EAGLE RIVER PM10 CONTROL PLAN

An Amendment to the Alaska State Air Quality Control Plan

Municipality of Anchorage
Department of Health and Human Services
Environmental Services Division
September 24, 1991

a. Background

Prior to the promulgation of the sub 10 micron particulate (PM10) standard, the Municipality of Anchorage was considered a rural fugitive dust area. Total suspended particulate (TSP) monitors in both Eagle River and Anchorage exceeded the primary TSP standard. During the period from 1973 through 1986, the Parkgate monitor in Eagle River exhibited the highest TSP concentrations in the Anchorage-Eagle River particulate network.

Based on an analysis of TSP data collected from both Eagle River and Anchorage, the EPA categorized the Municipality of Anchorage as a Group I area with a high probability of exceeding the new 150 microgram per cubic meter PM10 standard. Three monitoring locations in the monitoring network were determined to have a high likelihood of exceeding the standard. After three years of monitoring between 1985 and 1988, the Parkgate site in Eagle River is the only site in the Anchorage-Eagle River network to record an exceedance of the PM10 standard. Exceedances of the National Ambient Air Quality Standard (NAAQS) for PM10 have not been recorded at any of the Anchorage monitoring sites, including those predicted as likely to exceed the standard based on TSP data.

In January of 1988 a new microscale PM10 monitoring site (the Gambell site) was established in Anchorage along a major traffic corridor. This site has exhibited higher concentrations than other sites in Anchorage but has not exceeded the NAAQS. Every other-day sampling continues at this site.

Because ambient PM10 data to this date indicates that Anchorage is in attainment with the NAAQS for PM10, the State Implementation Plan will focus on strategies to reduce particulate emissions in Eagle River.

b. Description of the Eagle River Community

Eagle River is a community of about 25,000 people located approximately 10 miles northeast of downtown Anchorage. Eagle River is one of several communities which make up the Municipality of Anchorage. These communities range in character from rural to urban. Eagle River is suburban in nature, largely residential and light commercial with little industry. Most residents of Eagle River find employment in Anchorage.

The community of Eagle River is located at the end of a glacial river valley bounded on the west by Cook Inlet and on the south by the Eagle River. The Chugach Mountains bound the community to the northeast. Downtown Eagle River is located along the Old Glenn Highway corridor, which runs generally north-south through the community. Most of residential Eagle River lies to the east of this Old Glenn Highway corridor. The residential area

Monitoring has been conducted at five additional sites in the Eagle River area in order to provide a comparison with the existing Parkgate site. Of the five special purpose monitors, four have exhibited substantially lower concentrations than the Parkgate site. The highest 24-hour PM10 value recorded at any of these four sites was 55 micrograms per cubic meter.

Sampling was initiated at a fifth special purpose monitor in September 1988. This site is located adjacent to two intersecting gravel roads with moderate traffic. Although data from this site is limited, a comparison of coincident sampling data indicates that this new site may experience higher concentrations than the Parkgate site under certain conditions. The highest PM10 value recorded at this site was 140 micrograms per cubic meter. The Parkgate site registered a value of 84 micrograms per cubic meter on the same day. A summary of PM10 monitoring data from Anchorage and Eagle River can be found in the appendix (Vol III, Sec III.D.2-c).

d. Seasonality of Particulate Exposures

Both TSP and PM10 monitoring data indicate that the highest particulate exposures occur in the fall and spring. Exceedances of the PM10 or TSP standard are rare during the winter or summer months.

Nine of the eleven exceedances recorded between October 1985 and October 1988 have occurred in the late fall. These fall episodes are preceeded by extended periods without rain or snow and are characterized by cool, dry weather, lack of snow cover, and calm or near calm winds. The highest PM10 concentrations have occurred when the first significant snowfall does not occur until late in the year, when the ground is snow-free in late October or November.

Spring-time episodes are also generally preceeded by extended periods without precipitation and are characterized by cool, dry, and windy weather and a lack of snow cover. The highest PM10 concentration recorded at Parkgate during the spring seasons of 1986, 1987, and 1988 was 166 micrograms per cubic meter. Spring PM10 exposures are generally lower than those in the fall.

