are usually expressed in terms of the mass emission expected for a specific processing rate (e.g. grams of pollutant per tonne of raw material used). The total emissions can therefore be estimated simply by multiplying the expected plant processing rates by the relevant factor. However, these emissions factors must be used with caution and in accordance with the conditions for their use, recognising the numerous assumptions that go into their calculation.

With fugitive emissions, it can be difficult to measure the emissions directly because they can be very diffuse, intermittent, and variable. For this reason the published emission factors have a high degree of uncertainty, and the predicted emission rates should be treated with scepticism. In addition, many of the emission factors are for particles smaller than 30 µm, which only covers a fraction of the particles that can be emitted as nuisance dust. Where emission factors are applied to fugitive dust emissions, it is important that the underlying assumptions are clearly stated.

5.2 Dispersion modelling

Dispersion modelling is a mathematical method used to relate site emissions to downwind ambient air concentrations, under the full range of possible weather conditions. Studies of this type have long been recognised as an acceptable means of evaluating the impacts of contaminant discharges to air from point sources. They are especially suited to the assessment of facilities that have not yet been built. However, they also have advantages over ambient air monitoring for existing operations, including lower costs, and the ability to cover multiple locations and the possible variations in dispersion conditions over time.

There are a variety of models available for this type of work. One of the most common is known as AUSPLUME, which was originally developed for the Victoria EPA in Australia. More sophisticated models may be required for activities involving a large number of emission points, or for locations involving complex terrain or other confounding factors. Regardless of the model used, modelling for dust nuisance needs to take into account the size distribution of the dust particles, and the possible variations in deposition rates due to factors such as rainfall and vegetation effects. This level of detail is rarely available for most sources of nuisance dust.

Most proprietary dispersion models, and certainly those that have been well validated, are related to gaseous pollutants. Depending on the particle size, these models may or may not be valid for the dispersion of dust. If particles are less than 20 microns in size they can be considered to behave as a gas, and follow the standard Gaussian model. However, nuisance effects of dust are usually associated with particles greater than 20 microns. Gaseous dispersion models are therefore inadequate for predicting the concentration of nuisance dust.

There are some models that specifically relate to the dispersion of particulate matter. For example, the Fugitive Dust Model (FDM) developed by the United States Environmental Protection Agency is designed to predict deposition caused by mining operations, dirt roads, and other sources of fugitive dust. More general models such as AUSPLUME, also offer the option of including deposition due to gravitational settling. The model estimates the deposition of material on the ground, and the loss of material from the plume, on the basis of the wind speed and particle settling velocities. Reflection on the ground, expressed as a reflection coefficient, is also taken into account. The additional information required to run AUSPLUME in this way, is the mass fraction, settling velocity and reflection coefficient for each particle size fraction.

Most of these models provide, at best, a crude approximation of particle behaviour through the air. They are unable to account for the effects of localised wind turbulence and increased deposition due to changes in the nature of the terrain, or flow disturbances due to trees, buildings, or other obstructions. User experience with the models would suggest that major changes in the predictions could be achieved through relatively minor adjustments of some of the key parameters. In other words, the modelling is easily manipulated to give whatever result one requires. As such, dispersion modelling should not be regarded as a definitive method for predicting dust nuisance effects, particularly from fugitive sources.

5.3 Effect levels and criteria

There are no national air quality guideline values for nuisance dust effect levels that can be used to say a certain amount of deposition is minor or significant. However, there are a number of criteria in common use and these are discussed later in section 7.4. Generally, the criteria have been derived from subjective observations and investigation of dust levels and nuisance effects.

5.4 Limitations

The methodology described above is usually best suited to assessing the effects of emissions from controlled emission sources, such as vents and stacks. In the case of dust emissions, this would include grain drying and storage, timber mills, and mineral processing.

The method has also been used for assessing the effects of fugitive dust emissions from activities such as mines and quarries, constructions sites, and stockpiles. However, these predictions have a very high degree of uncertainty. The predictions can have some value in identifying the most significant dust sources on a site, or in highlighting the areas most likely to be affected by dust off-site. However, the actual dust concentrations predicted by the method should only be treated in a semi-quantitative sense.

The assessment method is not at all suitable for activities such as mobile abrasive blasting, because of the very high variability in dust emission rates and the lack of any effective containment systems.

The key point to recognise with most fugitive dust sources is that nuisance effects will almost certainly occur if the sources are not adequately controlled. Rather than spending time and money on extensive (and expensive) theoretical predictions of the possible effects, it is likely to be more appropriate to put the effort into the design and development of effective dust control procedures. These procedures should be thoroughly documented in a dust management plan, as described in Appendix 5.

Figure 2: Dust management plans are useful for large sites like this quarry where a range of different dust control measures will be required

6 Monitoring of Environmental Effects

6.1 Complaint monitoring

Complaint monitoring is the only method available for directly assessing the nuisance effects of dust emissions. However, it suffers from a number of shortcomings, including the following.

- Some people may be reluctant to complain, or simply not know who to complain to.
- Other people may complain excessively, or make frivolous complaints, because they are strongly opposed to a particular activity.
- People may stop complaining about a continuing problem, if they feel that no action is being taken.
- People's tolerance or intolerance to dust deposition and airborne dust can vary considerably with individual perception.
- It can sometimes be difficult to identify the cause of specific dust problems, so that one activity may be wrongly blamed for the actions of another.

Notwithstanding all of the above, complaint systems still have an important part to play in the management of dust problems. Prompt responses to complaints can be important in developing good relations between an operator and the surrounding community. Effective complaint investigation can also be important in identifying parts of the operation where dust control procedures need to be improved.

Some councils have developed complaint investigation forms that list the information that should be provided. An example of a form for recording and investigating dust complaints is given in Appendix 2.

6.2 Source emission testing

It is very difficult, if not impossible, to measure dust from ground-based sources, because of the diffuse and unconfined nature of the emissions. Some people have attempted to do this by measuring air concentrations downwind of the source and using reverse modelling to estimate the source emissions. However, this is only really effective if a two-dimensional array of dust monitors can be used for the measurements.

Dust emissions from a stack are much easier to measure, but specialised techniques are required to ensure representative sampling. Measurements should be taken using isokinetic sampling, which ensures that different size particles are all collected with the same sampling efficiency. Further details on this and other sampling procedures are given in the *Guide to Compliance Monitoring and Emissions Testing* (MfE, 1998a).

Specialised sampling methods are also required for the testing of roofline emissions from certain types of industrial processes, such as steel making. Unlike stack emissions, discharges from roof vents are made up of a wide range of particle sizes, and are therefore more likely to cause dust nuisance impacts. Sampling of roofline emissions is difficult, and requires specialised procedures (Trozzo and Turnage, 1981). Particular problems can include low particle concentrations and low discharge velocities. Access to the sampling points is sometimes a problem, and battery-powered sampling equipment is often used because of the absence of electrical power.

Emission testing can provide information on the variations in source emissions, and may be useful in pinpointing the possible causes of a dust nuisance problem. However, it tells us very little about the probable magnitude of the effects from fugitive dust sources.

6.3 Environmental monitoring

Environmental monitoring programmes should be carried out to determine the environmental impacts of the discharge and/or compliance with consent conditions. The extent and level of accuracy of monitoring required either as part of an assessment or as conditions on a resource consent, should be based on the predicted level of the effects and the nature of the receiving environment.

Programmes can be carried out for a variety of reasons, including the following.

Impact assessment

Monitoring the environmental impacts of a specific activity or group of activities. This information may be used in support of an application for consent renewal, or as a check that emission limits and other management procedures are achieving the desired level of control. It can also be used to monitor any changes in plant performance over time. Refer to Chapter 7 for a discussion of the various monitoring techniques available.

Compliance monitoring

Monitoring of compliance conditions specified in the discharge permit for a specific activity. In the case of point sources (i.e. discharge through a stack) these will usually be based on emission discharge limits. However for many dust sources, ambient limits will be more appropriate, at the site boundary and beyond.

Background monitoring

This usually refers to monitoring in areas unaffected by any polluting activities. However, it can also refer to monitoring existing air quality prior to the development of a new activity. Background monitoring is a useful adjunct to assessment monitoring, because it allows the impacts of an activity to be assessed against the existing background concentrations.

State of the environment monitoring

This refers to monitoring based around a regional or national network of monitoring sites. This type of programme determines the overall impact of multiple activities on the environment. It would generally not be directed at specific dust sources. However, dust monitoring may be included in the programme for areas with naturally high dust levels. Assessing the community's perception of dust nuisance may be an important component of such monitoring.

6.4 Monitoring programme design

Objectives

One of the first steps in any monitoring programme design should be to decide on the purpose and objectives of the programme. These will be related to the various monitoring categories described above, and could include the following:

- To monitor any dust impacts arising from an activity and relate them to existing dust levels in the vicinity, and relevant guidelines.
- To provide information that would assist in identifying the cause of any dust complaints.
- To monitor any changes in ambient dust levels over time. This could be important in highlighting any deterioration (or improvements) in dust control practices.
- To provide effects data for use in a future application for consent renewal.

Monitoring frequency and duration

Monitored dust levels can vary markedly over time because of variations in weather conditions, including rainfall, wind speed and wind direction, and also because of changes in the source emissions. These variations need to be given careful consideration in the development of monitoring strategies. In particular, there is very little value in the collection of occasional samples taken at irregular intervals in accordance with some vaguely defined monitoring scheme. Monitoring should be conducted in accordance with a fixed sampling schedule, and preferably over extended periods of time.

Continuous monitoring methods are the preferred approach for most pollutants, because these will effectively cover most of the possible variations in pollutant concentrations over time. However, the high capital and operating costs of continuous monitoring instruments would not be justified in many dust monitoring applications.

Monitoring for dust nuisance is normally carried out using time averaging methods, with sampling periods of 24 hours, seven days or one month. When 24-hour monitoring is being used, the normal approach is to take one sample every six days. This ensures equal coverage to all days of the week when the monitoring is carried out over an extended period of time. For this approach, the minimum monitoring period in any one location should ideally be at least one year to ensure adequate coverage of any seasonal variations. If shorter monitoring periods are to be used, then the sampling frequency should be increased, to at least one day in every three.

It may also be necessary to repeat the measurements at different times of the year to cover the possible seasonal variations.

When the monitoring methods involve weekly or monthly sample collection, meaningful data can only be expected from a continuous series of measurements over periods of at least one year. This is necessary to ensure that process and seasonal variations have been adequately covered.

Number and location of monitoring sites

Monitoring sites should be chosen on the basis of prevailing wind conditions and the expected areas of greatest impact. Dispersion modelling may be needed to determine the latter, although this can often be simply determined from a knowledge of local weather patterns and the location of nearby residential housing or other sensitive activities.

Multiple monitoring sites may be required around any individual source to ensure reasonable coverage of the areas of greatest impact. However, a single monitoring site may be acceptable if it can be shown to be reasonably representative of the worst-case situation.

A single monitoring site can sometimes be quite adequate for impact monitoring around point sources (stack discharges), provided there are no other sources nearby that might affect the results. A minimum of two to four sites will usually be required for most diffuse dust sources. Considerably more sites will be needed if the activity is spread over a wide area, such as an open cast mine (see Waihi Gold case study, Appendix 6).

Supporting information

Consideration should be given to including additional background or reference sites in any programme. This can sometimes be achieved by having sites at right angles to the prevailing wind line, or simply by having a series of three or more sites at increasing distances away from the source, along the prevailing wind line.

Meteorological conditions should be recorded at one of the monitoring sites. This should include a minimum of wind speed and direction, and rainfall. The data can be used to help identify the cause of any high dust results, or in complaint investigations. It will also serve to demonstrate that the monitoring sites have in fact been impacted by emissions from the activity.

Information on routine and non-routine site activities should be recorded on a daily basis. This information can be important in helping to identify the cause of any high dust results or in complaint investigations.

7 Dust Monitoring Methods and Assessment Criteria

7.1 Dust monitoring

There are two general types of dust measurements that can be used as indicators of nuisance effects; dust deposition and total suspended particulate. The key elements of each of these methods are summarised below, with more detailed descriptions given in Appendix 4.

The chosen methods are an integral part of the monitoring programme that should also be related to the scale and significance of the environmental effects and sensitivity of the receiving environment. It is important that accepted standard methods are followed. The advantages and disadvantages of each of the methods are discussed below.

In some cases dust monitoring will not be appropriate, given the scale and significance of the predicted effects. For such small-scale sources, concentrating on good practice dust management measures is likely to be more beneficial.

