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FINAL

2006 Alaska Fire Emissions Inventory

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PROJECT NO. 217-2
OCTOBER 2007

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EXECUTIVE SUMMARY

The Alaska Department of Environmental Conservation (DEC) in coordination with the Alaska Wildland Fire Coordinating Group (AWFCG) has developed Alaska's Enhanced Smoke Management Plan (ESMP). The ESMP and accompanying volume of appendices has been adopted by DEC and participating wildland owners and managers. According to the ESMP, DEC is responsible for collecting, reviewing, tracking, and summarizing statewide pre- and post-burn data for annual ESMP emissions inventory reports to be distributed to AWFCG, the U.S. Environmental Protection Agency (EPA), and the Western Regional Air Partnership (WRAP).

This report summarizes the development of emission estimates for fire for calendar year 2006 and summarizes the results for wildfire, wildland fire use (WFU), prescribed fire (Rx), and agricultural burning within the state of Alaska. The results are summarized in the format of the fire emissions inventory software tool (or "template"), which was developed for the DEC as part of the 2005 fire emissions inventory. This tool is intended to be used to calculate and report annual emissions in future years as required by the ESMP. In addition, tabular and graphical summaries for the 2006 emissions inventory are presented in this report.

Fire activity data were collected from federal databases as well as state sources for 2006. The federal fire activity data consisted of a national fire activity summary report prepared by the National Interagency Fire Center (NIFC), as well as the ICS-209 database. At the state level, data was obtained from the Alaska Geospatial Data Clearinghouse (AGDC), and the Alaska Interagency Coordination Center (AICC). This database consisted of GIS shape files of the large fire perimeters, and a fire activity database, respectively. The latter served as the main data source for wildfire, wildland fire use, and prescribed fire activity. Agricultural burning activity was compiled based on data from the National Agricultural Statistical Service (NASS) in combination with feedback from the Alaska Department of Natural Resources (DNR). Finally, in addition to the prescribed burning on federal and state lands, small permitted burn activity was included in the 2006 emissions inventory. The activity data for the small permitted burns was based on communication with the Alaska DNR.

The technical methods used for the 2006 emissions inventory are described in detail in the summary report of the 2005 Alaska fire emission inventory (Air Sciences, 2007a). The methods reflect specific feedback received on the draft 2005 report and in meetings with the Alaska Wildland Fire Coordination Group (AWFCG) Air Quality Committee in January and March of 2007. This report summarizes selected methods common to 2005 and 2006 emissions inventories and provides more detail for methods that deviate from the 2005 inventory.

The fire activity data and emission estimates are summarized by fire type, spatial and temporal distribution, total acreage burned, and estimated calculated emissions. After all quality

assurance procedures, 436 fire events remained in the inventory, totaling 307,343 acres of burned acres. The results indicate that in 2006 the fire activity in the state of Alaska was dominated by wildfire, compromising 84 percent burned acres, and 97 percent of fire emissions. Prescribed fire, including the small permit burning activity, accounted for 12 percent of burned acres, and 3 percent of fire emissions. WFU and agricultural burning accounted for 1 and 3 percent of burned acres, respectively, and only about 0.2 percent of fire emissions.

The deliverables for this project:

- Report: "2006 Alaska Fire Emissions Inventory" Air Sciences Inc., October 2007 (delivered as PDF and Microsoft Word files): PDF – AK 2006 Fire EI_20071026.pdf; Microsoft Word – AK 2005 Fire EI_20071026.doc.

- 2006 fire emissions inventory files (delivered as .dbf files):
  - Event Emissions Inventory: ADEC2006_events_20070622.dbf
  - Daily Emissions Inventory: ADEC2006_daily_20070622.dbf

Electronic files of all deliverables can be downloaded from the web site www.airsci.com/adec/2006ei/ (all lower case).

SECTION 1

ALASKA 2006 FIRE EMISSIONS INVENTORY METHODS

1.1 Background

The purpose of this inventory is to provide a database of fire activity and emissions within the political boundaries of the state of Alaska for calendar year 2006. Wildfire, wildland fire use, and prescribed burning on wildlands are included in this inventory. In addition, an agricultural burning activity inventory was developed, as well as an estimate of the burning activity under the small permits administered by Alaska DNR.

Emissions calculation methodologies and emission factors were adapted from ongoing work commissioned by the Fire Emissions Joint Forum (FEJF) of the WRAP (Air Sciences Inc., 2004, 2005), and the Alaska Department of Environmental Conservation (DEC) (Air Sciences, 2007a). The majority of the processing and quality control methods applied in the 2006 fire emissions inventory were adapted from, and consistent with, the 2005 Alaska fire emissions inventory (Air Sciences Inc., 2007a). This report will focus on the data sources utilized to build the 2006 fire emissions inventory and the technical methodologies that deviate from the 2005 fire emissions inventory.

Two emissions inventory files have been prepared as final deliverables for this project.

- 2006 ***Event*** Fire Emissions Inventory. The Event emissions inventory is comprised of the fire activity data as reported by the compiled input database. Multi-day fire events are represented as a single event in the Event emissions inventory. Total emissions (the sum of flaming and smoldering emissions) are calculated for each event. This emissions inventory file is most suitable for preparing annual fire activity and emissions summaries.

- 2006 ***Daily*** Fire Emissions Inventory. The Daily emissions inventory is comprised of individual fire and smoldering days. In the Daily emissions inventory, multi-day fire events have been disaggregated into daily events (acres) per day (Air Sciences, 2007a, Section 1.5). This emissions inventory file is most suitable when spatially and temporally resolved fire data are necessary, such as input files for dispersion models or for analyses to link daily emissions to monitored ambient air concentrations of pollutants.

1.2 Data Sources

The Alaska fire emissions inventory process adopts techniques developed by the WRAP (Air Sciences Inc., 2004, 2005). The general fire emissions calculation follows Equation 1:

*Emission Mass = Fire Size * Fuel Consumption * Emission Factor * 0.0005* (1)
(ton pollutant) (acre) (ton/acre) (lb/ton) (ton/lb)

Emission mass (tons of each pollutant estimated) is calculated for each event (in the Event emissions inventory) and for each fire and smoldering day (in the Daily emissions inventory). Fire size is a site-specific input provided in the original source data. Fuel consumption values are selected from spatial data layers (e.g., fuel model maps) and reference (Microsoft Excel look-up) tables based on input data and fire location. Emission factors are selected from reference (Microsoft Excel look-up) tables based on EPA- and WRAP-accepted emission factors from the literature. The pollutants to be inventoried are particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), particulate matter less than 10 microns in diameter (PM_{10}), elemental carbon (EC), organic carbon (OC), oxides of nitrogen (NO_X), oxides of sulfur (SO_X), carbon monoxide (CO), volatile organic compounds (VOC), methane (CH_4), and ammonia (NH_3).

1.2.1 Wildfire, Wildland Fire Use, and Prescribed Fire

The 2006 fire emissions inventory for wildfire, WFU, data were collected from several sources (Table 1.1). The two data sets from NIFC (NIFC, 2007a and 2007b) were consistent with each other and provided reference numbers for the total acreage burned by fire type and agency. The data from the NWCG (2007) consisted of nine (9) fire events (with sizes for the events ranging from 13 to 130,186 acres). The NWCG data was not utilized as the basis for the 2006 fire emissions inventory. However, this database provided useful daily acreages for the largest fire event in 2006, the 130,186 acre Parks Highway fire, resulting in a more accurate apportioning of the burned acreage over the duration of this fire event (Table 1.1). Final fire perimeters for some of the largest fire events were obtained from the Alaska Geospatial Data Clearinghouse (AGDC, 2007) and applied to develop refined estimates of the total acreage of the fire events as well as a weighted fuel loading value. Weighted fuel loading values were developed by a spatial overlay of the fire perimeters with a 30-meter CFFDRS fuel layer (Air Sciences, 2007a, section 1.4.1). Weighted fuel loading values are preferred over a single loading value because they account for the variation in fuel types that can exist within the perimeter of large fire events. Finally, data from the Alaska Interagency Coordination Center was downloaded (AICC, 2007a and 2007b). This data set provided all the required parameters to build the inventory (with the exception of fuel type) and therefore formed the basis of the 2006 fire emissions inventory. The other data sources either served to refine the compiled 2006 fire emissions inventory (AGDC, 2007; NWCG, 2007) or as reference materials in the quality control phase of the project (NIFC, 2007a and 2007b).

Table 1.1: Wildfire, Wildland fire use (WFU), and Prescribed Fire Sources

Data Source Code	Source Type	Description	Application
NIFC, 2007a	Wildfire, WFU, Rx	2006 fire acreage summary by fire type and agency. [text format]	- Served as reference for final acreage comparison. - Not applied in actual emissions inventory.
NIFC, 2007b	Wildfire, WFU, Rx	2006 fire acreage summary report by fire type and agency. [pdf format]	- Served as reference for final acreage comparison. - Not applied in actual emissions inventory.
NWCG, 2007	Wildfire, WFU, Rx	National database with daily fire activity information. [MS Access format]	- Provided improved daily acreage reports for largest fire event in 2006 (Parks Hwy fire, ~130,000 acres). - Not used a main database since large gaps in total acreage.
AGDC, 2007	Wildfire	Shape files of large fire event perimeters. [GIS format]	- Provided refined total burned acres estimates. - Applied to calculate weighted fuel loading for large fire events.
AICC, 2007a	Wildfire, Rx	2006 state wide database with fire event specific information. [MS Excel format]	- Served as main database to build baseline fire activity database. Included all necessary event parameters
AICC, 2007b	Wildfire, Rx	2006 state wide database with fire event specific information. [MS Access]	- Similar database as provided in previous source. - Served as reference in quality assurance process.

1.3.2 Small Fires

In addition to fires managed by the State of Alaska, there are a significant number of small, private burns that occur each summer. No official record is kept on the size, date, and frequency of these burns, as any fire less than 40 acres is not required by the DEC to be reported. It is useful to try to account for these fires and to include emissions from these fires in annual emissions summaries.

Air Sciences attempted to account for small, private burning emissions by estimating acreage from the number of permit activations issued each year in Alaska. Permit activation is a reasonable proxy for a fire event, as it represents an actual approval to burn on a given day. Based on personal communication with Robert Schmoll (Alaska DNR Division of Forestry, Fairbanks Area), permit activations were allocated for each Fire Management Zone (FMZ) in Alaska. The number of permits for Fairbanks, Tok, Delta, and Matanuska-Susitna were based on estimates provided by Alaska DNR; the remainder were allocated evenly for each FMZ (with the exception of military land) based on the approximation that Fairbanks handles 50% of all permits for the state. Military land was allocated zero permits.

Private burn permits are issued for three categories: 10′ x 10′ piles, 1 acre lawn burning, and classes A, B, C, D which require a site visit by a Fire Management Officer. Acres were derived for 1-acre lawn burning by number of permits. For classes A-D permits, a summary of total acres for all classes was provided by Alaska DNR. For piles, acres were approximated by converting from pile volume, shown in Equation 2. Pile shape was assumed to be a half-ellipsoid; the number of acres per cubic foot was obtained from other work performed by Air Sciences (Wyoming Fire Emissions Inventory, 2003 to 2005, WY DEQ, 2007; Air Sciences, 2007b). For each pile permit, the maximum allowable horizontal dimensions were assumed (10′ x 10′). Height was assumed to be 7′. Using these parameters, Equation 2 results in an approximation of 2.1 acres per pile for relevant permit activations.

$$\underset{(acres/ft^3)}{Acres\ per\ pile} = \underset{(acres/ft^3)}{0.0057} \times \underset{(cubic\ feet\ per\ pile)}{(Height \times Width \times Length \times \pi) / 6} \qquad (2)$$

All permit activations were classified as prescribed fire and were distributed evenly from May to September. Lawn burning and class A-D fires were classified as broadcast burns, the remainder as pile burns. Each event location was assigned in a GIS to the centroid of the FMZ in which it was assumed to occur. For Southwest and Chugach National Forest the centroid of the entire zone landed in the ocean. For these areas, the "centroid" was manually approximated to ensure it was over land.