Although winter levels of PM10 are generally well below the 24-hour standard, a concentration of 214 micrograms per cubic meter occurred on February 18, 1986. High winds were recorded throughout most of south-central Alaska, especially in the Matanuska-Susitna Valley to the north of Eagle River. Sustained winds in excess of 40 knots were recorded at the Palmer Airport in the Matanuska Valley. These high winds, combined with an unusual lack of snow cover, created an ideal

In 1987, a PM10 Emissions Inventory (Reference Document #2, "PM10 Emission Inventories for the Mendenhall Valley and Eagle River Areas") was also performed. The receptor modeling and emissions inventory were undertaken specifically as a part of the PM10 SIP development process and will be discussed in detail later.

f. PM10 Emission Inventory for the Eagle River Area

One of the first steps in the PM10 SIP development process is the compilation of a comprehensive emissions inventory. A PM10 emission inventory (Reference Document #2) was compiled by Engineering Science, Incorporated under contract to EPA.

It should be noted that the inventory was revised after submittal of the final report. The inventory was revised to more accurately reflect "activity levels" in the inventoried area. A detailed discussion of the modifications made to the final report can be found in the appendix (Vol III, Sec. III.D.2-f). The discussion below is based on the findings of the revised emission inventory.

In many cases the information obtained from an emissions inventory is used as input for air quality dispersion models. Dispersion modeling was not performed in this case because a high degree of uncertainty was associated with the emission factors for the major PM10 sources in Eagle River. Furthermore, meteorological data was not available for Eagle River. Given these limitations, it was decided that dispersion modeling would not be useful in the Eagle River situation.

The primary purpose of the emission inventory was to estimate the PM10 emissions of point and area sources in the Eagle River area. The information obtained from the inventory was used along with receptor modeling results to quantify the emissions and receptor impacts of PM10 sources in Eagle River. The inventory was also used to define the boundaries of the PM10 non-attainment area or problem zone.

The emission inventory estimated 24-hour and annual PM10 and TSP emissions by source category. When available, AP-42 emissions factors were used to estimate emissions. The Eagle River area was divided into 30 one-kilometer grid cells. Source contributions were estimated for each of these grid cells. In addition, particulate emissions from the Matanuska and Knik River valleys to the north of Eagle River were also quantified. Because PM10 emissions sources are seasonal in nature, a separate inventory was compiled for each of the four seasons. Table 1 summarizes 24-hour worst case PM10 emissions in Eagle River by source category for each season. The major source categories identified in the inventory consisted of fugitive

Unpaved streets were assumed to have the same emission potential in the fall and spring. Emissions from unpaved roads are the highest when they are dry and snow and ice-free. It was assumed that dry, ice and snow-free days could occur in spring, summer or fall. Mud track-out from unpaved roads onto paved roads was assumed to occur primarily in the fall, just after the pre-winter grading of gravel roads. Although mud track-out may be a problem in other seasons, it was assumed to be negligible in comparison with the track-out which occurs immediately after the fall road grading.

Spring and summer are the only seasons shown with a windblown dust contribution. Snow cover was assumed to suppress windblown dust emissions in the winter. Because wind speeds have been low when PM10 concentrations have been high in the fall, emissions of windblown dust from cleared or disturbed land areas were considered negligible, at least on days when autumn PM10 exposures were the highest.

According to Table 1, the highest worst-case PM10 emissions occur in the spring. PM10 emissions in the spring are shown to be about six times higher than in the fall. This appears to be in contradiction with ambient PM10 data which shows the highest PM10 levels occurring in the fall. There are a number of factors that may account for this disparity. Dispersion conditions in the high wind conditions assumed for spring may be orders of magnitude greater than those experienced in the fall when calm winds and stagnant conditions typically exist. The increased mixing on spring days may account for the apparent disparity between emissions and observed concentrations.

It should also be noted that inaccuracies in emission factors may also account for some of the disparity as well. The industrial paved road emission factor used in the inventory may not be an accurate reflection of actual spring season emissions from paved roads. If, instead of the industrial paved road factor, the paved road factor is used with an assumed silt leading that is <u>twice</u> the loading measured on Montana roads in the early spring, the resulting paved road factor for arterials is <u>five</u> times lower than predicted by the industrial paved road emission factor. This indicates that the emission inventory <u>may</u> have grossly overestimated spring emissions.

g. Source Apportionment in Eagle River

In order to develop a successful strategy for reducing PM10 exposures in Eagle River, it was essential to determine the sources of particulate pollution and to quantify the contributions of these sources to the ambient PM10 problem. For this reason, PM10 control strategies selected for Eagle River rely heavily on the results of receptor modeling.