Dust deposition

Deposited matter or dust deposition, is dust that settles out of the air. Measurement is by means of a collection jar or gauge, which simply catches the dust settling over a fixed surface area over a period of time. The dust is removed from the jar, filtered and weighed, and the results are reported in terms of the weight of dust collected per unit of surface area, and over a fixed period of time, e.g. $g/m^2/30$ days. ISO DIS-4222.2 is the preferred method for deposited dust monitoring in New Zealand (Appendix 4).

The equipment used for deposition monitoring typically collects dust particles greater than about 10–20 microns, although there is no sharp cut-off in particle size and the collection efficiency is known to vary for different particle sizes. The main attractions of the deposit gauge method are its relatively low cost (approximately $500) and simplicity. The main disadvantage is that the measurement period is typically 1 month, and cannot be reduced to anything less than about 15 days without a significant loss in measurement sensitivity. This makes the method quite unsuitable for the monitoring and control of short-term dust problems.

Dust gauges should be carefully sited, having regard to:

- the risk of tampering or vandalism by members of the public
- the impact of nearby structures on wind flow (and thus dust collection efficiency), as required by the monitoring method
- proximity to local dust sources (such as an unsealed road) that may affect the measurement.

Suspended particulate

Total Suspended Particulate (TSP) refers to particles that are suspended in air at the time of sampling. TSP is measured by sucking air through a filter and determining the weight of dust collected from a measured volume of air. The results are reported in concentration terms (typically $\mu g/m^3$). The equipment used for TSP measurements is intended to collect all particles from less than 0.1 up to about 100 microns, although different designs of sampling head can be used to make the system selective for specific size fractions. Once again, the collection efficiency is known to vary for different size particles, and can also vary between different TSP systems. Overall collection efficiencies are usually poor for particles above about 50 microns in size, which makes the method complementary to dust deposition. Conversely, this difference in size selectivity between the two methods means that neither system can be entirely relied upon for effective monitoring of all of the possible sizes of nuisance dust.

TSP samples are typically collected over 24-hour periods, but a number of continuous monitors are also available. The capital costs for TSP monitors are between $5000 and $50,000, depending on the type of system. This is considerably higher than the cost of about $500 for a deposition monitor. However, the TSP method provides much more useful data in terms of dust variations over time, and the possible causes of these variations.

7.2 Other monitoring methods

There are a variety of other monitoring methods that can also be used for assessing dust nuisance, including the following.

Directional dust monitoring – This can be used to identify specific dust sources. Systems are now available for linking dust samplers to a wind sensor, so that the monitor only operates when the wind is from a certain direction. Alternatively, there are directional dust gauges available in which the dust is collected through vertical slots, which can be lined up with the direction of interest. One of these systems is covered by an Australian Standard, AS 2724.5-1987. The effectiveness of this and other possible approaches was reviewed in a publication by Hall *et al* (1993).

Time-lapse video – This provides a simple method for visual monitoring of dust-producing activities over extended periods of time. Its main application is in identifying which activities on a site are in need of better dust control.

Microscopic examination – This can be very useful in investigating complaints of dust fallout. Examination of dust samples under a microscope can often assist in identifying the source. For example, fly ash from a boiler is made up of multi-coloured glass spheres, while dust from a panel beating shop will contain paint fragments. It is also extremely useful in identifying natural dust sources, such as pollen.

Tracer analysis – Analysis of dust for specific tracer elements can also be useful in identifying dust sources. For example, dust from a secondary steel mill will have high levels of iron and other metals such as lead and zinc.

7.3 Commentary

The main limitation with dust monitoring is that the results are nearly always produced some time after the event. As such, dust monitoring is not an effective method for the control of nuisance dust emissions. Dust monitoring programmes should be carried out for one or more of the reasons discussed above. This can include monitoring the effectiveness of dust control programmes. However, they should not be seen as a primary method of dust control.

(Note: It may be possible to use continuous monitors for the control of nuisance dust. However, this application has not yet been successfully demonstrated in New Zealand.)

7.4 Dust effect levels and criteria

National ambient air quality guidelines

National Ambient Air Quality Guidelines (AAQGs) were published by the Ministry for the Environment in 1994 and are currently under review. There were no criteria for dust nuisance in the 1994 guidelines (MfE, 1994), although a limit for dust deposition was included in an earlier proposal document (Bird, 1992). The rationale for not including the deposition guideline was stated as:

> *"In some situations they (indicators for deposited particulate, total suspended particulate, smoke and visibility-reducing particulates) may be useful in addition to the guidelines themselves. These indicators may be used in the immediate vicinity of an individual source or group of sources. Generally, smoke and deposited particulates occur during process upsets. They can be used to trigger remedial action. These indicators are not adequate, however, for purposes of assessing air quality."*

Trigger levels

De facto control limits have been used to assess dust nuisance in New Zealand in the past. The limits commonly used in the past were: 4 g/m^2/30 days deposited dust (as an increase above background concentrations); and 150 $\mu g/m^3$ (24-hour average) or 250 $\mu g/m^3$ (1-hour average) total suspended particulate, measured by high volume sampler. Similar criteria have been used in Australia (Dean et al, 1990), although these allow for a range of different effect levels depending on the nature of the surrounding area ("suburban/residential" or "other").

In the absence of any current national guidelines for dust nuisance, it is appropriate to recommend trigger levels or control limits that could be applied to individual dust sources (Table 7.1). The impact of dust emissions may then be assessed with regard to these limits, among other factors.

Table 7.1: Recommended trigger levels for deposited and suspended particulate

Dust type	Trigger level	Preferred method
Deposited dust	4 g/m^2/30 days (above background concentration)	ISO DIS-4222.2
Total suspended particulate	80 µg/m^3 (24-hour average) – sensitive area 100 µg/m^3 (24-hour average) – moderate sensitivity 120 µg/m^3 (24-hour average) – insensitive area	AS 3580.9.6-1990 (hi-volume sampler)

A sensitive area typically has significant residential development, whereas a sparsely populated rural area may be relatively insensitive to some discharges. Clearly the judgement of sensitivity will be somewhat subjective, depending on the specific circumstances in each case.

The acceptable concentration of *deposited* dust is also related to the sensitivity of the receiving environment. In some industrial or sparsely populated areas, deposition rates of more than 4 g/m^2/30 days may not cause significant nuisance. However, in highly sensitive residential areas deposition rates in the order of 2 g/m^2/30 days, above background concentration, may cause nuisance. It should also be noted that the type of dust may be significant. Highly visible dust, such as black coal dust, will cause visible soiling at lower concentrations than many other dusts.

It is important to note that the recommended trigger level for deposited dust normally applies to insoluble matter. As explained in Appendix 4, dissolved material is not significant when assessing nuisance effects from the majority of dust sources. The exception to this occurs when the source produces water soluble emissions, such as a pulp and paper mill, milk powder plant or fertiliser works.

The recommended trigger levels should only be considered in conjunction with the results of other assessments, including complaints surveys and community consultation. Site-specific trigger levels that are acceptable to the local community should be developed in each case. Estimates of background dust levels must be included in calculating values to compare with these trigger levels.

Current dust levels

General dust deposition levels measured in New Zealand range from about 1–4 g/m^2/30 days. Background concentrations are usually less than 1 g/m^2/30 days, but there are also areas such as Central Otago where the natural dust levels can be up to 10 times this amount. Measurements in the vicinity of specific industrial sources are commonly in the range of 4–8 g/m^2/30 days, but can be as high as 10–20 g/m^2/30 days in extreme cases. The industries include timber mills, quarries, mines, steel mills, and port operations, with the highest results being recorded alongside abrasive blasting operations.

There is only a limited amount of data available on TSP levels around the country, as much of this type of monitoring is directed at the fine fraction, PM_{10}. Background TSP levels in clean environments are about 10–20 µg/m^3. Levels of about 30–60 µg/m^3 have been reported for general urban areas, and about 50–100 µg/m^3 for general industrial areas, such as Penrose in Auckland and Hornby in Christchurch. Levels of up to 300 µg/m^3 have been recorded near some specific industrial sources (e.g. a scrap metal yard), but these are relatively extreme events.

Figure 3: Suspended particulate monitoring equipment

8 Dust Control Methods and Technologies

Control methods for the management of nuisance dust sources are described below. Obviously, not all of these procedures will be applicable to all activities.

8.1 Paved surfaces

Dust deposits on paved surfaces can be thrown into the air by wind or by vehicle movements. Dust pick-up by wind is usually only significant at wind speeds above 5 metres per second (10 knots), but vehicle re-entrainment can occur under any conditions. Dust emissions from paved surfaces can be minimised through use of the following procedures:

- The movement and handling of fine materials should be controlled to prevent spillages onto paved surfaces.
- Minimise mud and dust track-out from unpaved areas by the use of wheel wash facilities.
- Regular cleaning of paved surfaces, using a mobile vacuum sweeper or a water flushing system.
- Speed controls on vehicle movements (see below).
- Wind reduction controls (see below).

Dust emissions from paved surfaces can be reduced by factors of 90% or more, but this is highly dependant on the above procedures being applied rigorously and consistently.

8.2 Unpaved surfaces

Dust emissions from unpaved surfaces are caused by the same factors as for paved surfaces, but the potential emissions are usually much greater. Dust emissions can be controlled using the following procedures:

- Wet suppression of unpaved areas should be applied during dry windy periods, using a water cart and/or fixed sprinklers. As a general guide, the typical water requirements for most parts of New Zealand are up to 1 litre per square metre per hour. It is important to check that the available water supplies and the application equipment are able to meet this requirement.
- Chemical stabilisation can also be used in conjunction with wet suppression. This involves the use of chemical additives in the water, which help to form a crust on the surface and bind the dust particles together. Chemical stabilisation reduces watering requirements, but any savings can be offset by the cost of the additives. Repeat treatments are usually required at intervals of 1–4 weeks. The method is best suited to permanent site roads and is usually not cost-effective on temporary roads, which are common in mines, quarries and construction sites. (Note: chemical additives used for dust suppression should be shown to have no adverse effects on the environment. Waste oil has been used in the past but is generally not suitable for this purpose.)

- Re-vegetation of exposed surfaces. This should be done wherever practicable at mines, quarries and construction sites, and other similar activities subject to ongoing development. Techniques such as hydro-seeding and the use of geotextiles should be used on sloping ground and other difficult surfaces.
- Surface improvements. These include paving with concrete or asphalt, or the addition of gravel or slag to the surface. Paving can be highly effective but is expensive and unsuitable for surfaces used by very heavy vehicles or subject to spillages of material in transport. In addition, dust control measures will usually still be required on the paved surfaces. The use of gravel or slag can be moderately effective, but repeated additions will usually be required.
- Speed controls on vehicle movements (see below).
- Wind reduction controls (see below).

Unpaved surfaces can be a significant cause of dust problems on adjacent paved surfaces (e.g. roads) if there is no control over carry-out of mud and dirt. This can be controlled by the use of wheel wash facilities.

Wet suppression of unpaved areas can achieve dust emission reductions of about 70% or more, and this can sometimes be increased by up to 95% through the use of chemical stabilisation. Revegetation and paving can achieve up to 100% control efficiencies, but have only limited application.

8.3 Vehicles

Vehicles travelling over paved or unpaved surfaces tend to pulverise any surface particles and other debris. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents due to turbulent shear between the wheels and the surface. Dust particles are also sucked into the turbulent wake created behind the moving vehicles. The loads carried by trucks are a potential source of dust, either through wind entrainment or spillages. Mud and dust carry-out from unpaved surfaces is another potential problem, as discussed above.

Dust emissions due to vehicles can be minimised with the follow controls:

- Limiting vehicle speeds. A speed limit of 10–15 km/hr is commonly applied in New Zealand.
- Limiting load size to avoid spillages.
- Covering loads with tarpaulins or the use of enclosed bins to prevent dust re-entrainment from trucks.
- Minimising travel distances through appropriate site layout and design.
- The use of wheel and truck wash facilities at site exits.

Speed controls on vehicles have an approximately linear effect on dust emissions. In other words, a speed reduction from 30 km/hr to 15 km/hr will achieve about a 50% reduction in dust emissions. The other procedures listed can also be highly effective in limiting dust problems.