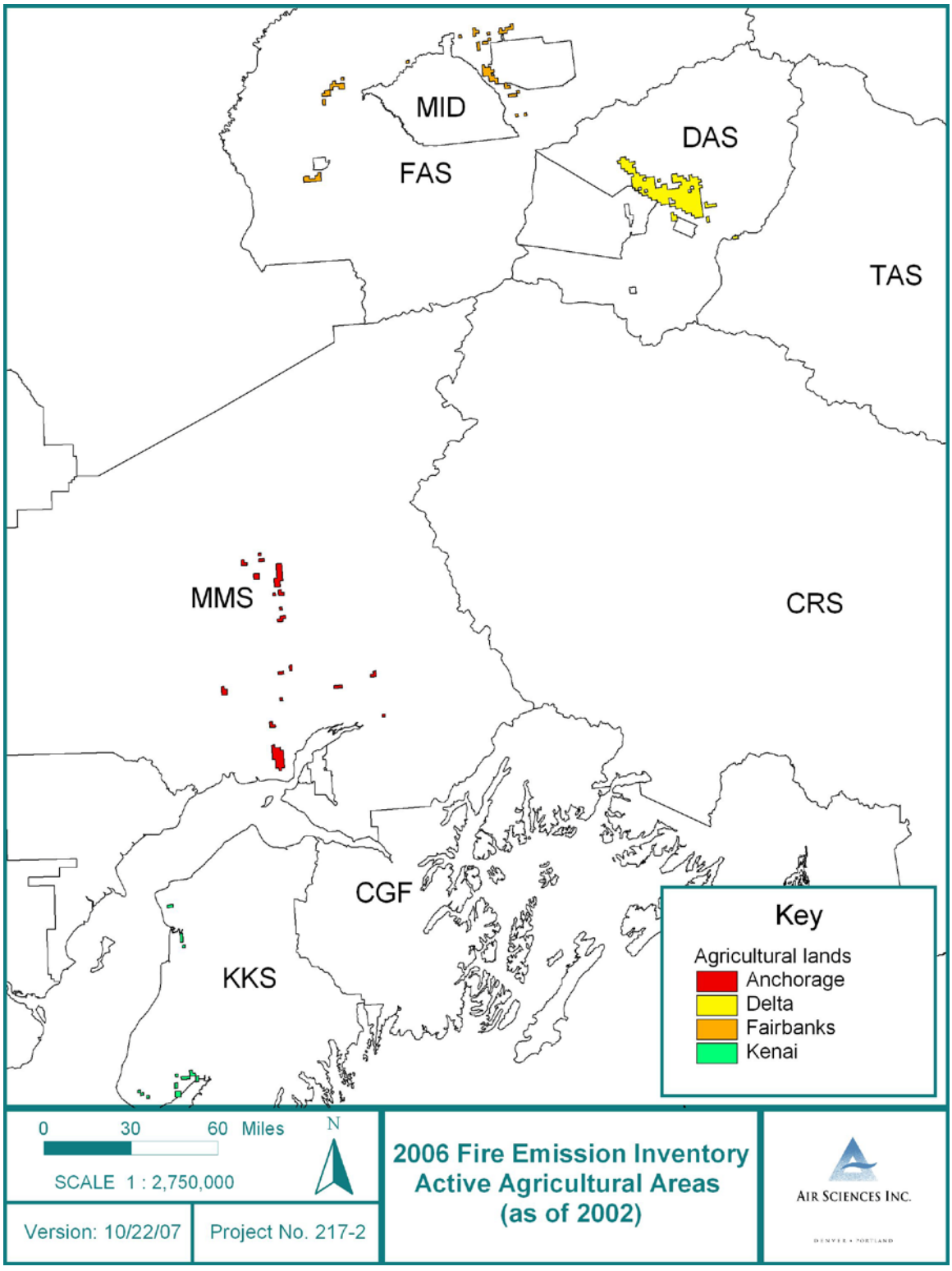
1.3.3 Agricultural Burning

Similar to small, private burns, no official record is kept for agricultural burning. There are no permits from which to approximate burned acres. Personal communication with the Alaska Cooperative Extension in Delta Junction (2007), as well as the Alaska DNR Forestry Division, Delta Area (2007a), provided anecdotal estimates for the magnitude of agricultural burning on an annual basis. Based on these conversations, agricultural land burned in 2006 was allocated to regions of Alaska with agricultural activity. Data on total cropland by region was obtained from the 2002 Census of Agriculture published by the USDA National Agricultural Statistics Service. Information on Conservation Reserve Program (CRP) land was obtained from the USDA Farm Service Agency (2007). Agricultural "regions" were derived using a GIS and a land ownership map layer, downloaded from the Alaska Geospatial Data Clearinghouse, highlighting land sections sold as agricultural.

Figure 1.1 shows the regions of Alaska with agricultural activity. Only regions with oats, barley, forage (hay, grass silage, and greenchop), or land designated as CRP were considered. All CRP land is located in the Delta region, and the majority of other eligible cropland is located in the Fairbanks region and Anchorage region. The GIS map layer was used to derive a centroid for each agricultural area to spatially allocate emissions.

Burning estimates were obtained only for the Fairbanks/Delta region and were resolved by total cropland and CRP land. To estimate burning in the Anchorage and Kenai regions, a ratio was calculated for burned acres to total harvested acres *for all crops* in the Fairbanks/Delta region and found to be 7percent (i.e., 7 percent of all harvested acres are assumed to be burned). Percent burned ratios developed for inventories of agricultural burning for the conterminous United States vary by state and by crop. A review of these burned ratios indicates that the ratio developed for the Alaska agricultural burning inventory is reasonable (examples: barley 2.4% - 10% (ERG, 2002 and Air Sciences, 2007b, respectively); oats approximately 5% (Air Sciences, 2007b)). The ratio of estimated CRP land burned (25%) was higher than reported previously on a country-wide basis (10%) (ERG, 2002).

Figure 1.1. Map highlighting active agricultural regions in Alaska as of 2002.



1.4 Fuel Consumption Assignment

1.4.1 Wildfire, WFU and Prescribed Burning

The methods of assigning fuel consumption for wildfire, prescribed fire, and WFU were identical to those used in the 2005 Alaska fire emissions inventory. The Canadian Forest Fire Danger Rating System (CFFDRS) and National Fire Danger Rating System (NFDRS) provided the basis for all fuel classification, adjusted for seasonal fuel moisture. For detailed information, please refer to the Final 2005 Alaska Fire Emissions Inventory (Air Sciences, 2007a). The basic hierarchy for assigning a fuel class and associated fuel consumption is as follows:

1. Fire Manager-assigned fuel description cross-walked to CFFDRS fuel model.
2. Fuel consumption refinement technique utilizing fire perimeters, GIS spatial layer of Canadian Forest Fire Danger Rating System CFFDRS fuel models, and calculated weighted fuel consumption rate (Air Sciences, 2007a, Section 1.4.1).
3. Single CFFDRS fuel model applied to the entire event derived by fire location and GIS drop onto spatial layer of CFFDRS fuel models
4. Single NFDRS fuel model applied to the entire event derived by fire location and GIS drop onto spatial layer of NFDRS fuel models. This was done for events that returned a "null" or "undefined" value when using the CFFDRS spatial fuel layer.
5. All records with fire perimeter information are adjusted for seasonality based on month and CFFDRS fuel class (Air Sciences, 2007a, Section 1.4.2).

1.4.2 Small Permit and Agricultural fuel consumption

No information was available regarding the typical fuel composition of small, permitted pile or broadcast burns (Section 1.3.2). Based on communication with Alaska DNR in Fairbanks (2007b), many permits for pile burns and lawn burning are for the purpose of clearing land. In this case, larger diameter fuels will likely be removed before burning, leaving smaller woody debris and litter. Given no further information, it is reasonable to estimate piles as composed of light slash and other small permit fires as understory—primarily litter fuels. The CFFDRS fuel model map used in 2005 and 2006 does not include a fuel classification for slash or understory burns. Therefore, WRAP-modified NFDRS fuel loadings (see Air Sciences 2007b) were used for small fires: NFDRS class K, Light Slash, at 13.1 tons/acre was assumed for small permit pile burns; NFDRS class R, Hardwood Litter (Summer), at 3.05 tons/acre was assumed for all other small permit fires. It is recognized there is likely to be some variation in actual fuel loading for individual permitted events, but the chosen fuel loadings are considered to be reasonable (and potentially conservative) estimates based on available information.

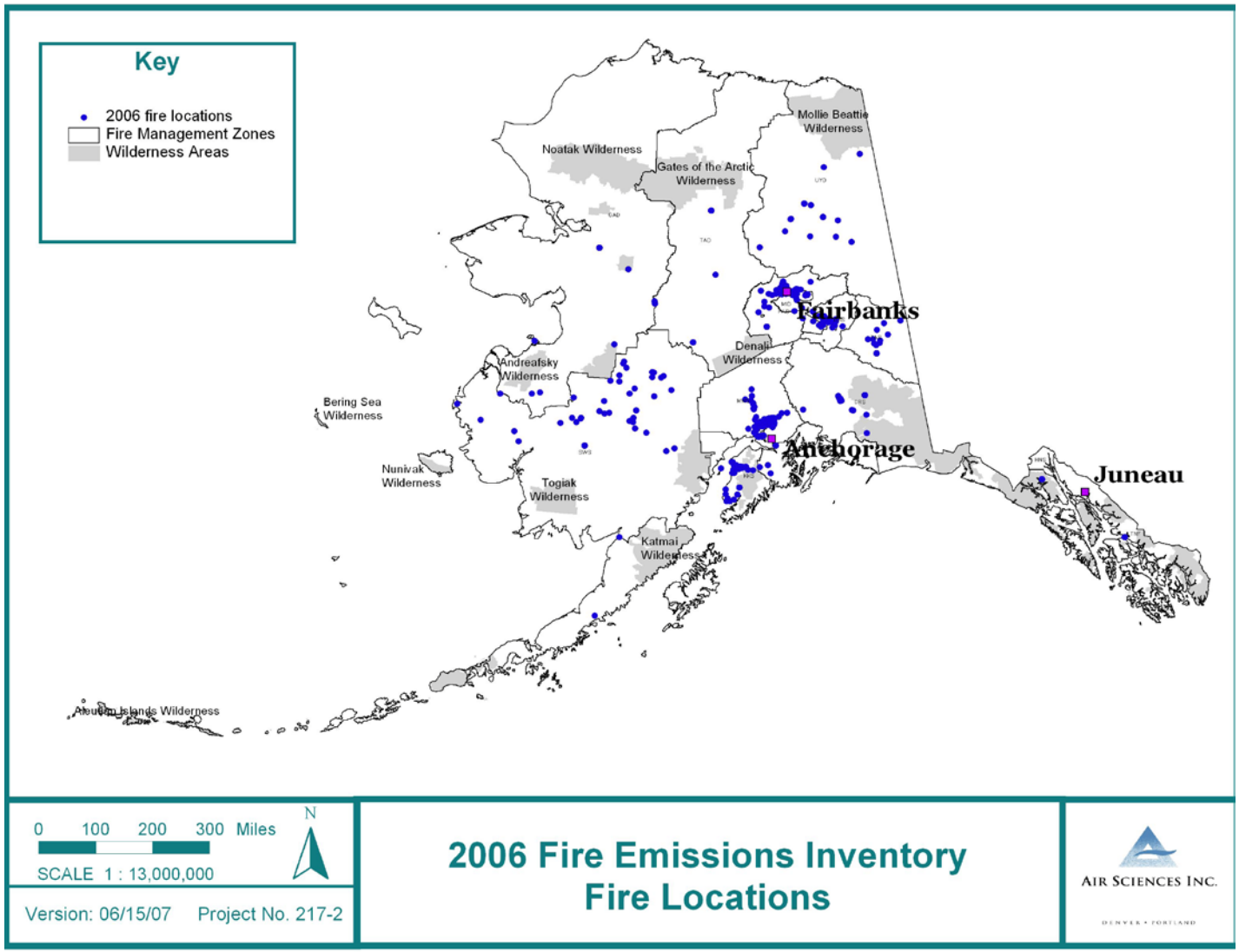
Fuel consumption rates for agricultural burning were uniformly assigned a fuel loading based on the seasonal adjustment outlined in the 2005 report. The Inter-RPO 2002 National Wildfire Emission Inventory (Air Sciences and ECR, 2007) includes seasonal fuel loadings for agricultural burning from 0.01 – 1.5 tons/acre. Previous inventories for the WRAP (Air Sciences, 2005) and the Wyoming DEQ (Air Sciences, 2007b) reported a higher fuel loading for CRP land compared to agricultural land, at 2.0 tons/acre. For the 2006 Alaska fire inventory, CRP burning was assigned a fuel loading of 2.0 tons/acre. All other agricultural fire was assigned a seasonal loading, described below.

1.4.3 Seasonal Fuel Consumption Adjustment

A seasonal adjustment for fuel consumption was applied to most fires in the 2006 emissions inventory following the methods outlined in the 2005 report (Air Sciences, 2007a). (CRP burning was excluded because it all occurred in the same month and has a higher reported fuel loading compared to other agricultural burning.) Incorporating seasonality into fire emission estimates was accomplished by applying one of six fuel moisture regimes (very wet to very dry) for every month of the year. Moisture regime-specific fuel consumption values for each CFFDRS/NFDRS fuel classification were utilized. Fuel consumption for small permit fires and agricultural burning were included along with all other fire events.

Figure 1.2: Fire Locations Extracted From the Source Data

Individual fire locations that fell within the Alaska landmass (blue circles).



1.5 Emission Factors

Similar to the 2005 Alaska fire emissions inventory the emission factors for wildfire, prescribed fire, and agricultural burning were assigned based on the WRAP Phase II 2002 fire emissions inventory (Air Sciences Inc., 2004, 2005) and were consistent with the 2005 Alaska fire emissions inventory (Air Sciences, 2007a). This suite of emission factors (Table 1.2) includes separate emission factors for broadcast burns (wildfire, WFU, and prescribed) and for prescribed pile burns.

Table 1.2: WRAP-Modified Emission Factors

Pollutant	Broadcast Burns (lbs/ton)	Piled Burns (lbs/ton)
$PM_{2.5}$	24.1	8.0
PM_{10}	28.1	8.0
SO_2	1.7	1.7
NO_X	6.2	6.2
VOC	13.6	6.3
CO	289	74.3
PM	34.1	12
EC	1.5	0.6
OC	11.6	4.3
CH_4	13.6	7.7
NH_3	1.3	0.5
PM-Coarse	4.0	0

1.6 Conversion from Fire Events to Daily Fire Records

The raw input data reports fire events in terms of start date (typically date of discovery) and end date (typically date controlled). These multi-day fires are referred to as "events" and are represented as a single record in the Events emissions inventory. For the Daily emissions inventory, it is necessary to disaggregate multi-day events into a sequence of fire days (acres burned per day over the duration of the event). Each row in the daily activity data file represents a "fire day." Only multi-day fire events greater than 100 acres in fire event size were distributed to the daily temporal scale. Fires less than or equal to 100 acres (including small permit burns and some agricultural burning) were assigned in their entirety to the activity record's start date. For the Daily emissions inventory, fire acreage and emissions for the multi-day fires events in the refined 2006 emissions inventory were, with the exception of the Parks Highway fire, evenly distributed between the start and end date of the fire. Growth in acreage for the Parks Highway fire (the largest fire in 2006) was reported in the ICS-209 database (NWCG, 2007) from 6/7/2006

to 6/30/2006 on a daily or semi-daily basis. These values were entered directly into the Daily emissions inventory. For the remainder of fire days for Parks Highway (after 6/30/2006), daily acres were evenly distributed.

Information provided by Alaska DNR (2007b) indicated that small permitted fires are approved, or activated, throughout the summer based on meteorological and visibility condition criteria similar to those used for the prescribed burning review and approval process. However, the dates on which small permitted fires occur are not recorded. For the 2006 fire inventory, small permit fires (piled and broadcast) were distributed evenly from May to September. This monthly distribution is reasonable based on the seasonal moisture profile used for assigning fuel consumption for fire events. That is, May to September represents the period of the year with the driest conditions, assumed to be more conducive to burning.

Agricultural burning data reported in previous inventories (Air Sciences, 2005, 2007b) indicates that the majority of cropland is burned in the spring and fall. The spring burning season for prescribed fire in Alaska is relatively short (from May 1 though June 15) due to Alaska's unique climate. For this inventory, half of cropland burning was allocated to the month of May and half to September. Burn events reported as >100 acres were evenly distributed to each day of the month. Fires < 100 acres were assumed to occur on the first of the month.