FIGURE 1A PM10 Source Contributions in Eagle River (fall season)

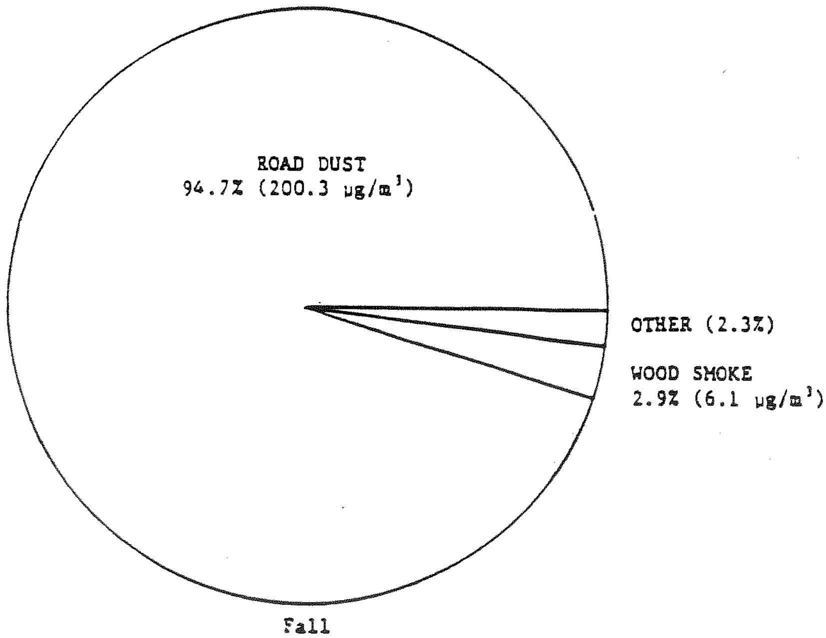
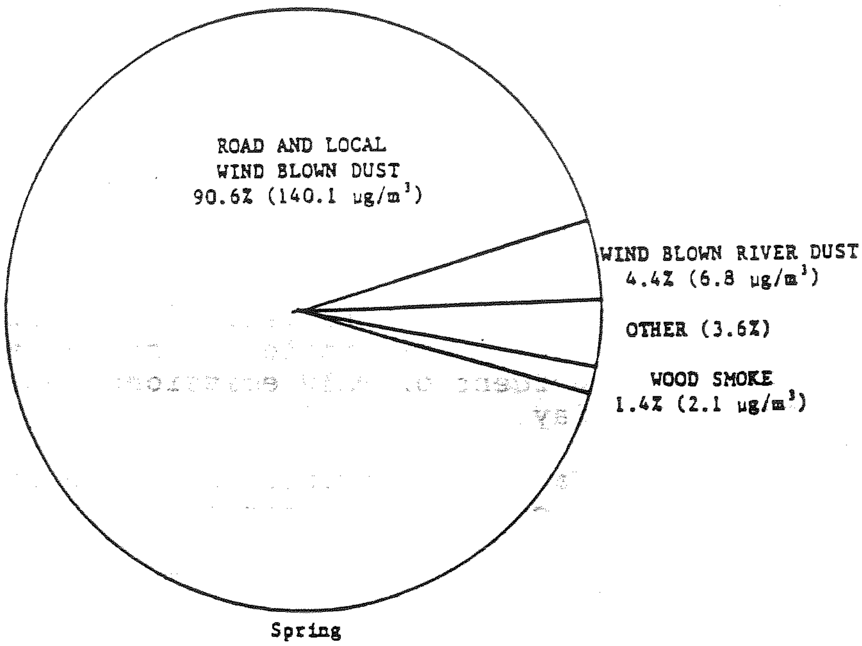


FIGURE 1B PM10 Source Contributions in Eagle River (spring season)



C. Dust generated from the riverbeds in the Matanuska Valley did not appear to significantly impact spring season PM10 exposures even on windy days. A maximum contribution of about 13 percent of the PM10 mass loading was attributed to riverbed dust.

Riverbed dust impacts were generally less than 10 percent of the PM10.