8.4 Material stockpiles

Fine material stored in stockpiles can be subject to dust pick-up at winds in excess of about 5 m/sec (10 knots). Dust emissions can also occur as material is dropped onto the stockpile from a conveyor. The options for dust control can include the following:

- Wet suppression using sprinklers.
- Covered storage of fine material. Obviously this is an expensive option, but should be seriously considered for use in especially sensitive locations, and for storage of finely divided material with a high dust potential, such as fertiliser, gypsum and other industrial minerals.
- Limiting the height and slope of the stockpiles can reduce wind entrainment. For example, a flat shallow stockpile will be subject to less wind turbulence than one with a tall conical shape. Consideration should also be given to the effect of other site features. For example, it may be possible to reduce wind effects by keeping the stockpile heights below the level of the site noise bund.
- Limiting drop heights from conveyors.
- Use of wind breaks. Wind speed near the pile surface is the primary factor affecting particle uptake from stockpiles. Although a large, solid windbreak is the most effective configuration, aesthetic and economic considerations may preclude that from being appropriate. A study by Stunder and Ayra (1988) found that a 50% porous windbreak was almost as effective as a solid wall in reducing wind speeds over much of the pile, when constructed to the following specifications:
  - height equal to the pile height
  - length equal to the pile length at the base
  - located at a distance of one pile height from the base of the pile.

Wind breaks can be constructed using horticultural cloth supported on poles, or by planting trees. Some of the species commonly used for this purpose include casuarina, cryptomeria and some variety of cupressus. Professional horticultural advice should be sought regarding suitable species for any specific site.

8.5 Conveyors

Dust emissions from conveyors can be caused by wind pick-up, and through losses during loading, discharge, and at transfer points. The following options should be considered for minimising these emissions.

- The use of enclosed conveyers for fine material.
- The use of water sprays or sprinklers at conveyor transfer points.
- Minimising drop heights at transfer points, including use of conveyors that can be raised and lowered.
- Regular clean-up of spillages around the transfer points and any other places where this might occur.

8.6 Other materials handling

Materials handling using front-end loaders or mechanical grabs is another potential source of dust emissions. These mainly occur when the load is dropped into a truck or hopper, but can also be caused by spillages during handling. Similar problems can occur when dusty loads are transferred by gravity discharge from hoppers into trucks.

These problems are best addressed by minimising drop heights, and regular clean-up of any spillages. In some cases (such as wharves or irregular surfaces) covering of the potential spill areas may be necessary to facilitate clean-up. Regular maintenance of hydraulic grabs is important to ensure complete closure. Hopper load systems should be designed to ensure a good match with truck size, and should be fully enclosed on the sides.

8.7 Wind protection

Wind is a major cause of dust emissions from many sites. The effects can be partially mitigated through the use of shelterbelts or temporary screening. It may also be possible to make use of natural land features, or artificial features such as noise bunds, to provide a degree of wind protection. This option should be considered in the initial development of the site layout and design.

Continuous monitoring of wind conditions should be considered when dusty activities are to be carried out in a sensitive location. The information can be used as a trigger for increased dust control activities (e.g. winds above 5 m/sec), or even as a signal for work to cease (e.g. winds above 10 m/sec).

8.8 Fixed plant

This includes equipment such as crushers, shredders, driers, and other processing equipment. These are point sources of dust emissions, which should be controlled using standard equipment such as cyclones, wet scrubbers and fabric filters. However, there is also the potential for fugitive emissions from this type of plant, and these emissions should be controlled using the following procedures:

- Minimise drop heights into hoppers and loading chutes.
- The use of sprinklers or water sprays around hoppers and other transfer points.
- Hooding or enclosure of significant fugitive sources, with the emissions being ducted to bag filters or other dust control equipment.

Fixed dust control systems can achieve control efficiencies ranging from about 70% for cyclones, and up to 95% or more for bag filters.

Figure 4: Wet suppression is an important dust control method for unconsolidated material, stockpiles and unpaved surfaces

8.9 Mobile abrasive blasting

Dust from abrasive blasting in fixed installations is normally controlled using enclosed equipment fitted with dust extraction systems. However, the dust emissions from mobile units are much harder to control because it is often not practical for the operation to be fully enclosed. Some of the options for dust control on mobile abrasive blasting are as follows.

- Partial enclosure of the work area using plastic or cloth sheeting.
- Use of synthetic blasting materials that generate less or no dust (e.g. synthetic carbides, plastic media and sodium carbonate).
- Use of vacuum blasters, in which the blast nozzle is surrounded by a vacuum extraction system.
- Wet blasting or use of a water curtain system around the edges of the structure.

The use of these methods can reduce dust emissions by 50–95%. Other general precautions, such as the use of wind protection, or only spraying under certain weather conditions, should also be observed.

8.10 Dust management plans

Many of the dust control procedures described above depend on people for their operation. As such, effective dust control systems will only be achieved through good site management and by ensuring that the appropriate operational procedures are in place. These procedures and the effects that they mitigate should be clearly described in a Dust Management Plan for the site. Staff responsible for implementing the plan should be clearly identified. The plan should include coverage of the following matters.

- What has to be done and why.
- Who has to do it and/or see that it is done.
- How it will be done.
- The desired outcomes.
- How these outcomes will be monitored.

The contents of the plan should also be subject to regular review.

An outline for a possible Dust Management Plan is given in Appendix 5.

8.11 Codes of practice

A code of practice developed for an industry can provide useful guidance on good practice measures to control emissions. Because these codes are developed by the industry, in consultation with councils, they are generally well accepted by individual businesses. Well-known codes of practice have already been published that address management practices and environmental effects for the pork and poultry industries, forestry and agricultural spraying.

Development of codes for dust-producing industries should be encouraged. A discussion of the benefits and limitations of codes of practice is provided in the Ministry's report *Managing the Amenity Conflicts Arising from Rural Activities* (MfE, 2000).

8.12 Summary

The information provided in this chapter demonstrates that there are many possible dust control options available. Selection of appropriate measures for a site will depend not only on the type of activity, but also on the scale of effects and the sensitivity of the receiving environment. It is important that procedures are in place to ensure that theoretical dust control measures, often discussed at the consent application stage, are implemented in practice. Dust management plans are recommended as a means of achieving this aim.

Appendix 1: Dust particle size

Dust particle size is an important factor in determining the way in which the dust moves through the air. It is also relevant for the possible environmental impacts, especially health effects. Particle sizes are normally measured in microns, and the size range of airborne particles is typically from less than 0.1 microns up to about 500 microns, or half a millimetre. A micron is one thousandth of a millimetre and therefore invisible to the naked eye. Particles deposited on a surface will only become individually visible at about 50 microns. For the purposes of comparison, a single sheet of paper is about 100 microns thick, and the diameter of human hair varies from about 30–200 microns.

When dust particles are released into the air they tend to fall back to ground at a rate proportional to their size. This is called the settling velocity. For a particle 10 microns in diameter, the settling velocity is about 0.5 cm/sec, while for a particle 100 microns in diameter it is about 45 cm/sec, in still air. To put this into a practical context, consider the generation of a dust cloud at a height of one metre above the ground. Any particles 100 microns in size will take just over two seconds to fall to the ground, while those 10 microns in size will take more than 200 seconds. In a 10-knot wind (5 m/sec), the 100-micron particles would only be blown about 10 metres away from the source while the 10-micron particles have the potential to travel about a kilometre. Fine particles can therefore be widely dispersed, while the larger particles simply settle out in the immediate vicinity of the source.

It is the larger dust particles that are generally responsible for nuisance effects. This is mainly because they are more visible to the naked eye, and therefore more obvious as deposits on clean surfaces. These are also the particles that will settle most readily onto exposed surfaces. For this reason, measurement methods for nuisance dust are generally directed at dust particles of about 20 microns in size and above.

Appendix 2: Dust complaint form

Part A: Complaint details

Date:	Time:	Complaint received by:
Name and address:		
Contact phone numbers:		
Complaint details and initial response (if any):		

Process information

(Check with the relevant people on site as to whether there were any abnormal conditions at the time of the alleged incident.)

Process A:

Process B:

Other:

External causes

(Check for road works, ploughing, construction activities, burn-offs, etc)

Possible causes and actions taken

Part B: Site investigation

Date:	Time:	Personnel:
Location:		
People spoken to on site:		
When did the incident occur?		
What was the weather like at the time of the complaint? (Note wind speed and direction, and any significant rainfall over the previous 24 hours)		
Are there any visible dust deposits? (Describe approximate quantities and extent)		
Describe the appearance of the deposits (colour, shape, size, crystalline or powdery, hard, soft, any odour, water soluble, etc)		
Does the problem extend to other properties? (Ask, but also check for yourself)		
Any other relevant observations?		
Any suggested causes (yours or the complainants)?		
Sample collection. Use a small paintbrush (clean) to sweep samples of the dust onto a sheet of paper and then into a clean plastic bag. At least half a teaspoonful will be required for analysis. Lesser amounts may be collected on strips of clear cellotape, which should then be stuck onto sheets of clear plastic to preserve the samples. Label all samples and record the date, time, location, etc. on a separate sheet of paper. Brief description of samples collected:		

Complaint recorded by: (sign) _____ Date: _____

Site visit details recorded by: (sign) _____ Date: _____

Appendix 3: Dust assessment criteria

The following matters should be considered by councils when determining whether or not a dust discharge has caused an objectionable or offensive effect. It will not be necessary to consider all the listed matters in items 2 to 10 in every case.

1) In all cases councils should consider:

   - the **frequency** of dust nuisance events
   - the **intensity** of events, as indicated by dust quantity and the degree of nuisance
   - the **duration** of each dust nuisance event
   - the **offensiveness** of the discharge, having regard to the nature of the dust
   - the **location** of the dust nuisance, having regard to the sensitivity of the receiving environment.

   Assessment will be based on the combined impact of these factors, determined from some or all of the following sources.

2) Other validated dust complaints or events relating to discharges from the same site, including previous validated complaints from one location.

3) Collection of dust samples and analysis to identify the source (where necessary and appropriate).

4) Weather conditions at the time of the dust event, notably wind speed, wind direction and rainfall.

5) Information regarding process conditions that may have caused the complaint. The effectiveness of dust control measures at the site should be taken into account.

6) A complaints register held at the site. Councils may require the discharger to keep such a register and identify any cause of an alleged dust nuisance, including remedial action taken.

7) Dust monitoring both within and beyond the site boundary. This includes both deposited dust and suspended particulate monitoring.

8) Results of dust deposition modelling carried out as part of an assessment of effects. These results may be compared to the trigger levels, as discussed in Chapter 7 of this document. Note that this method will have limited application to dispersed area sources or small-scale discharges. Its primary value lies in the prediction of the effects of point source dust discharges, such as stacks.

9) Contents of dust diaries held by people living and working in the affected area. People may be requested to keep such a diary. The diaries would record details of any dust nuisance event, including the date and time of the event, weather conditions (wind speed and direction, rainfall) at that time, a description of the type and amount of the dust detected, and the duration of the dust event.

10) Results of a public survey or field investigation commissioned by the council or the discharger. In this case it is critical that the survey or investigation is professionally designed to ensure that credible and reliable information is gathered.

Explanatory note

The extent of dust nuisance should be determined from all available evidence relating to one or more dust events. In most cases the information specified in items 7–10 (dust monitoring, modelling, diaries and public surveys) will not be necessary. Ideally, good practice dust control measures will be implemented by the discharger to remedy objectionable or offensive effects without the need for expensive investigation. However, for large-scale discharges with potential for significant nuisance or where enforcement action is likely to be required, some or all of the techniques discussed in items 7–10 may be required.

Appendix 4: Dust monitoring methods

Dust deposition

Dust deposition is monitored by determining the amount of dust collected over an exposed surface in a fixed period of time. The equipment used is commonly referred to as a deposit gauge. There are at least three different deposit gauge systems currently being used in New Zealand, and these are based on British, Australian and ISO standards.

The British deposit gauge (BS1747, part 1) consists of a 315 mm diameter glass bowl that is held in a steel stand fitted with a "bird guard". Dust deposits are collected in the bowl and washed by rain into a collection jar at the base of the stand.

The Australian system (AS3580.10.1-1991) is essentially a scaled down version of the BS system (and therefore cheaper), and consists of a 150 mm diameter conical glass funnel supported firmly in the neck of a wide-mouth four-litre glass bottle.

The ISO system (DIS 4222.2) differs from the other two in that the sampling unit and collection jar are one and the same. In this case the gauge is simply made from a plastic open-topped cylinder of about 200 mm diameter by 400 mm high. The cylinder is held in a wire frame, which also extends above the top of the gauge to serve as a bird guard.

Wind tunnel tests have shown that of these three systems, the ISO gauge has the most consistent collection efficiency for a range of different particle sizes and under varying wind speeds. In addition, the ISO gauges are easy to make, with a typical capital cost of about $500. The units are very robust and easily transported to and from the sampling sites. It is recommended that the ISO gauge should be the preferred method for use in New Zealand.