CRP land was allocated separately from cropland burning. Documentation on the Farm Service Agency website (2007) indicates that CRP land is traditionally burned in the fall. Therefore, all CRP burning was allocated to the month of September. CRP burning was defined in the 2006 inventory with a single event location since all CRP acres are located in the Delta Region. This results in 7000 acres distributed evenly throughout the month of September.

It is important to remember that emission estimates for cropland burning and CRP burning are developed for emission summaries. These are nominal emissions estimates and it may not be appropriate to use these data in dispersion models that attempt to reconcile modeled impacts due to fire emissions with actual monitoring data.

1.7 Additional Smoldering Emissions for Wildland Fire

Smoldering emissions were added to wildfire, WFU and prescribed fire (broadcast only) events. Prescribed pile burns were assumed not to smolder, consistent with the WRAP Phase II 2002 fire emissions inventory (Air Sciences Inc., 2004, 2005). For fires with fuel consumption greater than 5 tons per acre, smoke emissions from smoldering consumption were calculated. Smoldering emissions were calculated based on one of two methods:

- In the case the fuel consumption of a fire event was based on the weighted fuel loading from the CFFDRS map (Section 1.4.1), the fuel consumption in the smoldering phase, and thereby the emissions, was set to 17 percent of the emissions calculated for the flaming

phase for wildfire and WFU and 8.5 percent of the calculated emissions for the flaming phase of prescribed fire events. This method is consistent with the WRAP Phase II 2002 fire emissions inventory (Air Sciences Inc., 2004, 2005).

- Seasonal smoldering fuel loadings were derived in the Inter-RPO 2002 National Wildfire Emission Inventory as unique values for each NFDRS class and moisture regime. For the remaining fire events that were assigned a fuel loading based on a single CFFDRS/ NFDRS fuel classification, the fuel consumption in the smoldering phase was assigned a seasonal smoldering fuel loading following the method outlined in Section 1.4.3. This approach is consistent with the methodology in the Alaska 2005 fire emissions inventory (Air Sciences, 2007a).

In the Daily emissions inventory, to account for smoldering, for every wildfire and prescribed burn activity record tied to a specific date, a new activity record was inserted into the database on the subsequent day. The resulting database has an additional data field, *Smolrec*, enabling the user of the database to distinguish between emissions from each fire phase.

1.8 Quality Assurance and Quality Control

A critical task in the development of the fire emissions inventory was to implement quality assurance and control measures to (1) check the quality of raw input data and (2) to review the processes used to develop the fire activity database and emissions inventory for potential errors. The general quality assurance and control methods were consistent with those applied in the 2005 Alaska fire emissions inventory, and are described in detail in 2005 report (Air Sciences, 2007a). One of the steps was to compare the compiled source database with the summary reports received from other agencies. The compiled source database consisted of a complete fire activity data set, utilizing the AICC (2007a) as a basis, augmented with refinements from the additional databases (Section 1.2). A comparison of the final fire activity data with the reference reports is shown in table 1.3. The comparison indicates very good agreement between the 2006 Alaska fire inventory activity rates and other available data sets. The quality assurance and control steps developed for the Alaska 2005 fire emissions inventory (Air Sciences, 2007a) were implemented and data were corrected as appropriate. The 2006 Alaska fire emissions inventory can be considered to be a complete and accurate inventory of fire activity and the emissions estimates, based on sound fire science, have been executed accurately.

Table 1.3: Comparison of 2006 Fire Acres with Reference Materials

Note that the comparisons are limited to wildfire, WFU and prescribed on federal and state lands. Agricultural burning and small permitted burns are not included, since no reference materials exist for these sources.

Data Source	Wildfire	WFU	Wildfire + WFU	Prescribed Fire
2006 Emission Inventory	258,529	1,613	260,142	11,915
NIFC National Summary (NIFC, 2007a and 2007b)	266,266	317	266,583	12,039
Deviation from NIFC (Acres)	- 7,737	+ 1,296	- 6,441	- 124
AICC source data (AICC, 2007a)	264,951	Not included	264,951	12,015
Deviation from AICC (Acres)	- 6,422 (1)	---	- 4,809	- 100
AGDC fire perimeters (AGDC, 2007)	257,372	1,613	258,985	9510 (2)
Deviation from AGDC (Acres)	1,157	0	1,157	2,405

[1] The difference with the AICC data is accounted for by:

Data entry error in the AICC database: - 10,000 acres (Pers. Comm. AK BLM, May 2007)

Processing acreage refinements (net): + 3578 acres

Net difference: - 6,422 acres

[2] The AGDC fire perimeters did not include all prescribed fire events.

SECTION 2

ALASKA 2006 FIRE EMISSIONS INVENTORY RESULTS

Several charts (with associated data tables), maps, and tables are presented in this section to display the results of the 2006 Fire Emissions Inventory for Alaska. Quantitative results (e.g., tons of $PM_{2.5}$ due to wildfire events in 2006) are presented as displays of the spatial and temporal distribution of fire events in 2006. Spatial data are displayed by county and by Fire Management Zone (FMZ). FMZ boundaries are established by the State of Alaska and are included for the benefit of Alaska Fire Managers.

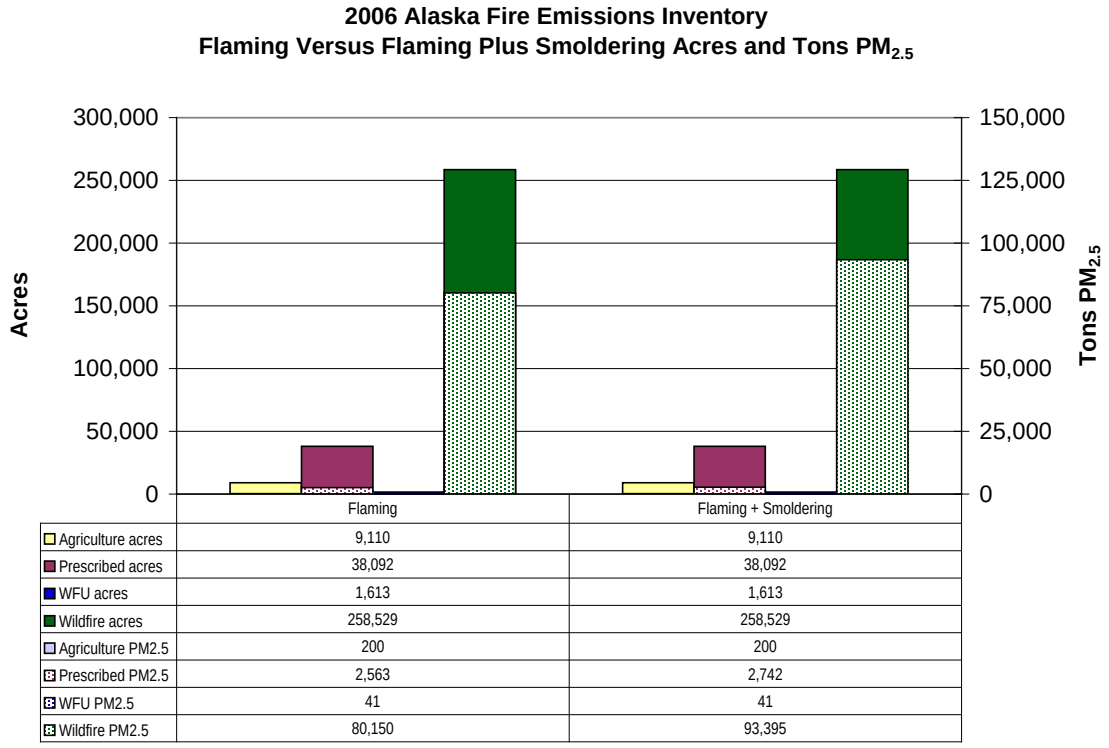
Table 2.1: Results Summary

Data Source	Wildfire	WFU	Agricultural burning	Prescribed Fire [1]	Total
Number of Fire Events	291	1	7	137	436
Fire Acres	258,529	1,613	9,110	38,092	307,343
Emissions (Tons) [2]					
$PM_{2.5}$	93,409	40	200	2,742	96,391
PM_{10}	108,912	47	233	3,115	112,308
Elemental Carbon (EC)	5,814	3	12	177	6,006
Organic Carbon (OC)	44,960	19	96	1,347	46,423
SO_2	6,589	3	14	263	6,869
NO_x	24,030	10	51	960	25,053
VOC	52,712	23	113	1,657	54,505
CO	1,120,128	485	2,399	31,547	1,154,559
CH_4	52,712	23	113	1,743	54,591
NH_3	5,039	2	11	152	5,204

[1] Includes the events in small permitted burns, administered by the Alaska DNR.

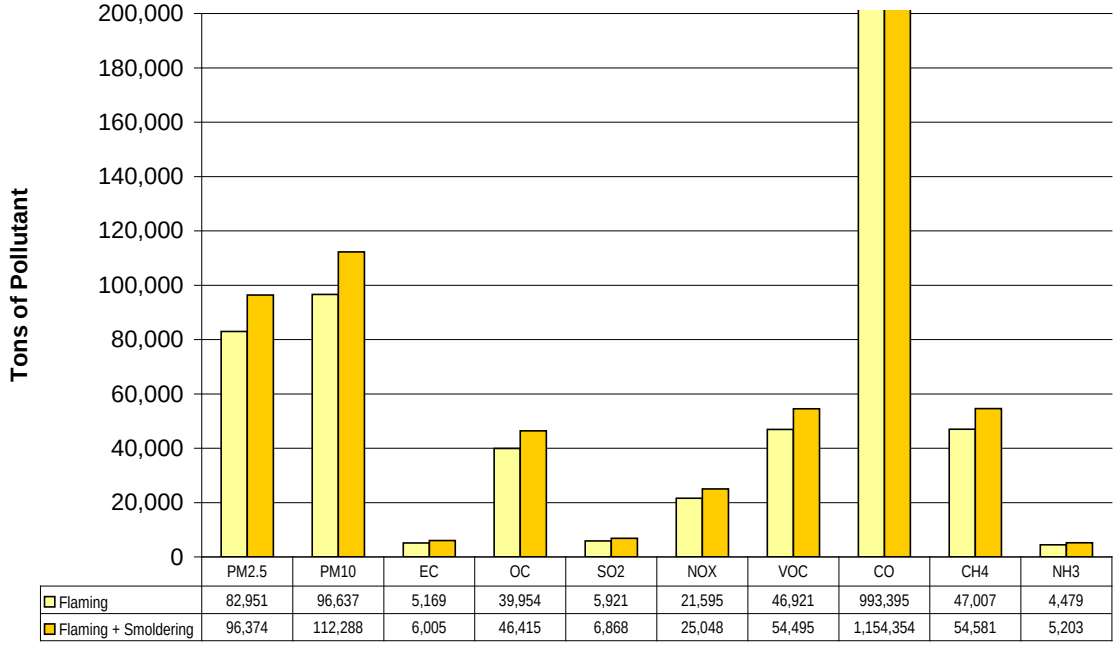
[2] Emission totals include both the estimated flaming and smoldering emissions

Figure 2.1: Summary of Fire Acres and $PM_{2.5}$ Emissions by Fire Type



	Flaming	Flaming + Smoldering
Agriculture acres	9,110	9,110
Prescribed acres	38,092	38,092
WFU acres	1,613	1,613
Wildfire acres	258,529	258,529
Agriculture PM2.5	200	200
Prescribed PM2.5	2,563	2,742
WFU PM2.5	41	41
Wildfire PM2.5	80,150	93,395

Figure 2.2: Summary of Total Emissions by Pollutant



	PM2.5	PM10	EC	OC	SO2	NOX	VOC	CO	CH4	NH3
Flaming	82,951	96,637	5,169	39,954	5,921	21,595	46,921	993,395	47,007	4,479
Flaming + Smoldering	96,374	112,288	6,005	46,415	6,868	25,048	54,495	1,154,354	54,581	5,203

Table 2.2: Acres Burned (and Number of Fire Days) by County and Month

Acres Burned in and Number of Wild, Prescribed and WFU Fires by Fire Type and County

Acres Burned
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 100,000
100,000 +

Acres (Number of Events)