D. Because receptor modelling was unable to distinguish local windblown dust from paved and unpaved road dust, there is a large degree of uncertainty in estimates of the relative contribution of these sources to spring season PM10.

i. Problem Zone Boundaries

Problem zone boundaries were determined after careful consideration of emissions inventory information, PM10 monitoring data and population and dwelling density data.

The primary tool used to designate the PM10 non-attainment area was the emissions inventory. Monitoring data indicated that some of the areas within the problem zone may in fact be in attainment with the standard. A conservative approach was adopted, however, which included all areas with high PM10 emissions as part of the problem area even if monitoring data suggested otherwise.

The PM10 emissions inventory area encompassed all of the downtown and suburban sections of the community as well as some of the outlying rural areas. The 30 square-kilometer inventoried area was selected to be much larger than the perceived problem area so that information from the inventory could be used to define problem area boundaries . Those grids with the highest estimated emissions were included in the problem zone.

PM10 emissions for each of the 30 grids in the inventoried area are shown in Table 2. Problem zone boundaries were determined mostly on the basis of fall season emissions because of higher ambient impacts experienced during that season. Any grid with significant emissions was included in the problem zone. It should be noted that only the north portions of Grids 503, 504, 505 and 506, containing the Eagle River Valley Road, were included in the problem zone. About 50 percent of the fall season emissions from these grids are attributed to paved road emissions resulting from mud track-out on to Eagle River Valley Road.

Monitoring data from special purpose PM10 sites was also considered in determining problem zone boundaries. This data conclusively indicated that there was not an area-wide problem.

In addition to the Parkgate monitoring site in downtown Eagle River, monitoring information was available from five other locations in Eagle River. Of these five monitors only one (the Colville monitor) exhibited the potential to exceed the 24-hour NAAQS. This monitor, like the Parkgate monitor, was located in close proximity to gravel roads with moderate to heavy local traffic.

Monitoring data suggested that the problem area was confined to areas with similar characteristics, areas served by gravel roads with moderate local traffic. The location of the Parkgate site is shown along with the other five Eagle River monitoring locations in Figure 2.

Problem zone boundaries are shown in Figure 2. Nine of the 30 one-square-kilometer grid cells in the emissions inventory were included as part of the problem zone. Most of the Eagle River population resides within problem zone boundaries.

i. Design Concentration Calculations - Justification for Separate Design Concentration Values for Fall and Spring

The seasonal nature of PM10 concentrations has been discussed in detail in a preceeding section of this report. Exceedances of particulate standards (TSP and PM10) have occurred most frequently in the spring and fall, with the most severe episodes occurring in late fall.

The PM10 emissions inventory determined that the sources of PM10 vary dramatically with season. Emissions from paved roads, for example, were considered to be a major component of ambient PM10 in the spring (because of unswept winter road sand) but not the fall.

The variation of PM10 exposures and emission sources by season suggests that emission control strategies should be adjusted by season. The PM10 problem is more severe in the fall and control goals and strategies should reflect that fact. For this reason, separate design concentrations were determined for fall and spring.

The fall design concentration was determined by the table look-up procedure described in Section 6.3.1 of the PM10 SIP Development Guideline. The design value was based on monitoring data from the Parkgate site in Eagle River. Three complete years of daily sampling data were available from this site between October 1985 and September 1988. The data base met the requirement of 75 percent data capture for each quarter.

The table look-up procedure specifies that the fourth highest PM10 value is to be used as the design concentration when three complete years of data are available. This value is 238 micrograms per cubic meter. Because all four of the highest PM10 concentrations measured at Parkgate have occurred in the fall, the fall design concentration is identical to a design concentration calculated from all data, regardless of season. This value was used as the design concentration for the fall.

The design concentration for spring was determined by excluding data from the fall. Only two exceedances have occurred outside of the fall. Because one of these "spring" exceedances occurred in February, "spring" was considered to be the six month period from January through June. Two methods were used to calculate the spring design value, the table look-up method and the upper 10 percent tail distribution method, an EPA recommended statistical method. These two methods yielded similar design values. Design values of 166 and 161 micrograms per cubic meter were yielded by the table look-up and statistical methods, respectively. A value of 166 micrograms per cubic meter was used for spring.