Mention should also be made of some other fairly recent developments in deposition sampling. These include a unit based around an inverted frisbee, and a so-called wedge flux gauge, both of which were developed in the UK. Apparently the wedge gauge has some significant advantages over conventional deposit gauges, for the monitoring of specific dust sources. Neither of these systems has yet been introduced into New Zealand.

Units of measurement

Dust deposition results are normally reported in units of $g/m^2/30$ days, although units of $mg/m^2/day$ have also been used in the past (1 $g/m^2/30$ days = 33.3 $mg/m^2/day$). The use of this latter unit can sometimes be confusing because people see it as meaning the measurements were taken on a daily basis. This is not so. Deposition samples are normally collected over periods of 28–32 days, and the results therefore need to be corrected to a standard time basis. Either time period (1–30 days) can be used, but most practitioners prefer 30 days.

Deposition levels have also been reported in terms of $g/m^2/month$. However, this is unacceptable unless accompanied by a clear definition of a standard "month".

Dissolved versus insoluble matter

The analysis methods for deposit gauge samples usually allow for the determination of both dissolved and insoluble matter. Insoluble matter is the solid material collected by filtering the sample, while the dissolved matter is determined by evaporating some or all of the liquid filtrate. As a general rule, the dissolved material is of no interest in assessing nuisance effects, and this part of the method should be ignored. It would only be of interest when dealing with a specific source that was known to produce water-soluble emissions (e.g. sodium sulphate from a pulp and paper mill, and milk powder from a dairy factory).

The dust deposition criteria given in section 7.4 are usually only applied to insoluble matter.

Total suspended particulate

The standard method for measuring TSP in many parts of the world is the high volume air sampler. This operates by drawing air at a rate of about 1.5 m^3/min through a 25 cm x 20 cm glass-fibre filter, which is weighed before and after sampling under conditions of constant humidity. The filter is mounted horizontally at the top of the sampler, and is protected by a triangular shaped roof. Samples are normally collected over 24 hours (midnight to midnight) using a 1-day-in-6 sampling regime, which is intended to give a representative coverage of the expected variations in particulate levels throughout any year. The method is covered by an Australian Standard, AS 2724.3-1984.

A scaled-down version of the high volume sampler was used in New Zealand for many years, and is still being used in some locations. The system was based around a 55 mm glass fibre filter that was held in a plastic holder mounted under a conical aluminium shelter. The air sampling rate was about 50–75 litres per minute, and samples were collected over periods of seven days.

The New Zealand system was developed for a variety of reasons including cost, portability, and reliability. However, experience over the last 10 years or so has shown that the system is not equivalent to the high-volume sampler and tends to give lower results. In addition, Hi-Vol units are now much more readily available than they were in the past. The local system is therefore being gradually phased out.

It is interesting to note that a number of medium volume samplers have also been developed in other countries (e.g. the Partisol 2000). These are mainly intended for PM_{10} monitoring, but can also be fitted with a so-called TSP head.

Mention should also be made here of a range of continuous dust monitor systems. These were developed mainly for PM_{10} monitoring, but most are available with TSP inlets as well. However, it should be noted that there is currently no standard specification for the size selectivity of these inlets. The available systems include the β-attenuation tape sampler, the Tapered-Element Oscillating Microbalance (TEOM), and a number of units based on light scattering.

The β-attenuation unit operates by drawing air at a rate of 15–20 litres/min through a continuous glass-fibre or teflon tape. A source of β-particles is used to sense the build-up of particles on the tape by changes in the amount of absorption. Measurements are normally averaged over periods of 0.5–2 hours to obtain sufficient sensitivity, and the tape is advanced either at the end of each cycle or some other pre-set interval. The unit can be used for continuous monitoring, and tape life is typically in the order of several months (or years with some recent instruments). The system is not covered by any Australian standard, but has been designated as an "equivalent" method by the US EPA.

In the TEOM, air is drawn through a filter, which is attached to a sensitive oscillating microbalance. Changes in the frequency of oscillation are directly related to the mass of material on the filter. Changes in mass are monitored continuously, although the instrument output is based on time-averaging of the signal, typically over 3–5 minutes. The sampling rate is 16.7 litres/min and micro-filters need to be changed every 1–4 weeks depending on the particle loadings. The system is not covered by any Australian standard, but has been designated as an "equivalent" method by the US EPA.

In the light scattering units, air is drawn through a chamber fitted with a small laser source. The scattering of light by dust particles is detected by a sensor placed at right angles to the beam. The main limitation with light scattering instruments is that the instrument response depends on both the size distribution and the numbers of particles, rather than the total mass of airborne particulate. This can be overcome to some extent by carrying out periodic calibrations using manual filter sampling. However, such calibration "factors" are likely to vary with different monitoring locations and different times of the year, because of the changes in composition and nature of the airborne particles.

The recommended monitor for routine TSP monitoring is the high-volume sampler. However, some of the continuous monitors will also be appropriate for the control of specific industrial sources.

Units of measurement

TSP results are normally reported in $\mu g/m^3$ although mg/m^3 may sometimes be used for very high levels (1 mg/m^3 = 1000 $\mu g/m^3$).

Appendix 5: Dust management plans

The following notes give an example of a possible outline for a dust management plan.

Introduction

This should describe the purpose and scope of the plan.

There should be a statement from the company manager or chief executive regarding support for the plan, along with references to any company environmental policy statements, and quality systems. Copies of any relevant material should be included in an appendix.

There should be a statement regarding the need for annual reviews of the plan contents.

Air quality management

This should give a brief description of the site activities, with special mention of the activities likely to generate dust. Specific statutory requirements regarding dust control (e.g. consent conditions) should be summarised here, with copies of the documents given in an appendix.

Specific staff responsibilities for dust management should be clearly stated, including responsibility for maintenance and updating of the plan.

Emission control and maintenance procedures

This should give details of all of the procedures that will be used on the site for dust management. Detailed operating instructions should be included in an appendix, if necessary.

There should also be specifications for any maintenance requirements for dust control equipment (e.g. sprinkler systems, bag filters).

Any requirements for performance testing of the control equipment should also be detailed here.

Sub-contractor management

If some of the work on site is to be done by sub-contractors, there should be a statement here of the procedures that will be used to ensure they are aware of and know what is required to comply with the dust management procedures. There should be a clear statement of reporting responsibilities. If necessary, specific dust control requirements should be written into the formal sub-contracting agreement.

Monitoring programmes

This should summarise the objectives and scope of any dust monitoring programmes, including methodology and site numbers and descriptions. Some of this detail may be given in an appendix.

Any emission testing requirements should also be described.

The system for use of the complaint register should be described, including investigation procedures and reporting requirements.

All monitoring results should be summarised in an annual report, copies of which should be made available to the public, and to the relevant regional and district councils (this may also be a consent requirement).

Appendices

These could include some or all of the following:

1. A copy of the company's environmental policy.
2. A detailed description of the site operations.
3. Copies of all relevant discharge permits or other statutory requirements.
4. Details of equipment maintenance programmes.
5. Details of dust monitoring sites, monitoring methods and control limits.
6. A plan of the site layout.
7. A map showing the locations of any monitoring sites.

Appendix 6: Case studies

1 Waihi Gold Mining Company

Background

The Waihi Gold Mining Company operates an open-cast mine in the town of Waihi. Mining operations started in 1987 and were originally planned to run for about 14 years. The company was granted approval for an extension to the mine in 1998, and mining will now continue through until about 2007.

The mining activities occupy a land area of about 300 hectares. Most of this is taken up by the pit itself (50 ha) and the waste disposal area, or tailings dam (200 ha). Obviously an activity of this size requires more than just one or two strategically located monitoring sites to provide effective coverage of the potential effects. In fact, the programme at Waihi is based around a total of 15 monitoring sites, eight of which are used for total suspended particulate, and 14 for dust deposition.

The dust monitoring programme was first set up in 1982, five years before the start of mining. This was a lot longer than necessary, but nonetheless the data provides an excellent record of "background" conditions prior to the mining activities. Seven monitoring sites were set up in 1982, five in 1984, two in 1986, and one in 1987. Five of the monitoring sites are directed at the open pit, seven of them surround the waste disposal area, and three provide information on dust levels within the town itself.

Monitoring results

A typical set of monitoring results for total suspended particulate (TSP) is shown in Figure A1. This is for the Barry Street site, which is one of the closest to the pit. The results are for seven-day averages. As shown there was no noticeable change in TSP levels at this site when mining commenced in 1987. There have only been a few breaches of the TSP limit specified in the air discharge consent, and no breaches of the mining licence limit.

Comparative results for a site in the commercial centre of Waihi are shown in Figure A2. This site is affected more by vehicle movements and other commercial activities, than by the mine.

Deposition results for the Barry Street site are shown in Figure A3. In this case the results are monthly averages. There were two breaches of the consent limit during the early stages of mine development. The high result recorded in 1996 was observed at all of the deposition monitoring sites. This was caused by the eruption of Mt Ruapehu, which is some 200 km to the south of Waihi.

Figure A1: Total suspended particulate (seven day average) measured at Barry Street, close to the pit

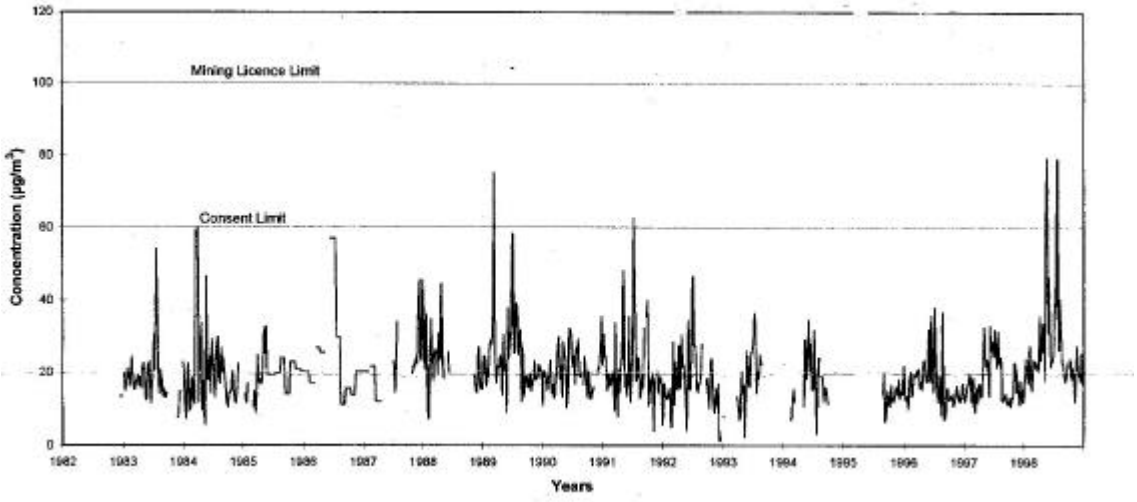


Figure A2: Total suspended particulate (seven day average) measured in the Waihi town centre