		Month								
Fire Type	County	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total Acres Burned (Number of Events)
Wildfire	Yukon-Koyukuk	0 (0)	4 (6)	125,460 (11)	27,836 (28)	11,965 (6)	8,106 (3)	0 (0)	0 (0)	173,371 (40)
	Wade Hampton	0 (0)	3,158 (2)	46,471 (1)	7,995 (3)	240 (2)	0 (0)	0 (0)	0 (0)	57,863 (5)
	Southeast Fairbanks	93 (6)	1,520 (13)	3,206 (11)	4,230 (6)	4,289 (5)	3,424 (9)	2,556 (4)	0 (1)	19,317 (40)
	Bethel	0 (0)	17 (2)	0 (0)	5,157 (16)	996 (1)	868 (1)	0 (0)	0 (0)	7,038 (18)
	Matanuska-Susitna	1 (6)	186 (48)	351 (12)	1 (8)	0 (2)	0 (3)	0 (0)	0 (0)	540 (77)
	Denali	0 (0)	0 (0)	0 (0)	110 (1)	32 (1)	0 (0)	0 (0)	0 (0)	142 (1)
	Kenai Peninsula	0 (0)	81 (18)	1 (7)	2 (5)	0 (2)	0 (1)	0 (0)	0 (0)	85 (33)
	Anchorage	0 (0)	84 (7)	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	84 (8)
	Fairbanks North Star	0 (1)	10 (21)	15 (23)	44 (7)	0 (1)	3 (5)	2 (3)	0 (0)	73 (57)
	Valdez-Cordova	0 (0)	1 (4)	1 (2)	10 (3)	0 (1)	0 (0)	0 (0)	0 (0)	12 (10)
	Nome	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)
	Bristol Bay	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Wildfire Total		94 (13)	5,061(121)	175,507 (68)	45,386 (79)	17,522 (21)	12,401 (22)	2,558 (7)	0 (1)	258,529(291)
Agriculture	Southeast Fairbanks	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7,000 (1)	0 (1)	0 (0)	7,000 (1)
	Fairbanks North Star	0 (0)	500 (2)	0 (1)	0 (0)	0 (0)	500 (2)	0 (1)	0 (0)	1,000 (4)
	Matanuska-Susitna	0 (0)	381 (2)	0 (1)	0 (0)	0 (0)	381 (2)	0 (1)	0 (0)	761 (4)
	Kenai Peninsula	0 (0)	174 (2)	0 (1)	0 (0)	0 (0)	174 (2)	0 (1)	0 (0)	349 (4)
Agriculture Total		0 (0)	1,055 (6)	0 (3)	0 (0)	0 (0)	8,055 (7)	0 (4)	0 (0)	9,110 (13)
Prescribed	Yukon-Koyukuk	0 (0)	3,720 (12)	11,886 (15)	3,010 (14)	3,010 (14)	3,010 (14)	0 (4)	0 (0)	24,635 (52)
	Matanuska-Susitna	0 (0)	654 (3)	654 (4)	654 (4)	654 (4)	654 (4)	0 (1)	0 (0)	3,272 (15)
	Kenai Peninsula	0 (0)	567 (6)	567 (8)	567 (8)	567 (8)	567 (8)	0 (2)	0 (0)	2,836 (30)
	Fairbanks North Star	0 (0)	2,293 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2,293 (4)
	Northwest Arctic	0 (0)	196 (3)	196 (4)	196 (4)	196 (4)	196 (4)	0 (1)	0 (0)	982 (15)
	Haines	0 (0)	196 (3)	196 (4)	196 (4)	196 (4)	196 (4)	0 (1)	0 (0)	982 (15)
	Wrangell-Petersburg	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Bethel	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Valdez-Cordova	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Southeast Fairbanks	0 (0)	88 (4)	88 (4)	88 (4)	88 (4)	88 (4)	0 (0)	0 (0)	438 (20)
	Anchorage	0 (0)	36 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	36 (1)
Prescribed Total		0 (0)	8,274 (45)	14,111 (51)	5,235 (50)	5,235 (50)	5,235 (50)	0 (12)	0 (0)	38,092(197)
WFU	Yukon-Koyukuk	0 (0)	0 (0)	1,613 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1,613 (1)
WFU Total		0 (0)	0 (0)	1,613 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1,613 (1)
Grand Total		94 (13)	14,390(172)	191,232(123)	50,621(129)	22,757 (71)	25,691 (79)	2,558 (23)	0 (1)	307,343(502)

Notes: Precision of reported values are potentially affected by rounding.
Monthly Number of Events will not sum to Total Annual Number of Events if there are fires that span multiple months.
Counties and months with no fire events do not appear in table.

Table 2.3: $PM_{2.5}$ Emissions (and Number of Fire Days) by County and Month

PM2.5 Emissions from and Number of Wild, Prescribed and WFU Fires by Fire Type and County

PM2.5 Emissions (tons)
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 100,000
100,000 +

PM2.5 Emissions in Tons (Number of Events)

		Month								
Fire Type	County	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total Tons PM2.5 (Number of Events)
Wildfire	Yukon-Koyukuk	0 (0)	3 (6)	59,971 (11)	11,762 (28)	6,298 (6)	4,426 (3)	0 (0)	0 (0)	82,460 (40)
	Southeast Fairbanks	1 (6)	381 (13)	1,060 (11)	1,729 (6)	1,821 (5)	1,263 (9)	616 (4)	3 (1)	6,872 (40)
	Wade Hampton	0 (0)	161 (2)	1,764 (1)	333 (3)	38 (2)	0 (0)	0 (0)	0 (0)	2,296 (5)
	Bethel	0 (0)	3 (2)	0 (0)	758 (16)	413 (1)	362 (1)	0 (0)	0 (0)	1,536 (18)
	Matanuska-Susitna	0 (6)	30 (48)	68 (12)	0 (8)	0 (2)	0 (3)	0 (0)	0 (0)	99 (77)
	Denali	0 (0)	0 (0)	0 (0)	57 (1)	17 (1)	0 (0)	0 (0)	0 (0)	73 (1)
	Fairbanks North Star	0 (1)	3 (21)	7 (23)	35 (7)	0 (1)	1 (5)	0 (3)	0 (0)	46 (57)
	Kenai Peninsula	0 (0)	7 (18)	0 (7)	0 (5)	0 (2)	0 (1)	0 (0)	0 (0)	8 (33)
	Valdez-Cordova	0 (0)	0 (4)	0 (2)	0 (3)	0 (1)	0 (0)	0 (0)	0 (0)	1 (10)
	Nome	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)
	Bristol Bay	0 (0)	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)
	Anchorage	0 (0)	0 (7)	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (8)
Wildfire Total		1 (13)	588(121)	62,871 (68)	14,676 (79)	8,587 (21)	6,051 (22)	616 (7)	3 (1)	93,392(291)
Agriculture	Southeast Fairbanks	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	169 (1)	0 (1)	0 (0)	169 (1)
	Fairbanks North Star	0 (0)	8 (2)	0 (1)	0 (0)	0 (0)	8 (2)	0 (1)	0 (0)	16 (4)
	Matanuska-Susitna	0 (0)	4 (2)	0 (1)	0 (0)	0 (0)	6 (2)	0 (1)	0 (0)	10 (4)
	Kenai Peninsula	0 (0)	2 (2)	0 (1)	0 (0)	0 (0)	3 (2)	0 (1)	0 (0)	5 (4)
Agriculture Total		0 (0)	14 (6)	0 (3)	0 (0)	0 (0)	186 (7)	0 (4)	0 (0)	200 (13)
WFU	Yukon-Koyukuk	0 (0)	0 (0)	40 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (1)
WFU Total		0 (0)	0 (0)	40 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (1)
Prescribed	Yukon-Koyukuk	0 (0)	191 (12)	2,071 (15)	63 (14)	63 (14)	53 (14)	0 (4)	0 (0)	2,440 (52)
	Fairbanks North Star	0 (0)	96 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	96 (4)
	Matanuska-Susitna	0 (0)	9 (3)	12 (4)	14 (4)	14 (4)	12 (4)	0 (1)	0 (0)	59 (15)
	Kenai Peninsula	0 (0)	7 (6)	10 (8)	12 (8)	12 (8)	10 (8)	0 (2)	0 (0)	51 (30)
	Northwest Arctic	0 (0)	3 (3)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	19 (15)
	Haines	0 (0)	3 (3)	3 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	18 (15)
	Valdez-Cordova	0 (0)	3 (3)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	17 (15)
	Bethel	0 (0)	3 (3)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	17 (15)
	Wrangell-Petersburg	0 (0)	2 (3)	3 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	16 (15)
	Southeast Fairbanks	0 (0)	2 (4)	2 (4)	2 (4)	2 (4)	2 (4)	0 (0)	0 (0)	9 (20)
	Anchorage	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)
Prescribed Total		0 (0)	319 (45)	2,113 (51)	109 (50)	109 (50)	92 (50)	0 (12)	0 (0)	2,742(197)
Grand Total		1 (13)	921(172)	65,024(123)	14,785(129)	8,696 (71)	6,329 (79)	616 (23)	3 (1)	96,374(502)

Notes: Precision of reported values are potentially affected by rounding.
Monthly Number of Events will not sum to Total Annual Number of Events if there are fires that span multiple months.
Counties and months with no fire events do not appear in table.

Table 2.4: Acres Burned (and Number of Fire Days) by Fire Management Zone and Month.

Acres Burned in and Number of Wild, Prescribed and WFU Fires by Fire Type and Region

Acres Burned
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 100,000
100,000 +

Acres (Number of Events)

		Month								
Fire Type	region	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total Acres Burned (Number of Events)
Wildfire	Fairbanks (DOF)	0 (1)	1,487 (21)	117,991 (26)	8,636 (10)	8,500 (4)	5,334 (4)	2,557 (4)	0 (1)	144,504 (57)
	Galena (AFS)	0 (0)	3,099 (3)	46,473 (2)	8,102 (3)	338 (2)	0 (0)	0 (0)	0 (0)	58,012 (6)
	Upper Yukon (AFS)	0 (0)	0 (1)	9,742 (7)	20,476 (7)	5,696 (2)	5,144 (1)	0 (0)	0 (0)	41,057 (12)
	Southwest (DOF)	0 (0)	78 (5)	0 (0)	6,079 (32)	1,113 (3)	970 (2)	0 (0)	0 (0)	8,239 (38)
	Tok (DOF)	0 (0)	0 (2)	472 (2)	1,674 (4)	1,733 (3)	951 (5)	0 (2)	0 (0)	4,831 (11)
	Tanana (AFS)	0 (0)	3 (1)	211 (1)	363 (3)	140 (1)	0 (0)	0 (0)	0 (0)	716 (4)
	Matanuska-Susitna (DOF)	1 (6)	186 (48)	351 (12)	1 (8)	0 (2)	0 (2)	0 (0)	0 (0)	540 (76)
	Delta (DOF)	2 (3)	36 (7)	262 (6)	0 (0)	0 (1)	0 (1)	0 (1)	0 (0)	300 (18)
	Military (AFS)	90 (3)	91 (11)	5 (3)	43 (4)	0 (0)	2 (5)	0 (0)	0 (0)	233 (25)
	Kenai-Kodiak (DOF)	0 (0)	81 (17)	1 (7)	2 (4)	0 (1)	0 (1)	0 (0)	0 (0)	84 (30)
	Copper River (DOF)	0 (0)	1 (4)	1 (2)	10 (3)	0 (1)	0 (1)	0 (0)	0 (0)	12 (11)
	Chugach National Forest (USFS)	0 (0)	0 (1)	0 (0)	0 (1)	0 (1)	0 (0)	0 (0)	0 (0)	0 (3)
Wildfire Total		94 (13)	5,061(121)	175,507 (68)	45,386 (79)	17,522 (21)	12,401 (22)	2,558 (7)	0 (1)	258,529(291)
Agriculture	Delta (DOF)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7,000 (1)	0 (1)	0 (0)	7,000 (1)
	Fairbanks (DOF)	0 (0)	500 (2)	0 (1)	0 (0)	0 (0)	500 (2)	0 (1)	0 (0)	1,000 (4)
	Matanuska-Susitna (DOF)	0 (0)	381 (2)	0 (1)	0 (0)	0 (0)	381 (2)	0 (1)	0 (0)	761 (4)
	Kenai-Kodiak (DOF)	0 (0)	174 (2)	0 (1)	0 (0)	0 (0)	174 (2)	0 (1)	0 (0)	349 (4)
Agriculture Total		0 (0)	1,055 (6)	0 (3)	0 (0)	0 (0)	8,055 (7)	0 (4)	0 (0)	9,110 (13)
Prescribed	Fairbanks (DOF)	0 (0)	2,747 (5)	2,617 (6)	2,617 (6)	2,617 (6)	2,617 (6)	0 (2)	0 (0)	13,215 (21)
	Galena (AFS)	0 (0)	830 (4)	9,072 (5)	196 (4)	196 (4)	196 (4)	0 (1)	0 (0)	10,492 (16)
	Matanuska-Susitna (DOF)	0 (0)	654 (3)	654 (4)	654 (4)	654 (4)	654 (4)	0 (1)	0 (0)	3,272 (15)
	Military (AFS)	0 (0)	2,199 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2,199 (4)
	Kenai-Kodiak (DOF)	0 (0)	393 (3)	393 (4)	393 (4)	393 (4)	393 (4)	0 (1)	0 (0)	1,963 (15)
	Upper Yukon (AFS)	0 (0)	272 (4)	196 (4)	196 (4)	196 (4)	196 (4)	0 (1)	0 (0)	1,058 (16)
	Haines (DOF)	0 (0)	196 (3)	196 (4)	196 (4)	196 (4)	196 (4)	0 (1)	0 (0)	982 (15)
	Tanana (AFS)	0 (0)	196 (3)	196 (4)	196 (4)	196 (4)	196 (4)	0 (1)	0 (0)	982 (15)
	Copper River (DOF)	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Chugach National Forest (USFS)	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Southwest (DOF)	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Tongass National Forest (USFS)	0 (0)	175 (3)	175 (4)	175 (4)	175 (4)	175 (4)	0 (1)	0 (0)	873 (15)
	Delta (DOF)	0 (0)	44 (2)	44 (2)	44 (2)	44 (2)	44 (2)	0 (0)	0 (0)	219 (10)
	Tok (DOF)	0 (0)	44 (2)	44 (2)	44 (2)	44 (2)	44 (2)	0 (0)	0 (0)	219 (10)
Prescribed Total		0 (0)	8,274 (45)	14,111 (51)	5,235 (50)	5,235 (50)	5,235 (50)	0 (12)	0 (0)	38,092(197)
WFU	Fairbanks (DOF)	0 (0)	0 (0)	1,613 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1,613 (1)
WFU Total		0 (0)	0 (0)	1,613 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1,613 (1)
Grand Total		94 (13)	14,390(172)	191,232(123)	50,621(129)	22,757 (71)	25,691 (79)	2,558 (23)	0 (1)	307,343(502)

Notes: Precision of reported values are potentially affected by rounding.
Monthly Number of Events will not sum to Total Annual Number of Events if there are fires that span multiple months.
Regions and months with no fire events do not appear in table.

Table 2.5: $PM_{2.5}$ Emissions (and Number of Fire Days) by Fire Management Zone and Month.