The percent reduction required to reach attainment is calculated as follows:

% reduction required = TR / (Design Conc - Backgrd Conc)

Given a background concentration of 20 micrograms per cubic meter, the percent reduction required in fall is:

% reduction required = 88 / (238 - 20) = 40 percent

The percent reduction required in spring is:

% reduction required = 16 / (166 - 20) = 11 percent

m. Calculation of PM10 Reductions Resulting from Road Paving and Surfacing Projects Completed and Planned for Eagle River, 1987 - 1989

Fall Reductions:

A significant reduction in PM10 emissions has occurred and will occur between 1987 and 1989 as a result of road paving and surfacing projects in Eagle River. Many of the more heavily traveled gravel roads have been paved, substantially reducing particulate emissions from these roads. Of the 22 miles of unpaved roads in the problem zone, 3.4 miles were strip paved by mid-1989.

In addition to these strip paving projects, recycled asphalt surfacing has been applied to several gravel roadways in Eagle River. During 1988 and 1989 recycled asphalt was applied to 3.2 miles of gravel roadway in the problem zone. Recycled asphalt has provided an attractive alternative to paving or other road surface treatments.

Traditional hot-asphalt strip paving is not economically practical in areas which are not currently served by public water and sewer service. Because water and sewer service extensions are anticipated, it is not practical to pave streets that will be torn up later to provide utilities.

Recycled asphalt is salvaged from roadways that have been torn up due to right-of-way alterations and other major roadway upgrades. The salvaged material is run through a rock crusher. After the unpaved road bed is graded, recycled asphalt is spread over the road and compacted. The recycled asphalt "sets-up" to form a road surface very similar to typical asphalt pavement. The result is a surface that performs very well as a

Table 3. Estimated PM10 Emission Reductions between 1987-1989 - Fall (tons per day)

Grid	1987 Emissions	Emission Reductions From: Paving	Recycled Asphalt	Reduced Track-Out	Total Reduction	% Reduction
202	1.26	0.00	0.00	0.27	0.27	21
203	0.48	0.00	0.05	0.00	0.05	10
302	1.33	0.44	0.00	0.37	0.81	61
303	1.38	0.22	0.00	0.10	0.32	23
402	0.57	0.00	0.00	0.00	0.00	0
403	0.74	0.00	0.34	0.00	0.34	47
404	0.83	0.19	0.18	0.03	0.41	49
405	0.53	0.10	0.02	0.00	0.13	25
406	0.22	0.04	0.00	0.00	0.04	17
TOTAL	7.34	1.00	0.60	0.77	2.37	32

Spring Reductions:

While fall PM10 emissions have been significantly reduced by road paving and surfacing projects, spring emissions have been reduced by improvements in winter sanding and street clean-up practices instituted in the winter of 1987-88. Because of changes in the administration of municipal street maintenance activities, the quantity of road sanding material applied during winter has been significantly reduced. Furthermore, by tightening material specifications, the silt fraction (grain size less than 75 microns) of the sanding material has been reduced from an estimated 8 percent to 4 percent overall. The Alaska Department of Transportation has estimated that the quantity of road sand applied to state and municipal roads in the Eagle River area has been cut from 17,000 to 10,000 tons during a typical winter. These changes in the quantity and quality of road sanding material have reduced the amount of PM10-sized material applied to roadways by approximately two-thirds. Paving and road surfacing projects have also impacted spring PM10 emissions, though to a lesser degree than fall.

Because the amount of PM10-sized material applied to roadways during winter sanding operations has been reduced by an estimated two-thirds, paved road emissions were assumed to be significantly reduced in the early spring. Because actual measurements of silt loadings before and after road sanding improvements were not available, emission reductions were conservatively estimated at 30 percent. This amounts to an estimated PM10 emission reduction of 2.75 tons per day from paved roads in the problem zone. In addition to reductions

o. Selection and Implementation of Further Control Strategies

In order to achieve the remaining 8 percent reduction required to meet the PM10 standard, a number of different strategies were evaluated. The Alaska Department of Transportation (ADOT) prepared a report (Reference Document #8, "Cost Effectiveness of Selected Roadway Dust Control Methods for Eagle River, Alaska") evaluating the effectiveness and economy of a number of different emission reduction proposals. Strategies evaluated focused on the control of dust emissions from paved and unpaved roads.