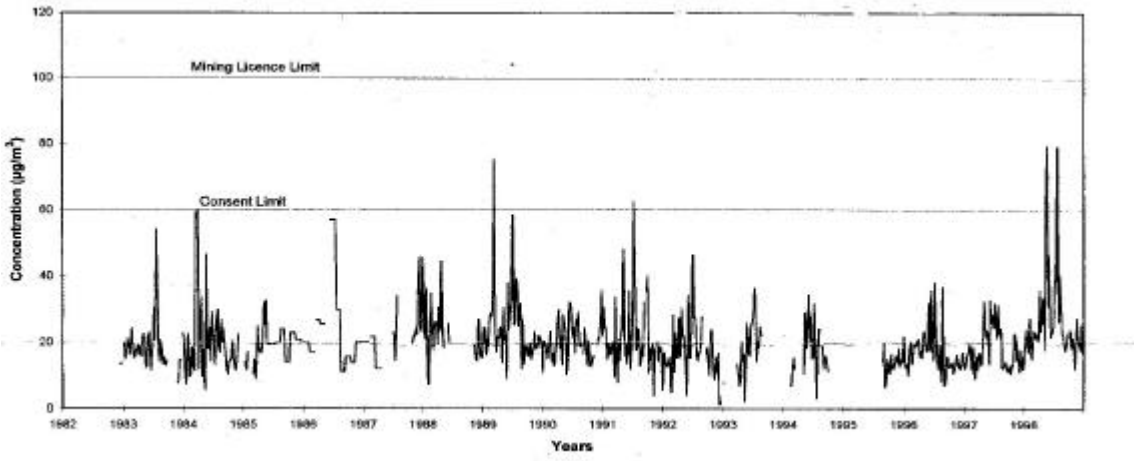
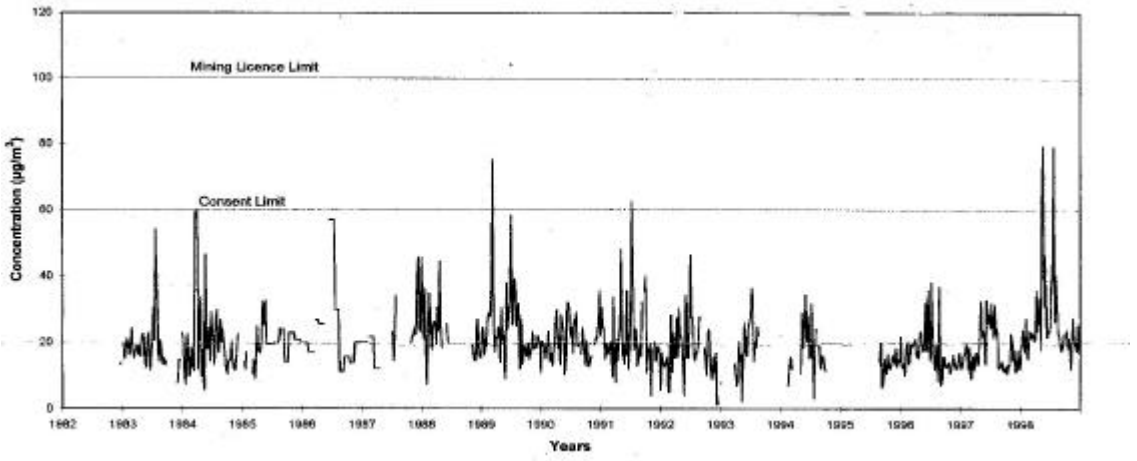


Figure A3: Deposited dust (monthly average) measured at Barry Street



Discussion

The monitoring programme at Waihi has served a number of purposes. It provided useful background data for the initial mining application, as well as important "performance" data to support the more recent application for an extension of the mine. It is used as a compliance monitoring system, although there is no obvious correlation between elevated dust levels and dust complaints. It also provides continual feedback to the company as to the effectiveness of its dust management programmes.

2 Pacific Steel Limited, South Auckland

Background

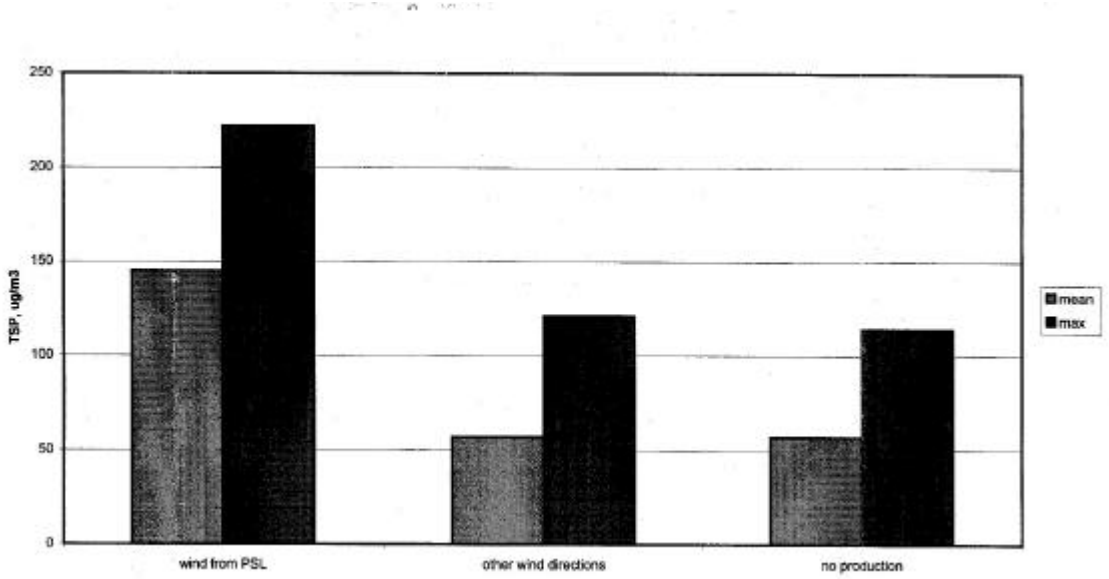
Pacific Steel, a business unit of Fletcher Challenge SteelMakers, have operated a secondary steel smelter in South Auckland for many years. The company established a dust monitoring programme at about the time that it applied for an air discharge permit under the RMA. The programme was based around a network of twelve deposition monitors, three directional dust gauges and two high volume samplers, which were used for monitoring both TSP and PM-10. Only the TSP results will be considered here.

The TSP monitors were located at two points to the east and north-east of the main plant. These were along the prevailing wind lines for the Auckland region. Samples were collected over 24 hours, using a one-day-in-six sampling regime. The company also installed a wind speed and direction monitor on the site, and this allowed the TSP data to be analysed on the basis of wind direction.

TSP monitoring results

TSP results for the period June 1994 to June 1995 are summarised in Figure A4. This shows the average and the maximum dust results for three different situations; wind from the direction of the plant, wind from all other directions, and dust results for the days on which the plant was not operating. This data shows that there was a measurable dust impact from the plant. The information assisted the company in developing management plans to improve the situation. However, the results also showed quite clearly that there were other significant dust sources in the area as well. The results should be compared with the trigger levels discussed in section 7.4.

Figure A4: Total suspended particulate concentrations (24-hour average) measured at the Pacific Steel monitoring sites, analysed on the basis of wind direction and plant operating hours



3 Fulton Hogan Mt Wellington Quarry

Background

Fulton Hogan Limited operates a quarry at Mt Wellington, Auckland (Figure A5). Basalt rock is being removed from the quarry with the intention of ultimately developing an industrial and residential subdivision on the site. Because of the close proximity of houses and the continuing residential development adjacent to the quarry, an intensive dust control and monitoring programme is undertaken. During the final stages of quarrying rock extraction will occur within 100 metres of neighbouring dwellings.

The primary activities within the quarry that have potential to discharge dust are:

- drilling and blasting
- excavation of rock
- crushing and screening of rock at up to 90 tonnes/hr
- stockpiling of quarried rock
- truck movement on unsealed surfaces
- an asphalt plant.

Consent requirements

A resource consent was granted by the Auckland City Council in May 1998 to undertake quarrying for five years. The consent contains several conditions relating to the dust discharge into air. As part of the application process a detailed dust management plan was prepared.

Figure A5: Aerial view of the Mt Wellington quarry

Note the proximity of residential properties at the upper right of the photograph.

The principal consent requirements relating to the dust discharge are:

- no noxious, offensive or objectionable discharges beyond the property boundary, in the opinion of an ACC enforcement officer
- ensuring discharges do not exceed concentrations of alert level 200 $\mu g/m^3$ or an absolute limit of 400 $\mu g/m^3$ (as explained below)
- a buffer zone with a width of 65 metres where the boundaries of the site adjoin residential areas
- no uncovered stockpiles within 200m of the site boundary.

Dust management plan and control measures

A comprehensive dust management plan was required by the Auckland City Council and was the subject of a submission from the Auckland Regional Council. The plan details staff responsibilities, contingency measures and specifies the staff members to be involved in an ongoing community liaison committee.

The main dust control measures specified in the plan include:

- application of water prior to blasting at a rate equivalent to 20 kg/m^2
- fine mist sprays at the crushing plant and conveyors
- location of the crushing plant within a raised bund
- dampening of haul roads with a water cart and fixed sprays, restriction of truck speed to 10 km/hr
- enclosing stockpiles of fine materials within a shed
- use of a drill for blasting with vacuum dust extraction and watering
- application of water to the rock excavation face
- removal of as little vegetation, overburden and soil as possible.

Dust monitoring

Dust monitoring is required by the management plan and consent conditions. The existing dust deposition gauge network continues to be used to monitor long term (30 day) dust nuisance at the property boundary. However in this situation the information gathered is of limited value when compared to that received from the real-time suspended particulate monitors.

Suspended particulate monitoring is undertaken using two real-time 'DataRam' monitors located within the plant and near the site boundary. The monitors measure the suspended particulate concentration every five minutes and are connected to an on-site alarm and the quarry manager's cell phone. The alarm is triggered when concentrations exceed 200 µg/m^3 and 400 µg/m^3. Triggering at the lower level requires that immediate action be taken to control dust emissions, while triggering at the higher level requires that work cease until the cause of the discharge is identified and rectified.

These suspended particulate limits have rarely been exceeded in the past. To remedy the limit breaches that have occurred, the sprinkler system has been extended to include the asphalt plant stockpile shed where crusher dust is stored. Fulton Hogan is currently in the process of automating the sprinkler system.

During one summer monitoring of PM_{10} was carried out using a high volume sampler to enable comparison to the real-time suspended particulate monitoring and to provide information relevant to health effects. PM_{10} values recorded were low, suggesting that significant health effects are unlikely to be associated with the quarry discharge.

Wind speed and direction are measured at the site. Thus the dust monitoring results can be compared to wind conditions at the time of measurement. This information is provided to the consent authority in a monthly monitoring report.

Community liaison

A community liaison group has been established that includes representatives of the Council, Fulton Hogan and local residents. Monthly meetings allow any concerns or complaints regarding dust emissions to be discussed. In addition, a complaints register is held by Fulton Hogan and individuals are encouraged to contact the company directly in the event of dust nuisance.

Discussion

Because of the location of the Mt Wellington quarry, there is potential for significant dust nuisance if strict dust control measures are not implemented. Careful attention to watering is required during dry conditions. In this case real-time dust monitors provide useful information regarding the effectiveness of the dust control measures. High short-term concentrations trigger an alarm that requires remedial action.

A comprehensive dust management plan is useful for this large site because it ensures staff responsibilities are clearly defined and specific actions are identified. Community liaison and complaints response play an important part in monitoring the effects of the dust discharge. Information gathered from the community, in combination with results from monitoring of dust and wind conditions, assist in identifying and remedying the cause of any dust nuisance events.

4 Port of Timaru Limited

Background

A wide range of bulk cargo materials are received and dispatched at the port of Timaru. Potentially dusty materials handled at the port include fertilisers, wood chips, soya meal, limestone, urea, sand, sugar, grains and seeds. Loose bulk cargo is transferred by hydraulic grabs between the ship and a mobile hopper on the wharf. Material is then discharged from the base of the hopper into trucks for transportation off-site or temporary storage within the port in silos or stockpiles.

Transfer of potentially dusty cargo has occurred at the port for many years and is adequately removed from residential properties that are elevated on a cliff to the west of the port. Few complaints have been made regarding dust emissions from the existing activities. In this case the nature of dust emissions and the scale of effects do not warrant dispersion modelling or complex dust monitoring techniques. This case study offers an example of one approach to the assessment and control of dust emissions from fugitive sources where significant adverse effects are not expected.

Resource consents and dust management plan

Resource consents for the discharge of dust to air and water were granted by Environment Canterbury in early 2001, following notification of the applications. A dust management plan was prepared as part of the consent applications and has been incorporated in the conditions of consent. The plan identifies staff members responsible for dust control, details the specific actions to be undertaken, and requires that dust complaints be recorded and actioned.

Dust control measures

A variety of good practice dust control measures are implemented via the management plan, including:

- use of water sprays on temporary stockpiles
- suction sweeping of the wharf and roadway areas where cargo material has been deposited
- avoiding cargo unloading during strong winds
- covering loaded trucks with tarpaulins
- locating stockpiles in sheltered areas and limiting the height and slope of stockpiles
- a regular maintenance schedule for the hydraulic grabs to minimise discharge via the seals
- minimising cargo transfer distances.

The dust management plan will be reviewed annually to incorporate any improvements to the dust management system.

Discussion

The Port of Timaru cargo handling operation is an example of a dust discharge where the scale and significance of effects does not warrant extensive dust monitoring. Because of the variable, dispersed and somewhat unpredictable nature of dust emissions from these activities, dispersion modelling is of little value as an assessment technique in this case.

The approach taken by the Port of Timaru Ltd to assessment and control of dust emissions has therefore focused on:

- examination of the ongoing history of any effects observed at neighbouring properties, including maintaining a record of any complaints and a point of contact with neighbouring parties
- implementation of good practice measures to minimise dust emissions from the various sources, via a dust management plan.

Development of a dust management plan is useful for this type of operation where there are various diffuse dust sources. The plan ensures that specific operational tasks are clearly identified and assigns responsibility to staff members. Any sub-contractors are required to appoint a staff member responsible for compliance with the plan.