PM2.5 Emissions from and Number of Wild, Prescribed and WFU Fires by Fire Type and Region

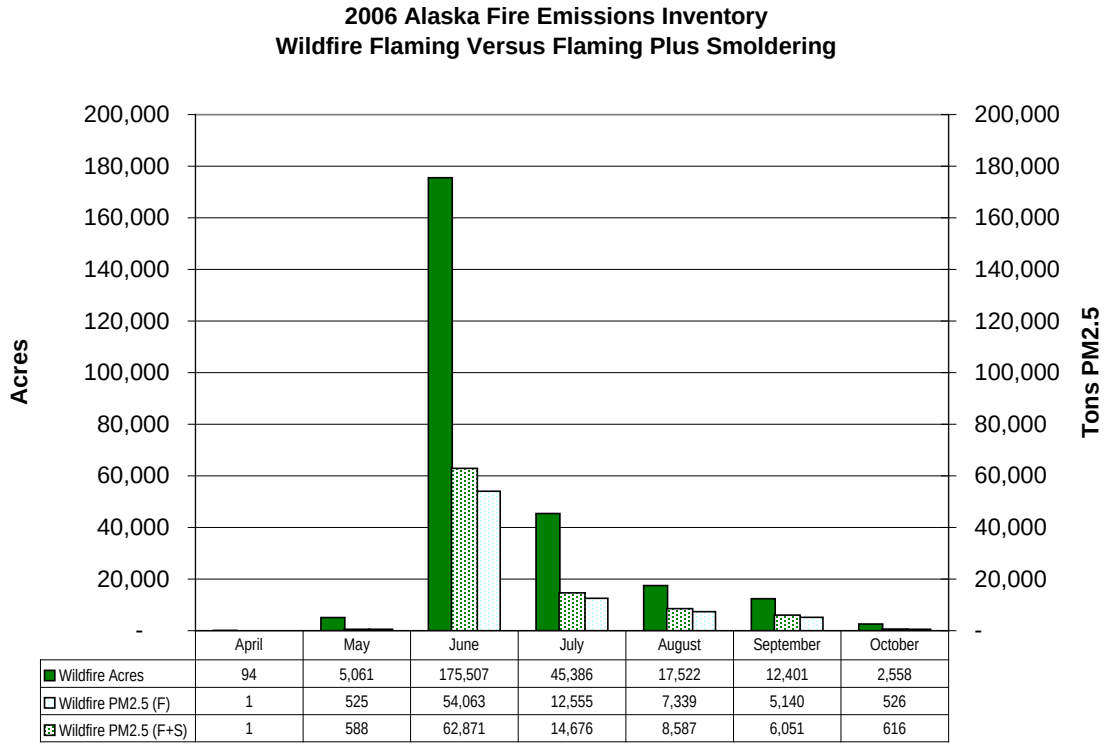
PM2.5 Emissions (tons)
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 100,000
100,000 +

PM2.5 Emissions in Tons (Number of Events)

		Month								
Fire Type	region	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total Tons PM2.5 (Number of Events)
Wildfire	Fairbanks (DOF)	0 (1)	356 (21)	56,844 (26)	3,593 (10)	3,514 (4)	2,003 (4)	616 (4)	3 (1)	66,929 (57)
	Upper Yukon (AFS)	0 (0)	0 (1)	3,724 (7)	8,670 (7)	3,282 (2)	2,979 (1)	0 (0)	0 (0)	18,655 (12)
	Tok (DOF)	0 (0)	0 (2)	312 (2)	1,114 (4)	1,205 (3)	667 (5)	0 (2)	0 (0)	3,297 (11)
	Galena (AFS)	0 (0)	118 (3)	1,764 (2)	379 (3)	81 (2)	0 (0)	0 (0)	0 (0)	2,341 (6)
	Southwest (DOF)	0 (0)	47 (5)	0 (0)	819 (32)	458 (3)	401 (2)	0 (0)	0 (0)	1,725 (38)
	Delta (DOF)	1 (3)	26 (7)	152 (6)	0 (0)	0 (1)	0 (1)	0 (1)	0 (0)	179 (18)
	Tanana (AFS)	0 (0)	2 (1)	6 (1)	66 (3)	47 (1)	0 (0)	0 (0)	0 (0)	122 (4)
	Matanuska-Susitna (DOF)	0 (6)	30 (48)	68 (12)	0 (8)	0 (2)	0 (2)	0 (0)	0 (0)	99 (76)
	Military (AFS)	0 (3)	1 (11)	0 (3)	35 (4)	0 (0)	1 (5)	0 (0)	0 (0)	37 (25)
	Kenai-Kodiak (DOF)	0 (0)	7 (17)	0 (7)	0 (4)	0 (1)	0 (1)	0 (0)	0 (0)	7 (30)
	Copper River (DOF)	0 (0)	0 (4)	0 (2)	0 (3)	0 (1)	0 (1)	0 (0)	0 (0)	1 (11)
	Chugach National Forest (USFS)	0 (0)	0 (1)	0 (0)	0 (1)	0 (1)	0 (0)	0 (0)	0 (0)	0 (3)
Wildfire Total		1 (13)	588(121)	62,871 (68)	14,676 (79)	8,587 (21)	6,051 (22)	616 (7)	3 (1)	93,392(291)
Agriculture	Delta (DOF)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	169 (1)	0 (1)	0 (0)	169 (1)
	Fairbanks (DOF)	0 (0)	8 (2)	0 (1)	0 (0)	0 (0)	8 (2)	0 (1)	0 (0)	16 (4)
	Matanuska-Susitna (DOF)	0 (0)	4 (2)	0 (1)	0 (0)	0 (0)	6 (2)	0 (1)	0 (0)	10 (4)
	Kenai-Kodiak (DOF)	0 (0)	2 (2)	0 (1)	0 (0)	0 (0)	3 (2)	0 (1)	0 (0)	5 (4)
Agriculture Total		0 (0)	14 (6)	0 (3)	0 (0)	0 (0)	186 (7)	0 (4)	0 (0)	200 (13)
WFU	Fairbanks (DOF)	0 (0)	0 (0)	40 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (1)
WFU Total		0 (0)	0 (0)	40 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (1)
Prescribed	Galena (AFS)	0 (0)	141 (4)	2,013 (5)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	2,165 (16)
	Fairbanks (DOF)	0 (0)	140 (5)	54 (6)	54 (6)	54 (6)	46 (6)	0 (2)	0 (0)	350 (21)
	Matanuska-Susitna (DOF)	0 (0)	9 (3)	12 (4)	14 (4)	14 (4)	12 (4)	0 (1)	0 (0)	59 (15)
	Kenai-Kodiak (DOF)	0 (0)	5 (3)	7 (4)	8 (4)	8 (4)	7 (4)	0 (1)	0 (0)	35 (15)
	Upper Yukon (AFS)	0 (0)	3 (4)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	19 (16)
	Tanana (AFS)	0 (0)	3 (3)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	19 (15)
	Haines (DOF)	0 (0)	3 (3)	3 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	18 (15)
	Copper River (DOF)	0 (0)	3 (3)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	17 (15)
	Southwest (DOF)	0 (0)	3 (3)	4 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	17 (15)
	Chugach National Forest (USFS)	0 (0)	2 (3)	3 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	16 (15)
	Tongass National Forest (USFS)	0 (0)	2 (3)	3 (4)	4 (4)	4 (4)	3 (4)	0 (1)	0 (0)	16 (15)
	Delta (DOF)	0 (0)	1 (2)	1 (2)	1 (2)	1 (2)	1 (2)	0 (0)	0 (0)	4 (10)
	Tok (DOF)	0 (0)	1 (2)	1 (2)	1 (2)	1 (2)	1 (2)	0 (0)	0 (0)	4 (10)
	Military (AFS)	0 (0)	2 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (4)
Prescribed Total		0 (0)	319 (45)	2,113 (51)	109 (50)	109 (50)	92 (50)	0 (12)	0 (0)	2,742(197)
Grand Total		1 (13)	921(172)	65,024(123)	14,785(129)	8,696 (71)	6,329 (79)	616 (23)	3 (1)	96,374(502)

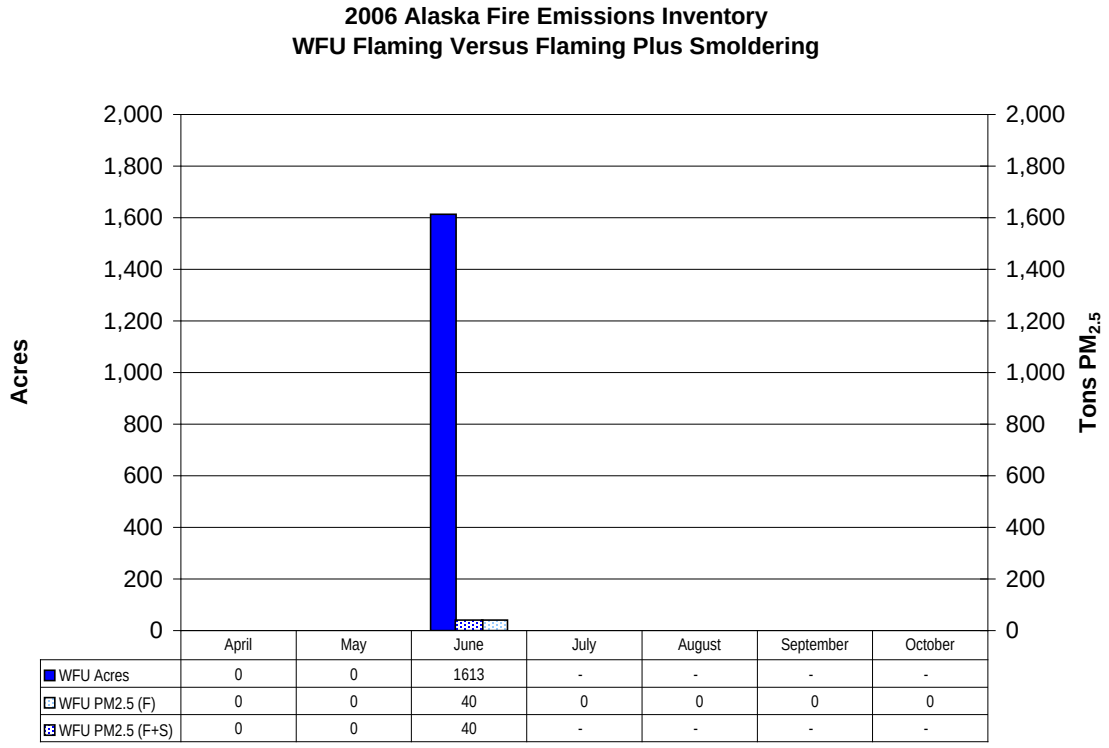
Notes: Precision of reported values are potentially affected by rounding.
Monthly Number of Events will not sum to Total Annual Number of Events if there are fires that span multiple months.
Regions and months with no fire events do not appear in table.

Figure 2.3: Fire Acres and $PM_{2.5}$ Emissions by Month - Wildfire



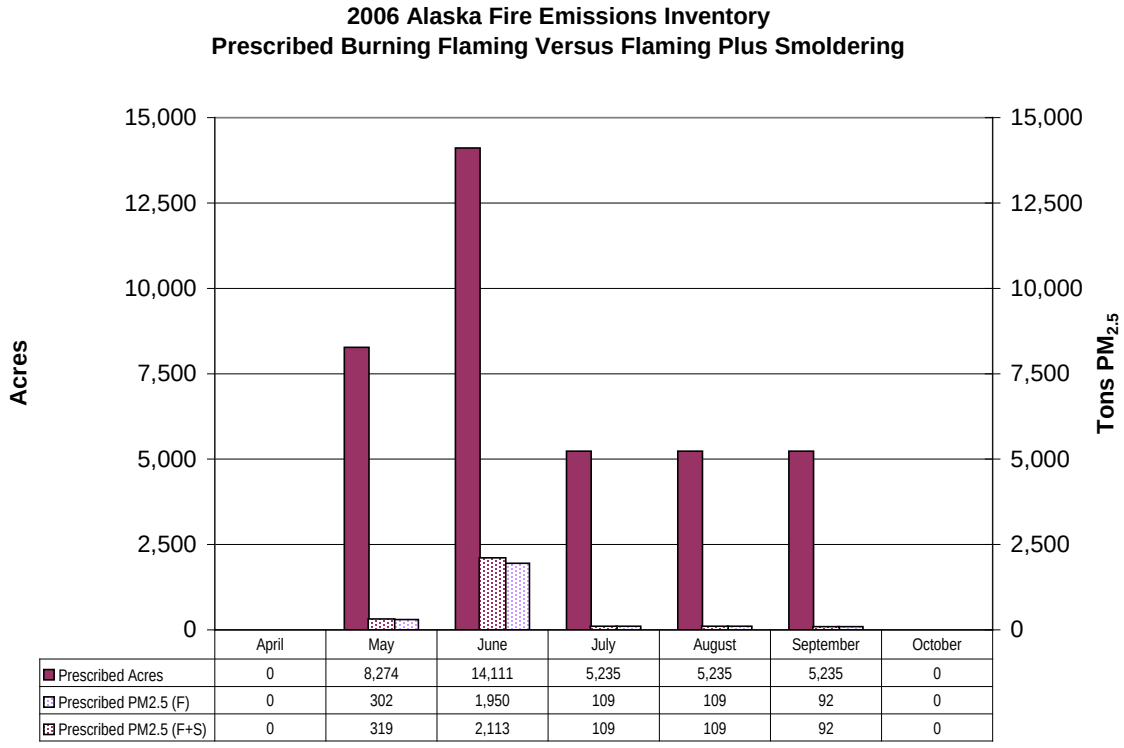
	April	May	June	July	August	September	October
Wildfire Acres	94	5,061	175,507	45,386	17,522	12,401	2,558
Wildfire PM2.5 (F)	1	525	54,063	12,555	7,339	5,140	526
Wildfire PM2.5 (F+S)	1	588	62,871	14,676	8,587	6,051	616