Among the strategies evaluated were:

- Surface application of asphalt emulsion (road oiling).
- Surface application of calcium chloride.
- Paving (hard asphalt and bituminous surface treatment).
- Paving of driveways and other areas near paved roads to reduce mud track-out onto paved roads.
- Use of cleaner (lower silt content) sand as a traction aid.
- Using less winter road sand and more effective clean-up.

The report provided cost estimates for each of the strategies on a cost per ton of PM10 reduced basis. The most cost effective strategies were calcium chloride application and road oiling. The effectiveness of these surface treatments as dust palliatives is substantially compromised by annual regrading of gravel roads, however. Road grading is often done immediately before freeze-up in late fall when PM10 concentrations are often elevated. For this reason, there are practical limitations to road oiling and calcium chloride applications.

The report also evaluated bituminous surface treatment (BST), an asphaltic-aggregate surface created without "hot-mix" asphalt. This surfacing is less expensive than "hot asphalt" pavement (HAP), but its thin surface lacks the durability of HAP. BST is rarely used within the Municipality and is not a preferred alternative.

Paving and road sanding improvements (using cleaner sand and less sand) were also evaluated. Paving was determined to be an effective, albeit expensive PM10 reduction strategy. Paving is a desirable alternative in a community interested in a permanent upgrade of local roads. Improved road sanding practice was also found to be an effective strategy for reducing PM10 emissions.

1988 and 1989, combined with reductions projected to result from anticipated 1990-92 projects. An overall reduction of 56 percent is estimated to result from these projects. This projected reduction exceeds the 40 percent reduction required to reach attainment.

Table 5. Projected Fall Season Reductions Resulting from Completed and Anticipated Paving and Recycled Asphalt Projects 1987-1992

Grid	1987 Emissions	Emission Reductions From: Paving	Recycled Asphalt	Reduced Track-Out	Total Reduction	% Reduction
202	1.26	0.00	0.35	0.27	0.63	50
203	0.48	0.00	0.20	0.00	0.20	43
302	1.33	0.44	0.22	0.51	1.17	88
303	1.38	0.15	0.31	0.17	0.63	46
402	0.57	0.00	0.13	0.03	0.16	28
403	0.74	0.00	0.37	0.01	0.38	52
404	0.83	0.19	0.34	0.11	0.64	77
405	0.53	0.10	0.06	0.01	0.17	32
406	0.22	0.03	0.09	0.00	0.12	55
TOTAL	7.34	0.91	2.07	1.11	4.09	56

Projected Reductions - Spring:

The spring season was projected to be in attainment as the result of improvements already accomplished between 1987 and 1989. Further improvements are projected to result from the paving projects anticipated through 1992. If funding for these projects is approved, spring emissions will be reduced an additional 4 percent over the 12 percent reduction already accomplished, for a total estimated reduction of 16 percent from base year 1987. This reduction is over and beyond the 11 percent reduction neccessary to reach attainment in the spring.

Table 6a. compares calculated fall season emission rates in 1987, 1989 and 1992 to the threshold emission rate for fall. Calculated emission rates in 1989 reflect the benefit of paving and recycled asphalt projects completed by fall of 1989. Emission rates in 1992 were calculated based on the cumulative benefit of projects completed by 1989 as well as projects anticipated to be completed between 1990 and 1992. The reductions resulting from the 8.6 miles of projects (either paving or recycled asphalt) anticipated for construction between 1990-92 were conservatively calculated using the lower reduction factor assumed for recycled asphalt (0.80) rather than paving (0.95).

Similarly, Table 6b. compares calculated emission rates in 1987, 1989, and 1992 to the threshold emission rate for spring.

Table 6a.

Grid-by-Grid Comparison of Fall PM10 Emission Rates in 1987, 1989 and 1992 to Threshold or Allowable Emission Rate.

FALL SEASON EMISSIONS (TONS PER DAY)

GRID	BASE YEAR 1987(a)	PROJECTED 1989(b)	PROJECTED 1992(c)	ATTAINMENT THRESHOLD
202	1.26	0.99	0.64	0.80
203	0.48	0.43	0.27	0.80
302	1.33	0.52	0.16	0.80
303	1.38	1.06	0.75	0.80
402	0.57	0.57	0.41	0.80
403	0.74	0.39	0.36	0.80
404	0.83	0.42	0.19	0.80
405	0.53	0.40	0.36	0.80
406	0.22	0.18	0.10	0.80

(a) Base year 1987 emissions as calculated from 1987 inventory.