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EXHIBIT H

13.2.2 Unpaved Roads

13.2.2.1 General

When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The particulate emission factors presented in the previous draft version of this section of AP-42, dated October 2001, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material[25]. EPA included these sources in the emission factor equation for unpaved public roads (equation 1b in this section) since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the unpaved public road emission factor equation only estimates particulate emissions from resuspended road surface material [23, 26]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOBILE6.2 [24]. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOBILE6.2 to estimate particulate emissions from vehicle traffic on unpaved public roads. It also incorporates the decrease in exhaust emissions that has occurred since the unpaved public road emission factor equation was developed. The previous version of the unpaved public road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

13.2.2.2 Emissions Calculation And Correction Parameters[1-6]

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Field investigations also have shown that emissions depend on source parameters that characterize the condition of a particular road and the associated vehicle traffic. Characterization of these source parameters allow for "correction" of emission estimates to specific road and traffic conditions present on public and industrial roadways.

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 micrometers [μm] in diameter) in the road surface materials.[1] The silt fraction is determined by measuring the proportion of loose dry surface dust that passes a 200-mesh screen, using the ASTM-C-136 method. A summary of this method is contained in Appendix C of AP-42. Table 13.2.2-1 summarizes measured silt values for industrial unpaved roads. Table 13.2.2-2 summarizes measured silt values for public unpaved roads. It should be noted that the ranges of silt content vary over two orders of magnitude. Therefore, the use of data from this table can potentially introduce considerable error. Use of this data is strongly discouraged when it is feasible to obtain locally gathered data.

Since the silt content of a rural dirt road will vary with geographic location, it should be measured for use in projecting emissions. As a conservative approximation, the silt content of the parent soil in the area can be used. Tests, however, show that road silt content is normally lower than in the surrounding parent soil, because the fines are continually removed by the vehicle traffic, leaving a higher percentage of coarse particles.

Other variables are important in addition to the silt content of the road surface material. For example, at industrial sites, where haul trucks and other heavy equipment are common, emissions are highly correlated with vehicle weight. On the other hand, there is far less variability in the weights of cars and pickup trucks that commonly travel publicly accessible unpaved roads throughout the United States. For those roads, the moisture content of the road surface material may be more dominant in determining differences in emission levels between, for example a hot, desert environment and a cool, moist location.

The PM-10 and TSP emission factors presented below are the outcomes from stepwise linear regressions of field emission test results of vehicles traveling over unpaved surfaces. Due to a limited amount of information available for PM-2.5, the expression for that particle size range has been scaled against the result for PM-10. Consequently, the quality rating for the PM-2.5 factor is lower than that for the PM-10 expression.

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS[a]

Industry	Road Use Or Surface Material	Plant Sites	No. Of Samples	Silt Content (%)	
				Range	Mean
Copper smelting	Plant road	1	3	16 - 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	1	1	-	7.1
Stone quarrying and processing	Plant road	2	10	2.4 - 16	10
	Haul road to/from pit	4	20	5.0-15	8.3
Taconite mining and processing	Service road	1	8	2.4 - 7.1	4.3
	Haul road to/from pit	1	12	3.9 - 9.7	5.8
Western surface coal mining	Haul road to/from pit	3	21	2.8 - 18	8.4
	Plant road	2	2	4.9 - 5.3	5.1
	Scraper route	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
Construction sites	Scraper routes	7	20	0.56-23	8.5
Lumber sawmills	Log yards	2	2	4.8-12	8.4
Municipal solid waste landfills	Disposal routes	4	20	2.2 - 21	6.4

[a]References 1,5-15.

The following empirical expressions may be used to estimate the quantity in pounds (lb) of size-specific particulate emissions from an unpaved road, per vehicle mile traveled (VMT):

For vehicles traveling on unpaved surfaces at industrial sites, emissions are estimated from the following equation:

$$E = k\,(s/12)^a (W/3)^b \quad (1a)$$

and, for vehicles traveling on publicly accessible roads, dominated by light duty vehicles, emissions may be estimated from the following:

$$E = \frac{k\,(s/12)^a (S/30)^d}{(M/0.5)^c} - C \quad (1b)$$

where k, a, b, c and d are empirical constants (Reference 6) given below and

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)
S = mean vehicle speed (mph)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The source characteristics s, W and M are referred to as correction parameters for adjusting the emission estimates to local conditions. The metric conversion from lb/VMT to grams (g) per vehicle kilometer traveled (VKT) is as follows:

1 lb/VMT = 281.9 g/VKT

The constants for Equations 1a and 1b based on the stated aerodynamic particle sizes are shown in Tables 13.2.2-2 and 13.2.2-4. The PM-2.5 particle size multipliers (k-factors) are taken from Reference 27.

Table 13.2.2-2. CONSTANTS FOR EQUATIONS 1a AND 1b

Constant	Industrial Roads (Equation 1a)			Public Roads (Equation 1b)		
	PM-2.5	PM-10	PM-30*	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9	0.18	1.8	6.0
a	0.9	0.9	0.7	1	1	1
b	0.45	0.45	0.45	-	-	-
c	-	-	-	0.2	0.2	0.3
d	-	-	-	0.5	0.5	0.3
Quality Rating	B	B	B	B	B	B

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 13.2.2-2 also contains the quality ratings for the various size-specific versions of Equation 1a and 1b. The equation retains the assigned quality rating, if applied within the ranges of source conditions, shown in Table 13.2.2-3, that were tested in developing the equation:

Table 13.2.2-3. RANGE OF SOURCE CONDITIONS USED IN DEVELOPING EQUATION 1a AND 1b

Emission Factor	Surface Silt Content, %	Mean Vehicle Weight		Mean Vehicle Speed		Mean No. of Wheels	Surface Moisture Content, %
		Mg	ton	km/hr	mph		
Industrial Roads (Equation 1a)	1.8-25.2	1.8-260	2-290	8-69	5-43	4-17[a]	0.03-13
Public Roads (Equation 1b)	1.8-35	1.4-2.7	1.5-3	16-88	10-55	4-4.8	0.03-13

[a] See discussion in text.

As noted earlier, the models presented as Equations 1a and 1b were developed from tests of traffic on unpaved surfaces. Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation. (Factors influencing how fast a road dries are discussed in Section 13.2.2.3, below.) The quality ratings given above pertain to the mid-range of the measured source conditions for the equation. A higher mean vehicle weight and a higher than normal traffic rate may be justified when performing a worst-case analysis of emissions from unpaved roads.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [23]. The emission factor also varies with aerodynamic size range

as shown in Table 13.2.2-4

Table 13.2.2-4. EMISSION FACTOR FOR 1980'S VEHICLE FLEET EXHAUST, BRAKE WEAR AND TIRE WEAR

Particle Size Range[a]	*C*, Emission Factor for Exhaust, Brake Wear and Tire Wear[b] lb/VMT
$PM_{2.5}$	0.00036
PM_{10}	0.00047
PM_{30}[c]	0.00047

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.
[b] Units shown are pounds per vehicle mile traveled (lb/VMT).
[c] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

It is important to note that the vehicle-related source conditions refer to the average weight, speed, and number of wheels for all vehicles traveling the road. For example, if 98 percent of traffic on the road are 2-ton cars and trucks while the remaining 2 percent consists of 20-ton trucks, then the mean weight is 2.4 tons. More specifically, Equations 1a and 1b are *not* intended to be used to calculate a separate emission factor for each vehicle class within a mix of traffic on a given unpaved road. That is, in the example, one should *not* determine one factor for the 2-ton vehicles and a second factor for the 20-ton trucks. Instead, only one emission factor should be calculated that represents the "fleet" average of 2.4 tons for all vehicles traveling the road.

Moreover, to retain the quality ratings when addressing a group of unpaved roads, it is necessary that reliable correction parameter values be determined for the road in question. The field and laboratory procedures for determining road surface silt and moisture contents are given in AP-42 Appendices C.1 and C.2. Vehicle-related parameters should be developed by recording visual observations of traffic. In some cases, vehicle parameters for industrial unpaved roads can be determined by reviewing maintenance records or other information sources at the facility.

In the event that site-specific values for correction parameters cannot be obtained, then default values may be used.In the absence of site-specific silt content information, an appropriate mean value from Table 13.2.2-1 may be used as a default value, but the quality rating of the equation is reduced by two letters. Because of significant differences found between different types of road surfaces and between different areas of the country, use of the default moisture content value of 0.5 percent in Equation 1b is discouraged. The quality rating should be downgraded two letters when the default moisture content value is used. (It is assumed that readers addressing industrial roads have access to the information needed to develop average vehicle information in Equation 1a for their facility.)

The effect of routine watering to control emissions from unpaved roads is discussed below in Section 13.2.2.3, “Controls”. However, all roads are subject to some natural mitigation because of rainfall and other precipitation. The Equation 1a and 1b emission factors can be extrapolated to annual

average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual average emissions are inversely proportional to the number of days with measurable (more than 0.254 mm [0.01 inch]) precipitation:

$$E_{ext} = E\ [(365 - P)/365] \quad (2)$$

where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT

E = emission factor from Equation 1a or 1b

P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation (see below)

Figure 13.2.2-1 gives the geographical distribution for the mean annual number of "wet" days for the United States.

Equation 2 provides an estimate that accounts for precipitation on an annual average basis for the purpose of inventorying emissions. It should be noted that Equation 2 does not account for differences in the temporal distributions of the rain events, the quantity of rain during any event, or the potential for the rain to evaporate from the road surface. In the event that a finer temporal and spatial resolution is desired for inventories of public unpaved roads, estimates can be based on a more complex set of assumptions. These assumptions include:

1. The moisture content of the road surface material is increased in proportion to the quantity of water added;
2. The moisture content of the road surface material is reduced in proportion to the Class A pan evaporation rate;
3. The moisture content of the road surface material is reduced in proportion to the traffic volume; and
4. The moisture content of the road surface material varies between the extremes observed in the area. The CHIEF Web site (http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html) has a file which contains a spreadsheet program for calculating emission factors which are temporally and spatially resolved. Information required for use of the spreadsheet program includes monthly Class A pan evaporation values, hourly meteorological data for precipitation, humidity and snow cover, vehicle traffic information, and road surface material information.

It is emphasized that the simple assumption underlying Equation 2 and the more complex set of assumptions underlying the use of the procedure which produces a finer temporal and spatial resolution have not been verified in any rigorous manner. For this reason, the quality ratings for either approach should be downgraded one letter from the rating that would be applied to Equation 1.

13.2.2.3 Controls[18-22]

A wide variety of options exist to control emissions from unpaved roads. Options fall into the following three groupings:

1. Vehicle restrictions that limit the speed, weight or number of vehicles on the road;

2. Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and
3. Surface treatment, such as watering or treatment with chemical dust suppressants.

Available control options span broad ranges in terms of cost, efficiency, and applicability. For example, traffic controls provide moderate emission reductions (often at little cost) but are difficult to enforce. Although paving is highly effective, its high initial cost is often prohibitive. Furthermore, paving is not feasible for industrial roads subject to very heavy vehicles and/or spillage of material in transport. Watering and chemical suppressants, on the other hand, are potentially applicable to most industrial roads at moderate to low costs. However, these require frequent reapplication to maintain an acceptable level of control. Chemical suppressants are generally more cost-effective than water but not in cases of temporary roads (which are common at mines, landfills, and construction sites). In summary, then, one needs to consider not only the type and volume of traffic on the road but also how long the road will be in service when developing control plans.

Vehicle restrictions. These measures seek to limit the amount and type of traffic present on the road or to lower the mean vehicle speed. For example, many industrial plants have restricted employees from driving on plant property and have instead instituted bussing programs. This eliminates emissions due to employees traveling to/from their worksites. Although the heavier average vehicle weight of the busses increases the base emission factor, the decrease in vehicle-miles-traveled results in a lower overall emission rate.