Figure 2.4: Fire Acres and $PM_{2.5}$ Emissions by Month - Wildland Fire Use



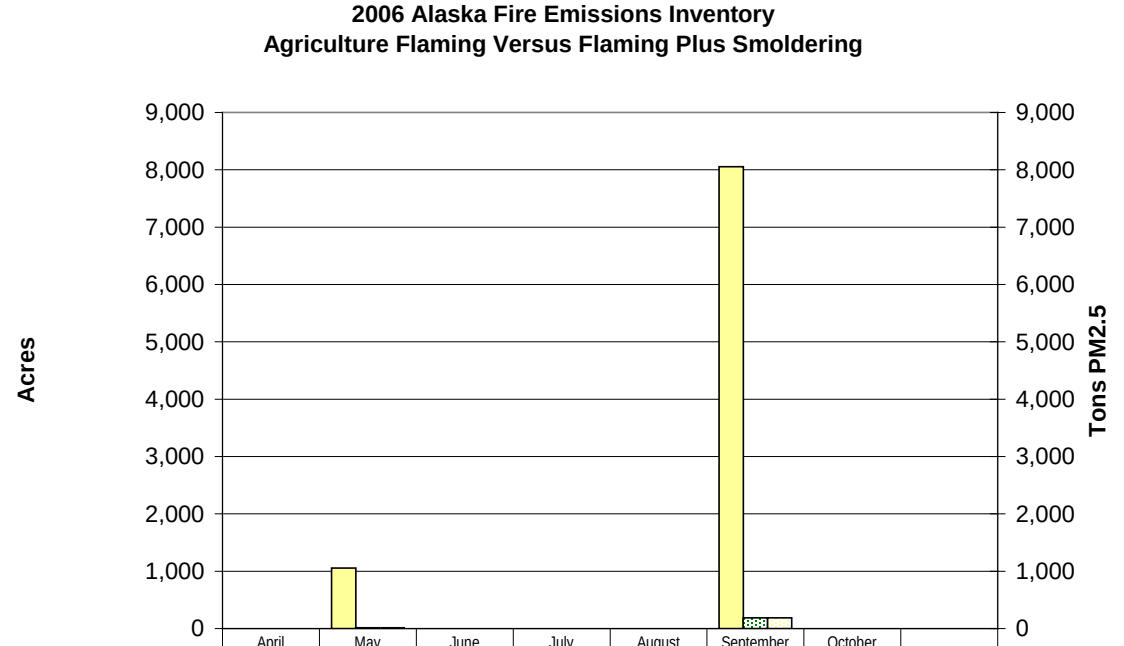
	April	May	June	July	August	September	October
WFU Acres	0	0	1613	-	-	-	-
WFU PM2.5 (F)	0	0	40	0	0	0	0
WFU PM2.5 (F+S)	0	0	40	-	-	-	-

Figure 2.5: Fire Acres and $PM_{2.5}$ Emissions by Month - Prescribed Fire



	April	May	June	July	August	September	October
Prescribed Acres	0	8,274	14,111	5,235	5,235	5,235	0
Prescribed PM2.5 (F)	0	302	1,950	109	109	92	0
Prescribed PM2.5 (F+S)	0	319	2,113	109	109	92	0

Figure 2.6: Fire Acres and PM2.5 Emissions by Month - Agricultural Fire



	April	May	June	July	August	September	October	
Agriculture Acres	0	1,055	0	0	0	8,055	0	
Agriculture PM2.5 (F)	0	14	0	0	0	186	0	
Agriculture PM2.5 (F+S)	0	14	0	0	0	186	0	-

Figure 2.7: Summary Map of Fire Acres.

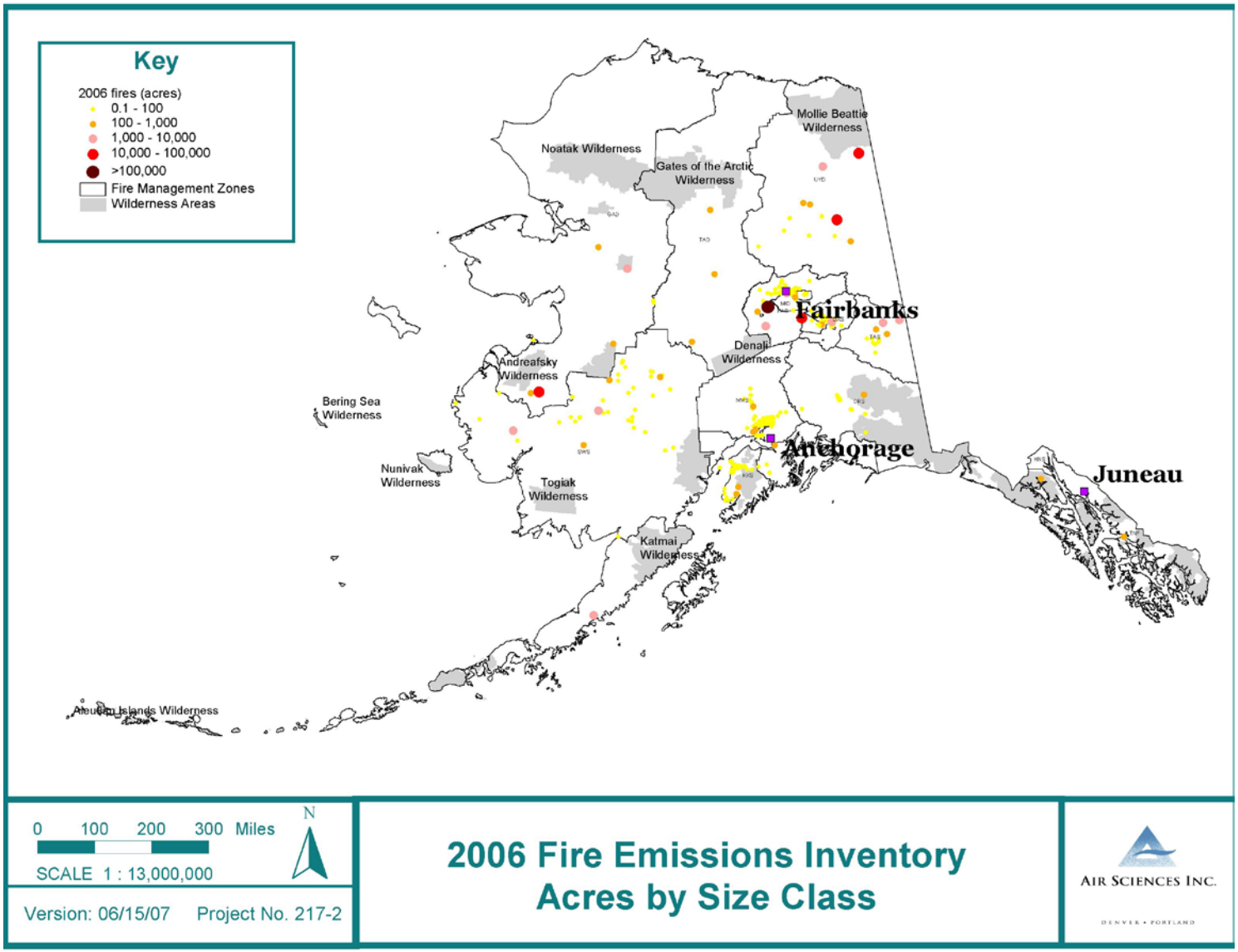


Figure 2.8: Summary Map of $PM_{2.5}$ Emissions Locations.

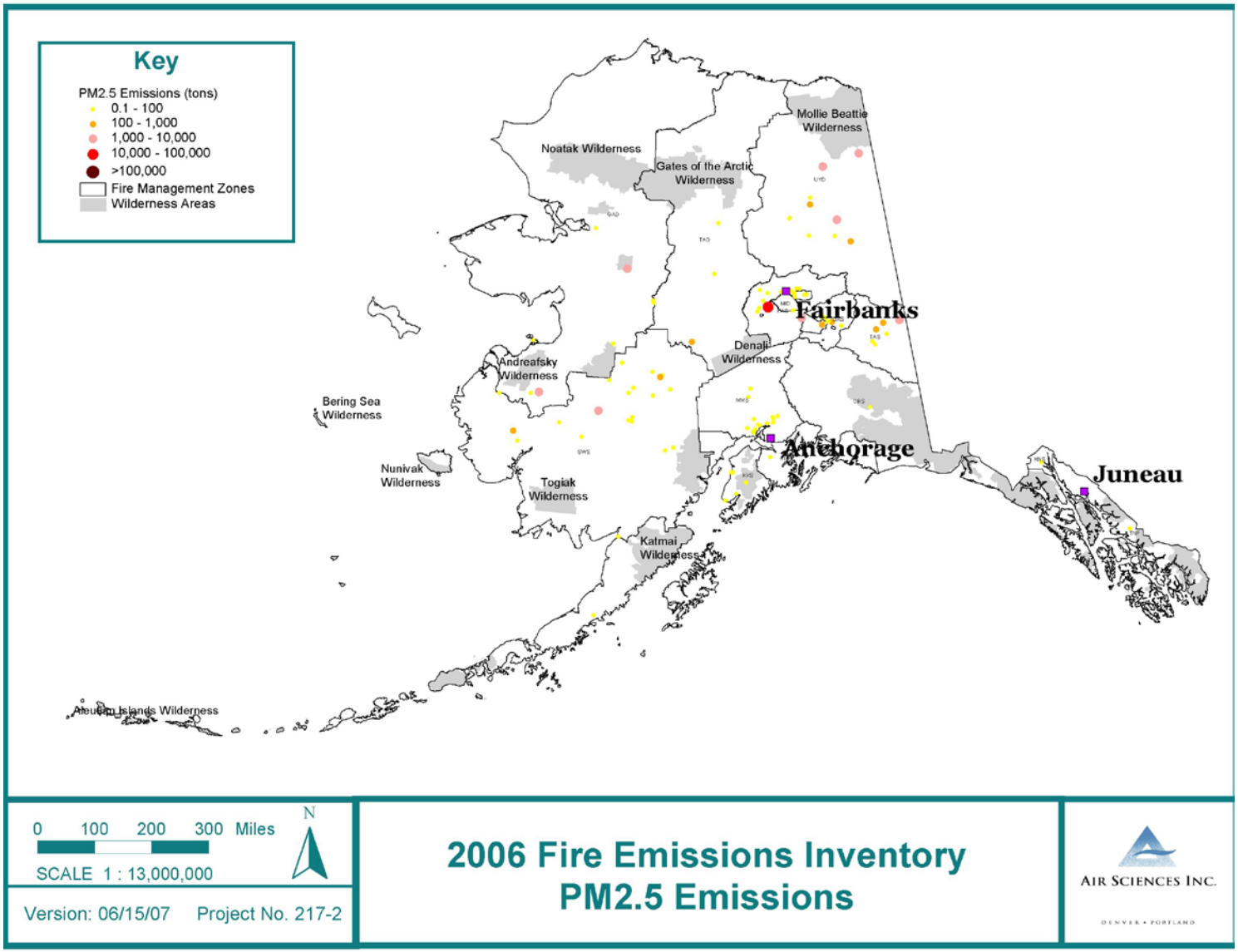
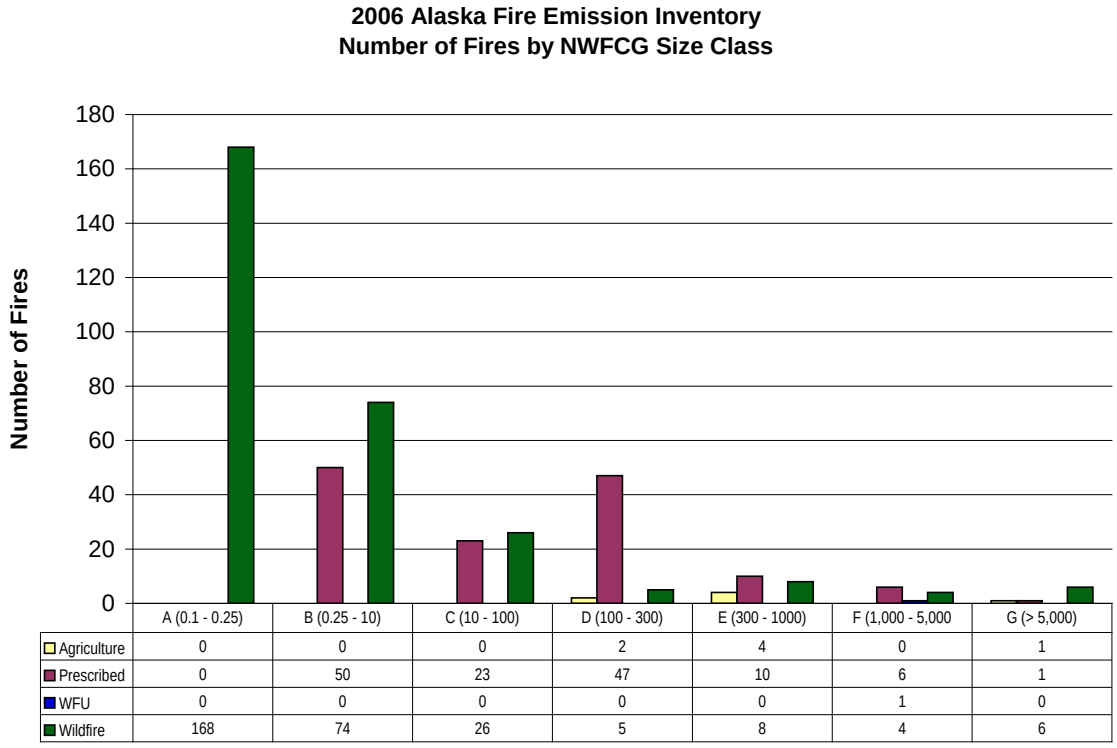
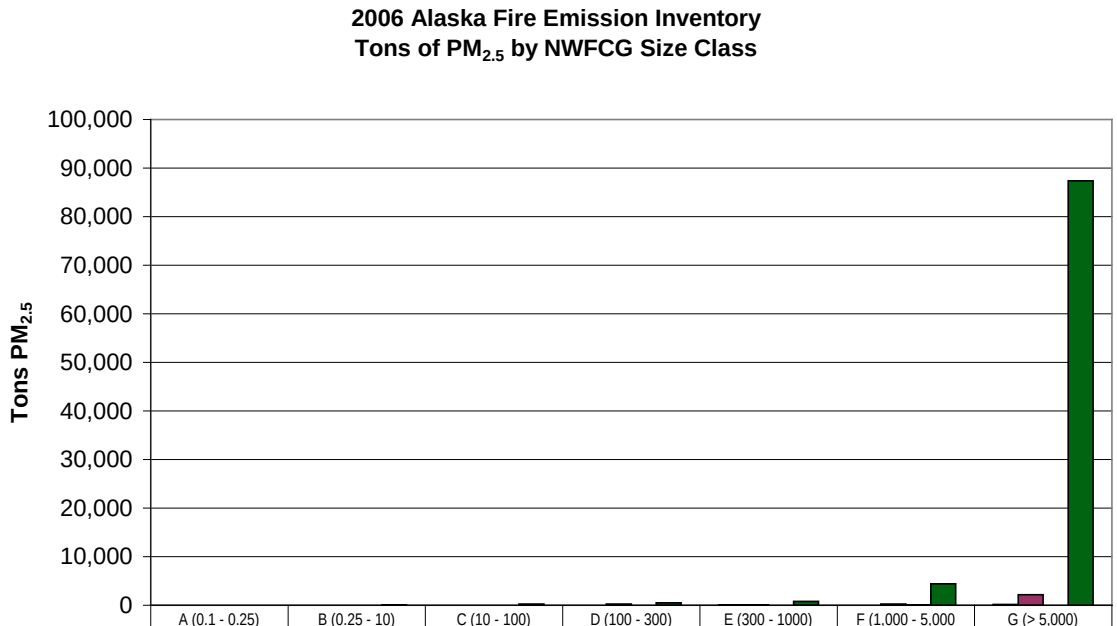