(b) Projected 1989 emissions after completion of previously funded paving and recycled asphalt projects.

(c) Projected 1992 emissions after completion of anticipated projects.

Table 6a. shows that attainment is projected by 1992 for all grids in the fall season. Fall 1989 emissions exceed the threshold value in Grids 202 and 303. The Eagle River Rural Road Service Board has made paving projects in these grids a high priority. If funding for paving projects is not received, recycled asphalt can be used as an interim measure. Anticipated paving and/or recycled asphalt projects will reduce fall PM10 emissions to levels below the threshold in all grids by 1992.

r. Contingency Plan

The current SIP calls for a primary control mechanism of strip paving or surfacing with recycled asphalt product (RAP) of 8.6 miles of gravel roads in the problem zone. This amount of surfacing is more than sufficient to provide the reductions necessary to achieve attainment.

The Municipality will employ two contingency measures should Eagle River fail to attain the standard. The first measure entails surfacing additional roadway mileage within the problem zone with RAP. This effort would focus on treating the remaining higher traffic volume streets in the problem zone. A minimum of two additional miles would be surfaced.

The second contingency measure involves "sweetening" a portion of the existing RAP surfaced roads with asphalt emulsion. A two mile portion of roadways already surfaced with RAP will be sprayed with a light coat of asphalt emulsion to seal the wearing surface of road thus providing a greater degree of dust control on those roads. The RAP roads selected for "sweetening" would be the most heavily traveled roads in the problem zone. Asphalt emulsion would be reapplied on an as-needed basis.

Engineering evaluations indicate that an 80% reduction in PM10 emissions is accomplished through RAP treatment or application of asphalt emulsion. The control effectiveness of sweetened RAP is estimated to exceed 90%, approaching the reduction achieved through strip paving. The implementation of these contingency measures, in combination with primary measures already employed will provide an estimated total fall season PM10 emission reduction of over 60 percent. A reduction of only 40 percent is necessary to achieve attainment.

This action is effected through the adoption of a resolution by the Anchorage Assembly and complemented by an internal directive issued to initiate these contingency measures if Eagle River fails to achieve the the PM10 standard by the end of 1994.

s. Maintenance Plan for Continued Compliance

The Eagle River Rural Road Service Board supports this air quality control plan and has agreed to continue road maintenance and strip paving activities. A letter of support from the road board can be found in the appendix (Vol.III, Sec.III.D.2-s). The Eagle River area-wide strip paving program is expected to continue even after ambient standards are achieved in Eagle River. This is an on-going program that is part of an overall effort to upgrade roads and provide utilities to the residents of Eagle River. This program continues independently of air quality considerations. The more densely populated areas of Eagle River, those areas lying within the boundaries of the problem zone, can be expected to benefit the most from this program.

Reference Documents (to be included as part of list of references supporting parts D.2 and D.3 of Volume II, Section 3 of the SIP)

2. PM10 Emission Inventories for the Mendenhall Valley and Eagle River Areas
   EPA Contract No. 68-02-4398, Work Assignment 7
   Engineering-Science, Inc. February 1988

5. Source Apportionment by Chemical Mass Balance Technique of PM10 Sources in Eagle River and Juneau, Alaska
   Prepared for the Alaska Dept. of Environmental Conservation
   NEA, Inc. May 23, 1988

8. Cost Effectiveness of Selected Roadway Dust Control Methods for Eagle River, Alaska
   Prepared for the Alaska Dept. of Environmental Conservation
   Report No. AK-RD-88-07
   Alaska DOT&PF Research Section July 1988

9. Aerosol Characterization Study of Anchorage, Alaska: Chemical Analysis and Source Apportionment
   Prepared for the Anchorage Air Pollution Control Agency
   NEA, Inc. January 23, 1985

10. A Preliminary Examination of the Impact of Residential Wood Combustion on Air Quality in the Anchorage Bowl
    Richard Myers May 2, 1984

11. The 1984 - 1985 Girdwood and Eagle River Valley Wood Smoke Study
    Anchorage Air Pollution Control Agency June 1985