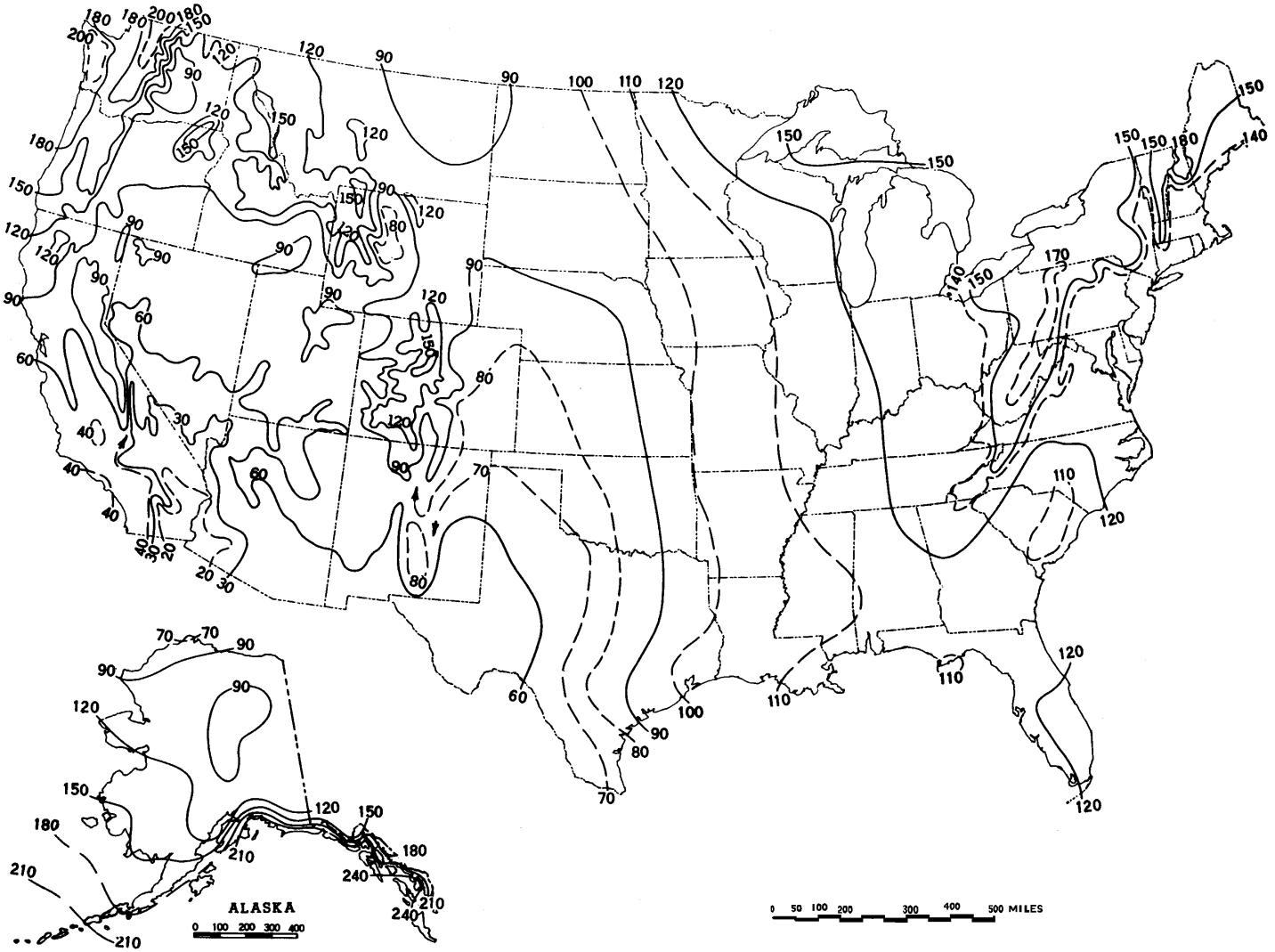

Figure 13.2.2-1. Mean number of days with 0.01 inch or more of precipitation in United States.

Surface improvements. Control options in this category alter the road surface. As opposed to the "surface treatments" discussed below, improvements are relatively "permanent" and do not require periodic retreatment.

The most obvious surface improvement is paving an unpaved road. This option is quite expensive and is probably most applicable to relatively short stretches of unpaved road with at least several hundred vehicle passes per day. Furthermore, if the newly paved road is located near unpaved areas or is used to transport material, it is essential that the control plan address routine cleaning of the newly paved road surface.

The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions. The predictive emission factor equation for paved roads, given in Section 13.2.1, requires estimation of the silt loading on the traveled portion of the paved surface, which in turn depends on whether the pavement is periodically cleaned. Unless curbing is to be installed, the effects of vehicle excursion onto unpaved shoulders (berms) also must be taken into account in estimating the control efficiency of paving.

Other improvement methods cover the road surface with another material that has a lower silt content. Examples include placing gravel or slag on a dirt road. Control efficiency can be estimated by comparing the emission factors obtained using the silt contents before and after improvement. The silt content of the road surface should be determined after 3 to 6 months rather than immediately following placement. Control plans should address regular maintenance practices, such as grading, to retain larger aggregate on the traveled portion of the road.

Surface treatments refer to control options which require periodic reapplication. Treatments fall into the two main categories of (a) "wet suppression" (i. e., watering, possibly with surfactants or other additives), which keeps the road surface wet to control emissions and (b) "chemical stabilization/ treatment", which attempts to change the physical characteristics of the surface. The necessary reapplication frequency varies from several minutes for plain water under summertime conditions to several weeks or months for chemical dust suppressants.

Watering increases the moisture content, which conglomerates particles and reduces their likelihood to become suspended when vehicles pass over the surface. The control efficiency depends on how fast the road dries after water is added. This in turn depends on (a) the amount (per unit road surface area) of water added during each application; (b) the period of time between applications; (c) the weight, speed and number of vehicles traveling over the watered road during the period between applications; and (d) meteorological conditions (temperature, wind speed, cloud cover, etc.) that affect evaporation during the period.

Figure 13.2.2-2 presents a simple bilinear relationship between the instantaneous control efficiency due to watering and the resulting increase in surface moisture. The moisture ratio "M" (i.e., the x-axis in Figure 13.2.2-2) is found by dividing the surface moisture content of the watered road by the surface moisture content of the uncontrolled road. As the watered road surface dries, both the ratio M and the predicted instantaneous control efficiency (i.e., the y-axis in the figure) decrease. The figure shows that between the uncontrolled moisture content and a value twice as large, a small increase in moisture content results in a large increase in control efficiency. Beyond that, control efficiency grows slowly with increased moisture content.

Given the complicated nature of how the road dries, characterization of emissions from watered roadways is best done by collecting road surface material samples at various times between water truck passes. (Appendices C.1 and C.2 present the sampling and analysis procedures.) The moisture content measured can then be associated with a control efficiency by use of Figure 13.2.2-2. Samples that reflect average conditions during the watering cycle can take the form of either a series of samples between water applications or a single sample at the midpoint. It is essential that samples be collected during periods with active traffic on the road. Finally, because of different evaporation rates, it is recommended that samples be collected at various times during the year. If only one set of samples is to be collected, these must be collected during hot, summertime conditions.

When developing watering control plans for roads that do not yet exist, it is strongly recommended that the moisture cycle be established by sampling similar roads in the same geographic area. If the moisture cycle cannot be established by similar roads using established watering control plans, the more complex methodology used to estimate the mitigation of rainfall and other precipitation can be used to estimate the control provided by routine watering. An estimate of the maximum daytime Class A pan evaporation (based upon daily evaporation data published in the monthly Climatological Data for the state by the National Climatic Data Center) should be used to insure that adequate watering capability is available during periods of highest evaporation. The hourly precipitation values in the spreadsheet should be replaced with the equivalent inches of precipitation (where the equivalent of 1 inch of precipitation is provided by an application of 5.6 gallons of water per square yard of road). Information on the long term average annual evaporation and on the percentage that occurs between May and October was published in the Climatic Atlas (Reference 16). Figure 13.2.2-3 presents the geographical distribution for "Class A pan evaporation" throughout the United States. Figure 13.2.2-4 presents the geographical distribution of the percentage of this evaporation that occurs between May and October. The U. S. Weather Bureau Class A evaporation pan is a cylindrical metal container with a depth of 10 inches and a diameter of 48 inches. Periodic measurements are made of the changes of the water level.

The above methodology should be used only for prospective analyses and for designing watering programs for existing roadways. The quality rating of an emission factor for a watered road that is based on this methodology should be downgraded two letters. Periodic road surface samples should be collected and analyzed to verify the efficiency of the watering program.

As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. These materials suppress emissions by changing the physical characteristics of the existing road surface material. Many chemical unpaved road dust suppressants form a hardened surface that binds particles together. After several applications, a treated road often resembles a paved road except that the surface is not uniformly flat. Because the improved surface results in more grinding of small particles, the silt content of loose material on a highly controlled surface may be substantially higher than when the surface was uncontrolled. For this reason, the models presented as Equations 1a and 1b cannot be used to estimate emissions from chemically stabilized roads. Should the road be allowed to return to an

uncontrolled state with no visible signs of large-scale cementing of material, the Equation 1a and 1b emission factors could then be used to obtain conservatively high emission estimates.

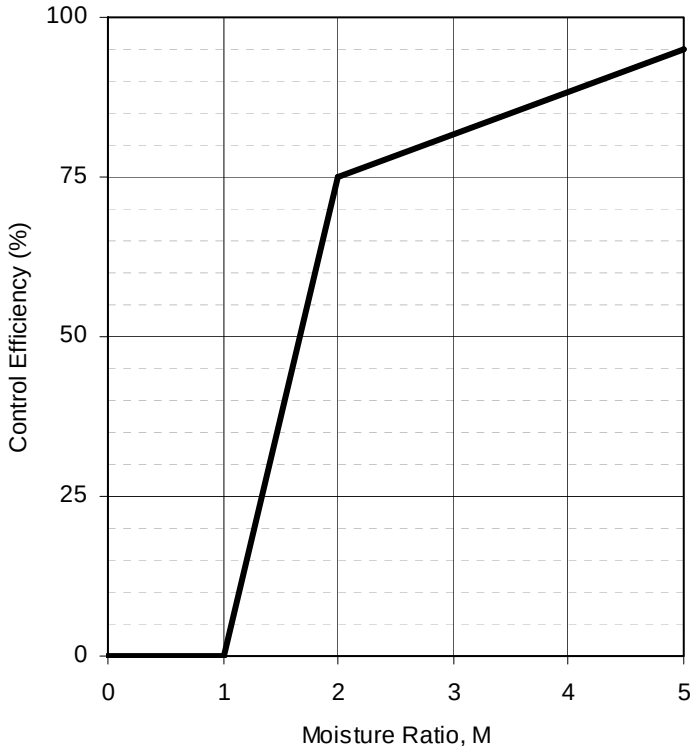

Figure 13.2.2-2. Watering control effectiveness for unpaved travel surfaces

The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of about 80 percent when applied at regular intervals of 2 weeks to 1 month.

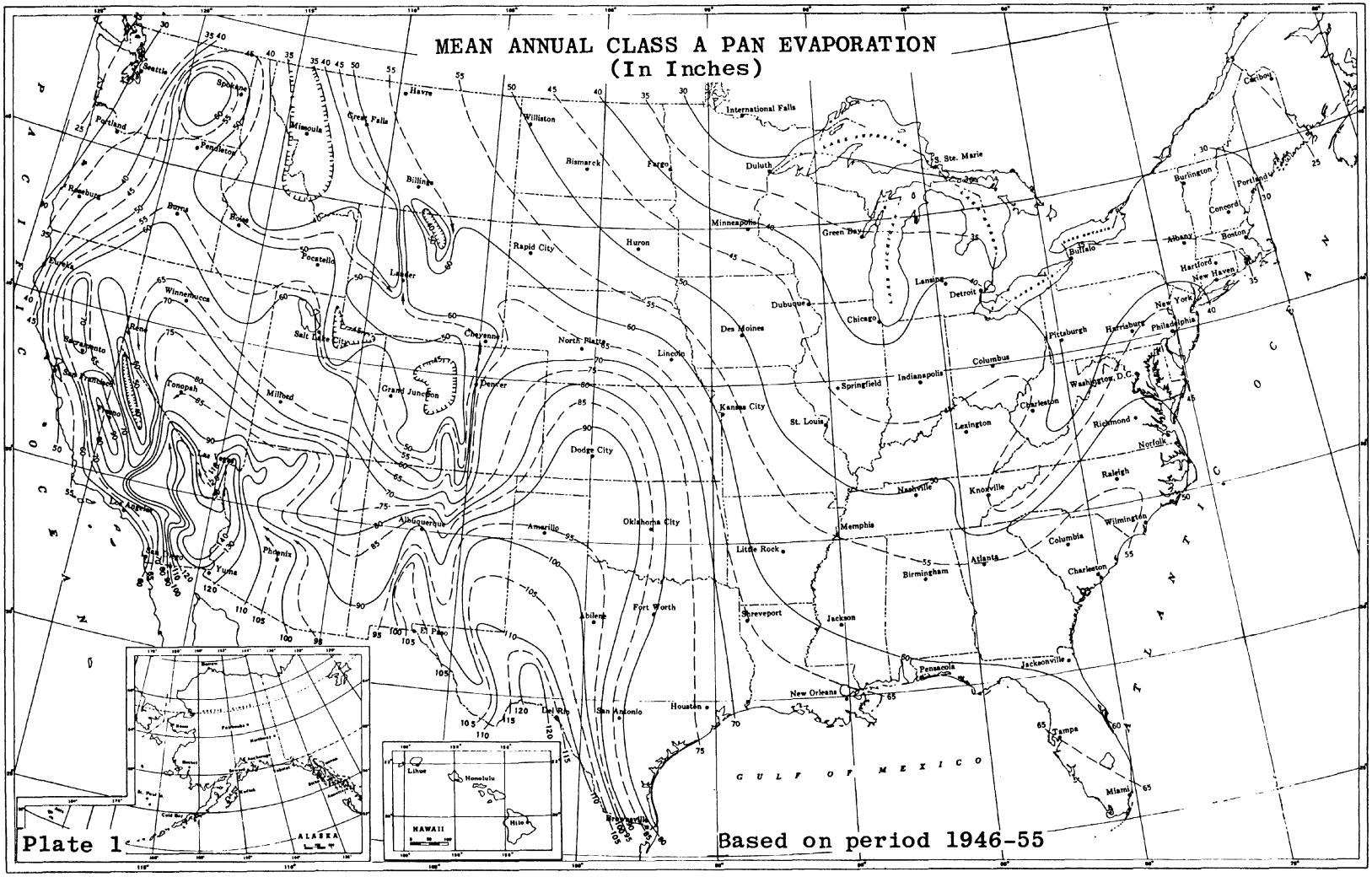

Figure 13.2.2-3. Annual evaporation data.