Figure 2.9: Number of Fire Events by NWFCG Size Class and Fire Type



	A (0.1 - 0.25)	B (0.25 - 10)	C (10 - 100)	D (100 - 300)	E (300 - 1000)	F (1,000 - 5,000	G (> 5,000)
Agriculture	0	0	0	2	4	0	1
Prescribed	0	50	23	47	10	6	1
WFU	0	0	0	0	0	1	0
Wildfire	168	74	26	5	8	4	6

Figure 2.10: $PM_{2.5}$ Emissions by NWFCG Fire Size Class and Fire Type



	A (0.1 - 0.25)	B (0.25 - 10)	C (10 - 100)	D (100 - 300)	E (300 - 1000)	F (1,000 - 5,000	G (> 5,000)
Agriculture	0	0	0	5	27	0	169
Prescribed	0	2	11	237	93	253	2,146
WFU	0	0	0	0	0	41	0
Wildfire	6	49	243	496	810	4,432	87,360

Table 2.7: Acres Burned (and Number of Fire Days) by NFDRS Fuel Model and Month

Acres Burned in and Number of Wild, Prescribed and WFU Fires by Fire Type and Fuel Type

Acres Burned
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 100,000
100,000 +

Acres (Number of Events)

		Month								
Fire Type	Fuel Type	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total Acres Burned (Number of Events)
Wildfire	G: Short needle (heavy dead)	1 (4)	197 (54)	115,875 (28)	6,831 (16)	5,945 (4)	2,861 (7)	2 (2)	0 (0)	131,712(106)
	Q: Alaskan black spruce	93 (6)	1,583 (29)	12,852 (21)	25,840 (38)	11,045 (13)	9,246 (10)	2,555 (3)	0 (1)	63,214 (96)
	A: Western grasses (annual)	0 (1)	3,250 (12)	46,477 (3)	11,891 (10)	0 (2)	0 (0)	0 (0)	0 (0)	61,618 (26)
	L: Western grasses (perennial)	0 (0)	0 (0)	42 (1)	377 (1)	531 (1)	291 (2)	0 (0)	0 (0)	1,241 (3)
	S: Tundra	0 (1)	1 (7)	259 (6)	169 (2)	0 (0)	2 (2)	0 (2)	0 (0)	431 (17)
	F: Intermediate brush	0 (0)	18 (6)	2 (4)	266 (6)	0 (0)	0 (0)	0 (0)	0 (0)	287 (16)
	R: Hardwood litter (summer)	0 (1)	10 (12)	1 (4)	12 (5)	0 (1)	0 (1)	0 (0)	0 (0)	23 (24)
Wildfire Total		94 (13)	5,061(121)	175,507 (68)	45,386 (79)	17,522 (21)	12,401 (22)	2,558 (7)	0 (1)	258,529(291)
Agriculture	ag	0 (0)	1,055 (6)	0 (3)	0 (0)	0 (0)	8,055 (7)	0 (4)	0 (0)	9,110 (13)
Agriculture Total		0 (0)	1,055 (6)	0 (3)	0 (0)	0 (0)	8,055 (7)	0 (4)	0 (0)	9,110 (13)
WFU	G: Short needle (heavy dead)	0 (0)	0 (0)	1,613 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1,613 (1)
WFU Total		0 (0)	0 (0)	1,613 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1,613 (1)
Prescribed	K: Light slash	0 (0)	5,014 (24)	5,014 (35)	5,014 (35)	5,014 (35)	5,014 (35)	0 (11)	0 (0)	25,070(120)
	A: Western grasses (annual)	0 (0)	2,799 (4)	8,876 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	11,675 (4)
	R: Hardwood litter (summer)	0 (0)	221 (14)	221 (15)	221 (15)	221 (15)	221 (15)	0 (1)	0 (0)	1,107 (70)
	G: Short needle (heavy dead)	0 (0)	230 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	230 (2)
	Q: Alaskan black spruce	0 (0)	10 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	10 (1)
Prescribed Total		0 (0)	8,274 (45)	14,111 (51)	5,235 (50)	5,235 (50)	5,235 (50)	0 (12)	0 (0)	38,092(197)
Grand Total		94 (13)	14,390(172)	191,232(123)	50,621(129)	22,757 (71)	25,691 (79)	2,558 (23)	0 (1)	307,343(502)

Notes: Precision of reported values are potentially affected by rounding.
Monthly Number of Events will not sum to Total Annual Number of Events if there are fires that span multiple months.
Months with no fire events do not appear in table.
The data in this table may vary slightly from the inventory because a single fuel is assigned to each fire for this table, whereas the inventory uses multiple fuel types for some fires.

Table 2.8: $PM_{2.5}$ Emissions (and Number of Fire Days) by NFDRS Fuel Model and Month

PM2.5 Emissions from and Number of Wild, Prescribed and WFU Fires by Fire Type and Fuel Type

PM2.5 Emissions (tons)
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 100,000
100,000 +

PM2.5 Emissions in Tons (Number of Events)

		Month								
Fire Type	Fuel Type	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total Tons PM2.5 (Number of Events)
Wildfire	G: Short needle (heavy dead)	0 (4)	34 (54)	56,322 (28)	2,986 (16)	2,898 (4)	1,408 (7)	0 (2)	0 (0)	63,648(106)
	Q: Alaskan black spruce	1 (6)	425 (29)	4,705 (21)	10,613 (38)	5,312 (13)	4,435 (10)	616 (3)	3 (1)	26,109 (96)
	A: Western grasses (annual)	0 (1)	124 (12)	1,764 (3)	681 (10)	0 (2)	0 (0)	0 (0)	0 (0)	2,570 (26)
	L: Western grasses (perennial)	0 (0)	0 (0)	1 (1)	266 (1)	377 (1)	209 (2)	0 (0)	0 (0)	853 (3)
	F: Intermediate brush	0 (0)	3 (6)	0 (4)	125 (6)	0 (0)	0 (0)	0 (0)	0 (0)	128 (16)
	S: Tundra	0 (1)	0 (7)	78 (6)	5 (2)	0 (0)	0 (2)	0 (2)	0 (0)	84 (17)
	R: Hardwood litter (summer)	0 (1)	0 (12)	0 (4)	0 (5)	0 (1)	0 (1)	0 (0)	0 (0)	1 (24)
Wildfire Total		1 (13)	588(121)	62,871 (68)	14,676 (79)	8,587 (21)	6,051 (22)	616 (7)	3 (1)	93,392(291)
Agriculture	ag	0 (0)	14 (6)	0 (3)	0 (0)	0 (0)	186 (7)	0 (4)	0 (0)	200 (13)
Agriculture Total		0 (0)	14 (6)	0 (3)	0 (0)	0 (0)	186 (7)	0 (4)	0 (0)	200 (13)
WFU	G: Short needle (heavy dead)	0 (0)	0 (0)	40 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (1)
WFU Total		0 (0)	0 (0)	40 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (1)
Prescribed	A: Western grasses (annual)	0 (0)	138 (4)	2,009 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2,146 (4)
	K: Light slash	0 (0)	84 (24)	102 (35)	107 (35)	107 (35)	91 (35)	0 (11)	0 (0)	492(120)
	G: Short needle (heavy dead)	0 (0)	94 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	94 (2)
	R: Hardwood litter (summer)	0 (0)	1 (14)	2 (15)	2 (15)	2 (15)	1 (15)	0 (1)	0 (0)	7 (70)
	Q: Alaskan black spruce	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Prescribed Total		0 (0)	319 (45)	2,113 (51)	109 (50)	109 (50)	92 (50)	0 (12)	0 (0)	2,742(197)
Grand Total		1 (13)	921(172)	65,024(123)	14,785(129)	8,696 (71)	6,329 (79)	616 (23)	3 (1)	96,374(502)

Notes: Precision of reported values are potentially affected by rounding.
Monthly Number of Events will not sum to Total Annual Number of Events if there are fires that span multiple months.
Months with no fire events do not appear in table.
The data in this table may vary slightly from the inventory because a single fuel is assigned to each fire for this table, whereas the inventory uses multiple fuel types for some fires.

SECTION 3

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APPENDIX A

Assumptions

APPENDIX A

ASSUMPTIONS

Due to the volume of data compiled and analyzed in an emissions inventory, certain assumptions are made in regards to data quality and completeness. In addition, methods used or concepts mentioned in the report may require additional justification, or simply be unfamiliar to some readers. This appendix is provided to further explicate and document those areas of the report not covered thoroughly elsewhere.

A.1 Data Limitations

Below is a brief list of the limitations of and assumptions made about the data set upon which the inventory is based. While not exhaustive, the authors tried to capture those elements most relevant to this particular inventory and to burning in Alaska, partly based on feedback received during the AWFCG Air Quality Committee Meeting in January 2007.

- Prescribed data reported in the BLM/AFS database and post-burn reports from ADEC were used to estimate prescribed burning activity. In addition, small-permit and private fire activity was estimated based on the number of permit activations in 2006; there was no record of actual acres burned. Assumptions made with this method are detailed in section 1.3.2 and section 1.4.2.

- Similarly, agricultural burning was estimated based on total cropland and cropland harvested. There was no record of actual agricultural acres burned. Assumptions made with this method are detailed in section 1.3.3 and section 1.4.2.

- The administrative end date for all fire events was assumed to be equivalent to the out date (the dates were manually checked for obvious unlikely values).

- Burn type was assumed to be "broadcast" unless "pile" burn was indicated in the source database. In addition, small-permit piles were assumed to always be the maximum allowable size: 10' x 10'.

- For any event where primary vegetation type or fuel loading was provided by the Fire Manager, those values superseded the default assigned classification.

- The default fuel classification system used is the latest CFFDRS fuel map created by the Alaska Fire Service. A crosswalk, associating vegetation types with CFFDRS classes, was done with a statewide vegetation map patched together using 30-meter LANDSAT-7 remote sensing images from the 1980's and early 1990's (Parker Martyn, AFS, personal communication 3/9/2007). Details about associating CFFDRS fuel model classes with fuel loadings, and differences between the CFFDRS fuel map and the original 1-km

NFDRS map used in the draft report are outlined in Appendix B of .the 2005 Alaska fire emissions inventory (Air Sciences Inc., 2007a).

- The fuel classification for small-permit and agricultural fires was not GIS-based. Details on choosing a fuel class for these fires types are provided in section 1.4.2.

- Emission factors for broadcast burning across all fuel classifications were assumed to be identical. Pile burning had a unique set of emission factors that are also identical across fuel types.

A.2 WRAP-Modified Fuel Loadings

Fuel loading values presented in Table 1.3 were originally derived by the WRAP for the 1996 WRAP-wide emission inventory. Fuel loadings for dead and live fuels originally published as part of the NFDRS (Andersen, 1982) were augmented with fuel loading estimates for two additional fuel layers, crown and duff, shown in Table A.1. These values represent the maximum fuel available for each vegetation type outlined in the NFDRS. With input from David V. Sandberg (USFS – retired, 2001), percent consumption for each fuel layer, outlined in Table A.2, were estimated for wildfire, prescribed fire, and prescribed fire for class Q (black spruce). With the exception of Q, percentages were applied identically over all NFDRS classes. Final fuel consumption estimates, identical to those presented in Table 1.3, are shown in Table A.3 for wildfire and prescribed burning.

Table A.1: Original NFDRS fuel loadings with Duff and Crown fuel layers added.

Original NFDRS Fuel Load (ton/acre)

			DEAD				LIVE		OTHER *	
Letter Code	NFDRS	Total	1-h	10-h	100-h	1000-h	Wood	Herb	Duff	Crown
A	Western grasses (annual)	0.50	0.20	0.00	0.00	0.00	0.00	0.30	0.00	0.00
F	Intermediate brush	15.00	2.50	2.00	1.50	0.00	9.00	0.00	0.00	0.00
G	Short needle (heavy dead)	59.90	2.50	2.00	5.00	12.00	0.50	0.50	18.20	19.20
L	Western grasses (perennial)	0.75	0.25	0.00	0.00	0.00	0.00	0.50	0.00	0.00
Q	Alaskan black spruce	96.70	2.00	2.50	2.00	1.00	4.00	0.50	57.90	26.80
R	Hardwood litter (summer)	3.60	0.50	0.50	0.50	0.00	0.50	0.50	1.10	0.00
S	Tundra	35.60	0.50	0.50	0.50	0.50	0.50	0.50	32.60	0.00

Dead and Live fuel source: The National Fire-Danger Rating system: Basic Equations, USDA, 1985

* Duff and Crown source: David V. Sandberg emails, 9/25/01 and 10/04/01

Table A.2: Percent fuel consumed by fuel type for WRAP-modified fuel loading calculations.

ETT Defined Percent NFDRS Consumed

	DEAD				LIVE		OTHER	
Fire Type	1-h	10-h	100-h	1000-h	Wood	Herb	Duff	Crown
Wildfire consumption - all classes	100%	100%	100%	100%	100%	100%	50%	62%
Prescribed burning consumption - all classes but Q	100%	100%	100%	50%	100%	100%	50%	0%
Prescribed burning consumption - Q	100%	100%	100%	50%	100%	100%	50%	31%

Source: David V. Sandberg email, 9/25/01

Table A.3: Final fuel consumption for wildfire and prescribed burning after application of percentages in Table X.2.