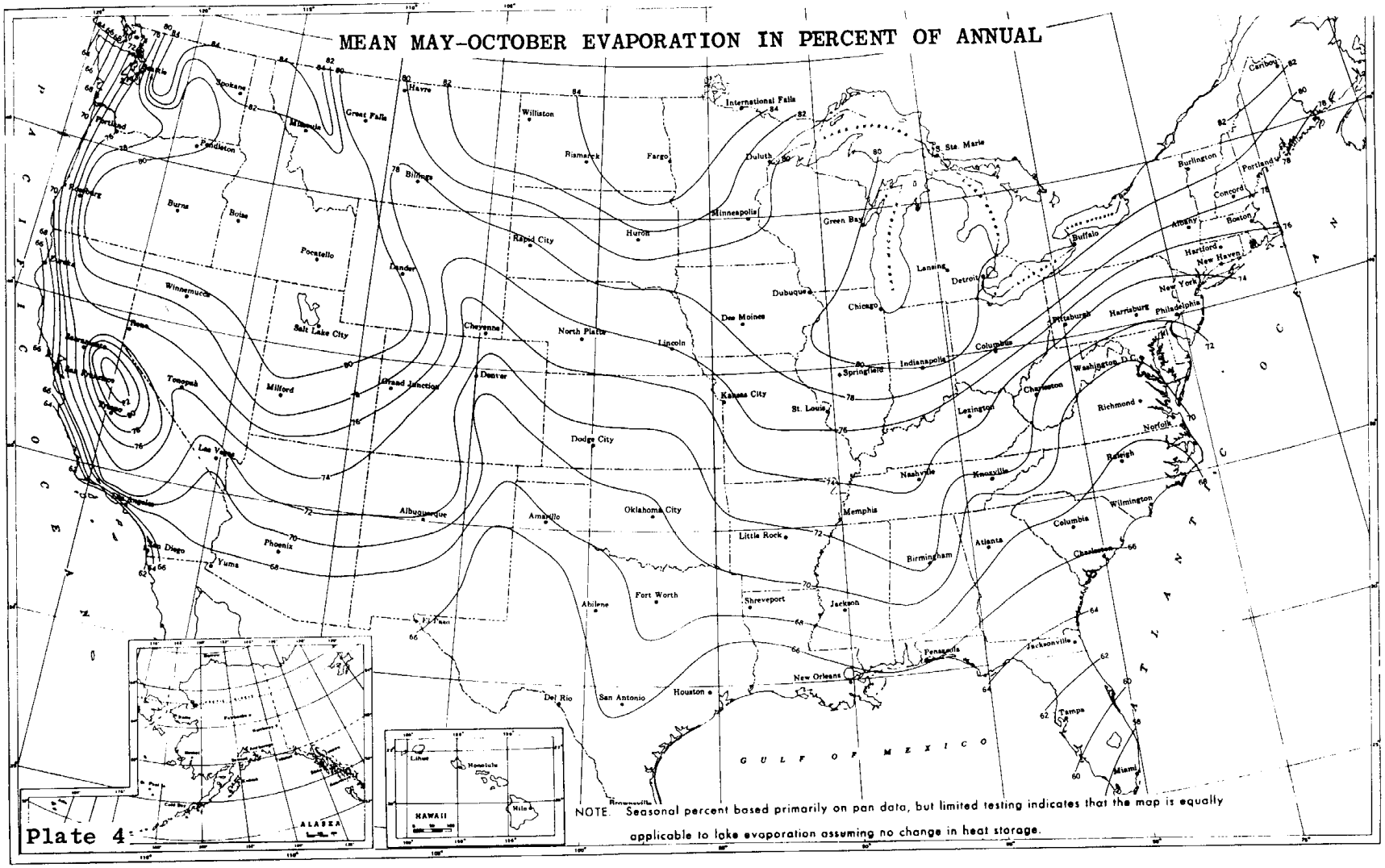

Figure 13.2.2-4. Geographical distribution of the percentage of evaporation occurring between May and October.

Petroleum resin products historically have been the dust suppressants (besides water) most widely used on industrial unpaved roads. Figure 13.2.2-5 presents a method to estimate average control efficiencies associated with petroleum resins applied to unpaved roads.[20] Several items should be noted:

1. The term "ground inventory" represents the total volume (per unit area) of petroleum resin concentrate (*not solution*) applied since the start of the dust control season.

2. Because petroleum resin products must be periodically reapplied to unpaved roads, the use of a time-averaged control efficiency value is appropriate. Figure 13.2.2-5 presents control efficiency values averaged over two common application intervals, 2 weeks and 1 month. Other application intervals will require interpolation.

3. Note that zero efficiency is assigned until the ground inventory reaches 0.05 gallon per square yard (gal/yd^2). Requiring a minimum ground inventory ensures that one must apply a reasonable amount of chemical dust suppressant to a road before claiming credit for emission control. Recall that the ground inventory refers to the amount of petroleum resin concentrate rather than the total solution.

As an example of the application of Figure 13.2.2-5, suppose that Equation 1a was used to estimate an emission factor of 7.1 lb/VMT for PM-10 from a particular road. Also, suppose that, starting on May 1, the road is treated with 0.221 gal/yd^2 of a solution (1 part petroleum resin to 5 parts water) on the first of each month through September. Then, the average controlled emission factors, shown in Table 13.2.2-5, are found.

Table 13.2-2-5. EXAMPLE OF AVERAGE CONTROLLED EMISSION FACTORS FOR SPECIFIC CONDITIONS

Period	Ground Inventory, gal/yd^2	Average Control Efficiency, %[a]	Average Controlled Emission Factor, lb/VMT
May	0.037	0	7.1
June	0.073	62	2.7
July	0.11	68	2.3
August	0.15	74	1.8
September	0.18	80	1.4

[a] From Figure 13.2.2-5, $\leq$10 µm. Zero efficiency assigned if ground inventory is less than 0.05 gal/yd^2. 1 lb/VMT = 281.9 g/VKT. 1 gal/yd^2 = 4.531 L/m^2.

Besides petroleum resins, other newer dust suppressants have also been successful in controlling emissions from unpaved roads. Specific test results for those chemicals, as well as for petroleum resins and watering, are provided in References 18 through 21.

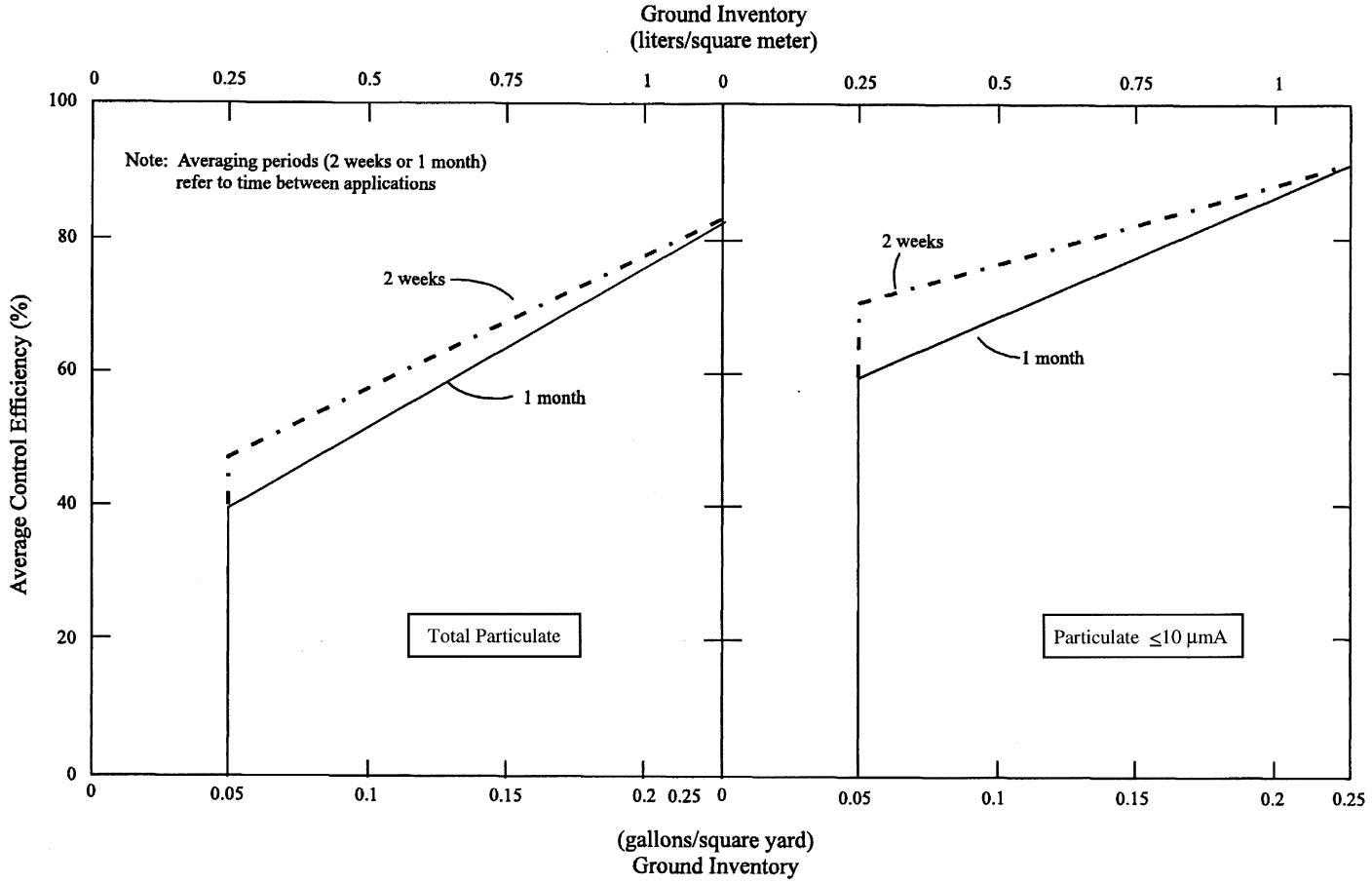

Figure 13.2.2-5. Average control efficiencies over common application intervals.

13.2.2.4 Updates Since The Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the background report for this section (Reference 6).

October 1998 (Supplement E)– This was a major revision of this section. Significant changes to the text and the emission factor equations were made.

October 2001 – Separate emission factors for unpaved surfaces at industrial sites and publicly accessible roads were introduced. Figure 13.2.2-2 was included to provide control effectiveness estimates for watered roads.

December 2003 – The public road emission factor equation (equation 1b) was adjusted to remove the component of particulate emissions from exhaust, brake wear, and tire wear. The parameter C in the new equation varies with aerodynamic size range of the particulate matter. Table 13.2.2-4 was added to present the new coefficients.

January 2006 – The PM-2.5 particle size multipliers (i.e., factors) in Table 13.2.2-2 were modified and the quality ratings were upgraded from C to B based on the wind tunnel studies of a variety of dust emitting surface materials.

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