Wildfire Adjusted Fuel Loading / Fuel Consumption (ton/acre)

			DEAD				LIVE		OTHER	
Letter Code	NFDRS	Total	1-h	10-h	100-h	1000-h	Wood	Herb	Duff	Crown
A	Western grasses (annual)	0.50	0.20	0.00	0.00	0.00	0.00	0.30	0.00	0.00
F	Intermediate brush	15.00	2.50	2.00	1.50	0.00	9.00	0.00	0.00	0.00
G	Short needle (heavy dead)	43.50	2.50	2.00	5.00	12.00	0.50	0.50	9.10	11.90
L	Western grasses (perennial)	0.75	0.25	0.00	0.00	0.00	0.00	0.50	0.00	0.00
R	Hardwood litter (summer)	3.05	0.50	0.50	0.50	0.00	0.50	0.50	0.55	0.00
S	Tundra	19.30	0.50	0.50	0.50	0.50	0.50	0.50	16.30	0.00

Prescribed Burning Adjusted Fuel Loading / Fuel Consumption (ton/acre)

			DEAD				LIVE		OTHER	
Letter Code	NFDRS	Total	1-h	10-h	100-h	1000-h	Wood	Herb	Duff	Crown
A	Western grasses (annual)	0.50	0.20	0.00	0.00	0.00	0.00	0.30	0.00	0.00
F	Intermediate brush	15.00	2.50	2.00	1.50	0.00	9.00	0.00	0.00	0.00
G	Short needle (heavy dead)	25.60	2.50	2.00	5.00	6.00	0.50	0.50	9.10	0.00
L	Western grasses (perennial)	0.75	0.25	0.00	0.00	0.00	0.00	0.50	0.00	0.00
Q	Alaskan black spruce	48.76	2.00	2.50	2.00	0.50	4.00	0.50	28.95	8.31
R	Hardwood litter (summer)	3.05	0.50	0.50	0.50	0.00	0.50	0.50	0.55	0.00
S	Tundra	19.05	0.50	0.50	0.50	0.25	0.50	0.50	16.30	0.00

APPENDIX B

2005 Emission Inventory Details

APPENDIX B

2005 EMISSION INVENTORY METHOD DETAILS

B.1 Fuel Consumption Assignment

In order to calculate emissions, the activity data must include either total mass of fuel consumed or a fuel class. The fuel class selection process made use of the National Fire Danger Rating System (NFDRS) and the Canadian Forest Fire Danger Rating System (CFFDRS). The CFFDRS system served as the primary source of fuels information as it is used by the BLM and Alaska Fire Service (AFS) (who manage the majority of all fire activity in Alaska). The information for the fuel loading and associated fuel consumption was selected using the following modified hierarchy:

6. Fire Manager-assigned fuel description cross-walked to CFFDRS fuel model.

   The raw database did not provide quantitative fuel loading or total fuel consumption. However, there were 80 records with a primary vegetation type (fuel model) assigned by the Fire Manager. These primary fuel categories were specific enough to cross-reference these with the CFFDRS fuels models and to assign a fuel model to each of the fires. For the remaining majority of the records, a GIS technique was utilized to derive fuel consumption rates for each event.

7. Fuel consumption refinement technique utilizing fire perimeters, GIS spatial layer of CFFDRS fuel models, and calculated weighted fuel consumption rate (see Section B.1.1).

8. Single CFFDRS fuel model applied to the entire event derived by fire location and GIS drop onto spatial layer of CFFDRS fuel models.

   For any event greater than 100 acres for which a fire perimeter was available, the refined fuel consumption method described in Section 1.4.1 was used. For all remaining fires, a CFFDRS model was assigned with a GIS-based overlay of the fire location, provided in the data as a latitude-longitude pair, with the CFFDRS GIS map, (Figure 1.1) provided by the AFS (BLM and Alaska Fire Service, 2007). The assigned fuel model and associated fuel consumption rate was used to represent the entire fire event.

9. Single NFDRS fuel model applied to the entire event derived by fire location and GIS drop onto spatial layer of NFDRS fuel models. This was done for events that returned a "null" or "undefined" value when using the CFFDRS spatial fuel layer.

   For several events, the CFDRS overlay resulted in an "undetermined" value, in many cases corresponding to areas with rock or glaciers, but in others it was unclear. In addition, the 30-meter resolution of the map allowed for inclusion of rivers in the data set, resulting in some fires showing up on the edge of a river boundary and given a "water" value. In these cases, the NFDRS classification derived from a lower-resolution map (Figure 1.2) was used as a basis for a

crosswalk. This affected a small fraction of the total acreage, and therefore it was not expected to alter the results significantly.

Since default fuel consumption values for CFFDRS classes have not been published, the fuel consumption was based on the WRAP-modified NFDRS classes in Table 1.3 (Air Sciences Inc., 2004). The modified classes were broken out by fire type, specifically by wildfire and prescribed burning. These fuel consumption rates include the default NFDRS loadings for dead and live fuel, with additional duff and crown biomass, and assumptions about the percent of each consumed (for further discussion, see Appendix A). Based on the fuel class descriptions, the NFDRS classes were cross-walked to corresponding CFFDRS classes based on those present in Figure 1.1. For CFFDRS classes O1a/O1b and M1/M2, the average of the two corresponding NFDRS classes was used. Total fuel consumption (tons fuel consumed per event or per fire day) is then calculated by looking up nominal per-acre fuel model-specific fuel consumption rates (stored in reference tables) from each fuel model, and multiplying by the acres in the fire event.

10. All records with fire perimeter information are adjusted for seasonality based on month and CFFDRS fuel class (see Section B.1.2).

Table B.1: WRAP-Modified Fuel Consumption for NFDRS Fuel Model, Cross-Walked to CFFDRS

Fuel Model	Description	Wildfire/WFU Fuel Consumption (ton/acre)	Prescribed Fire (ton/acre)	CFFDRS Crosswalk
A	Western grasses (annual)	0.5	0.5	O1a/O1b
F	Intermediate brush	15	15	M1/M2
G	Short needle (heavy dead)	43.5	25.6	M1/M2
L	Western grasses (perennial)	0.75	0.75	O1a/O1b
Q	Alaskan black spruce	57.57	48.76	C2
R	Hardwood litter (summer)	3.05	3.05	M1/M2
S	Tundra	19.3	19.05	O1

Figure B.1: 30-Meter CFFDRS Fuel Classification Layer (BLM and Alaska Fire Service, 2006)

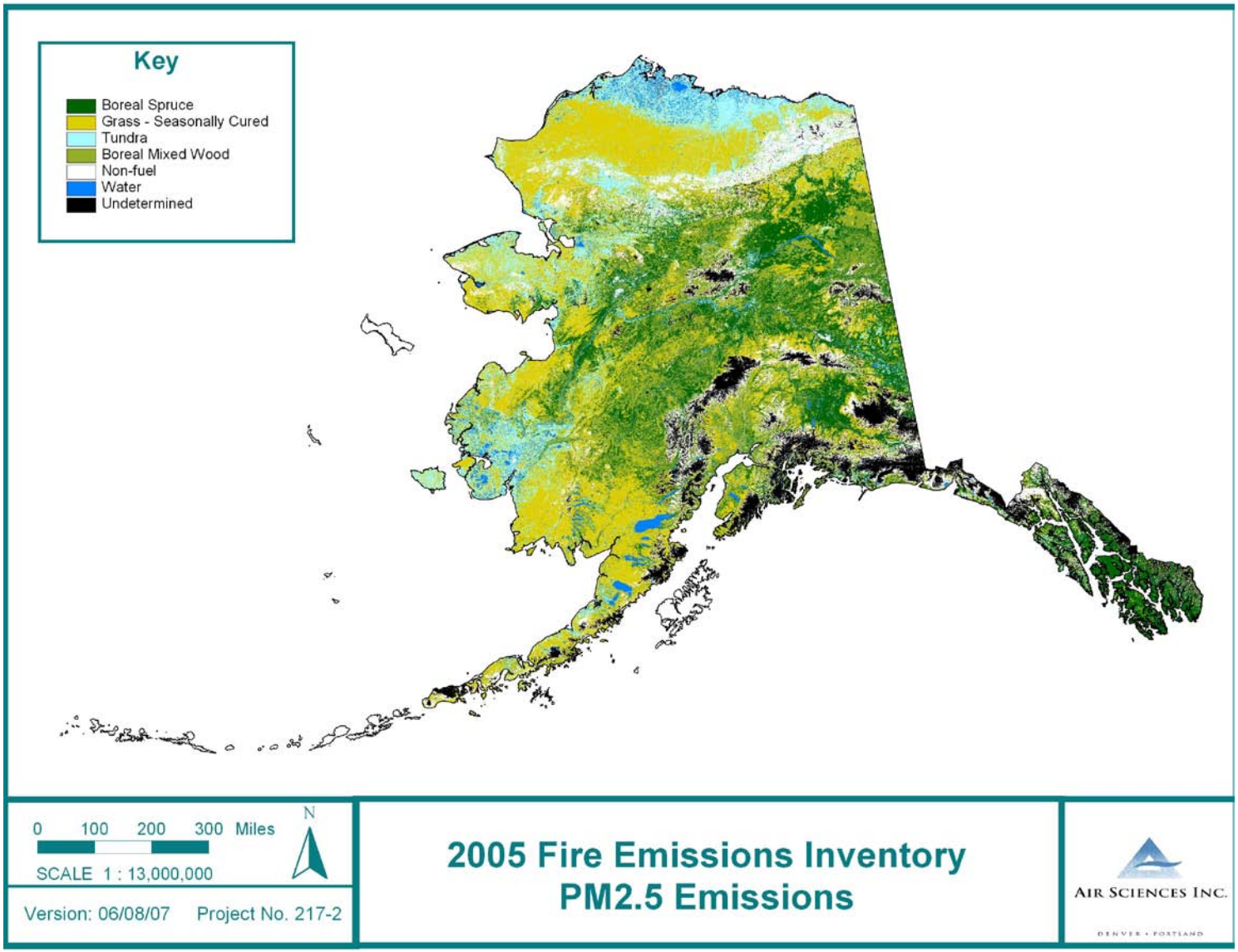
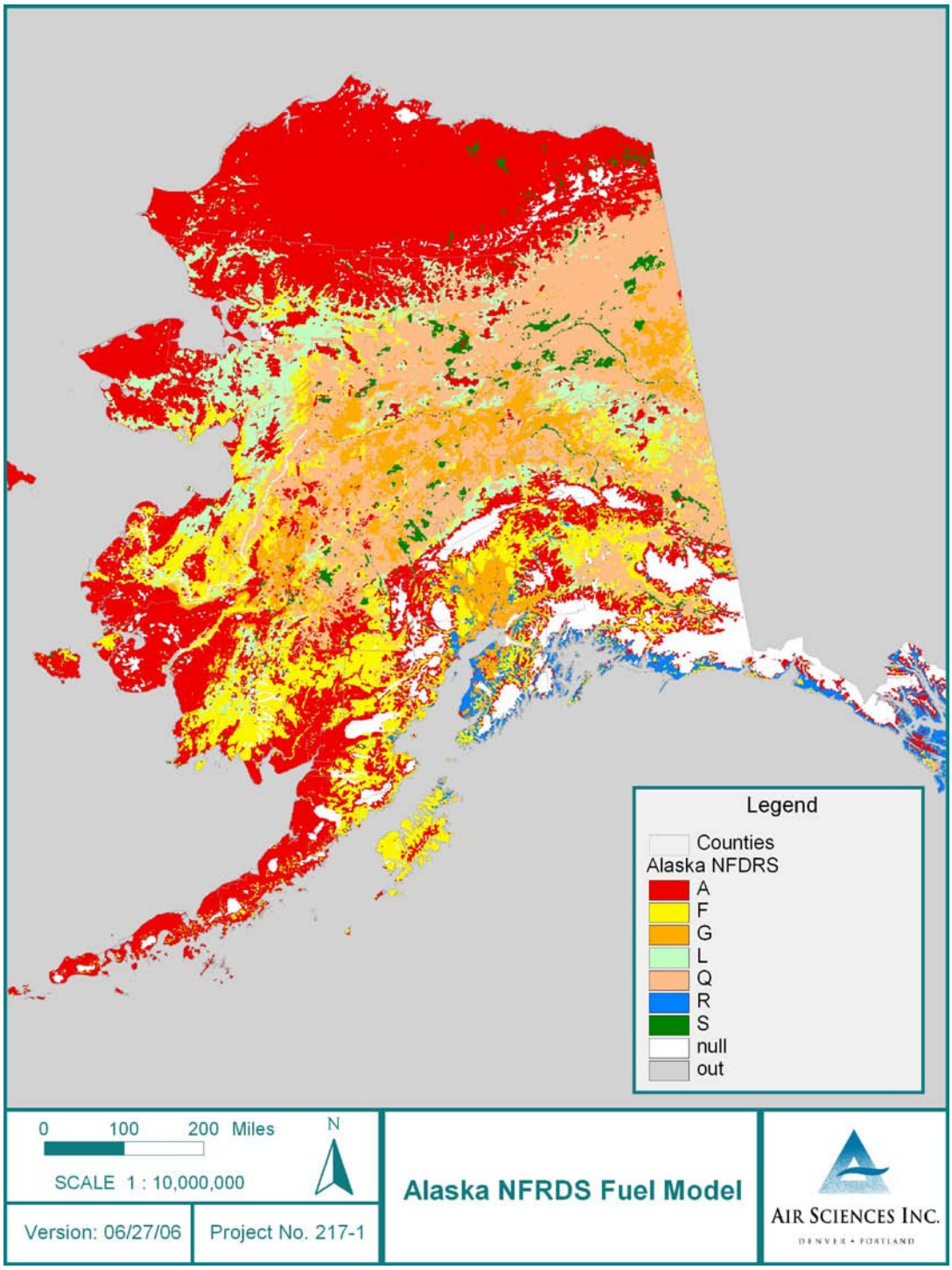


Figure B.2: NFDRS Fuels Models Map for Alaska (Alaska Geospatial Clearinghouse, 2006)
"Null" (white) indicates non-burnable areas such as rock, glaciers, and water. "Out" (grey) indicates areas outside of the Alaska landmass. Fires that fell in either of these classes were removed from the inventory.



Fire locations were plotted on the CFFDRS fuel model coverage map, and the corresponding fuel model code was recorded to the activity record. The following steps were involved in the spatial overlay of the fire locations with the CFFDRS fuel model map:

1. A data point for each fire is created from its latitude and longitude recorded in the fire activity.
2. The fire point is converted to the projection coordinates of the CFFDRS map. (Conversion from latitude/longitude to Lambert Equal Area Azimuthal)
3. The fire point is intersected with the NFDRS Fuel Model map.
4. The fuel model of the grid cell at that point is identified and saved to a new column in the fire activity record.
5. The numeric code from the GIS overlay is translated to the standard CFFDRS Fuel Model letter code using a reference table.

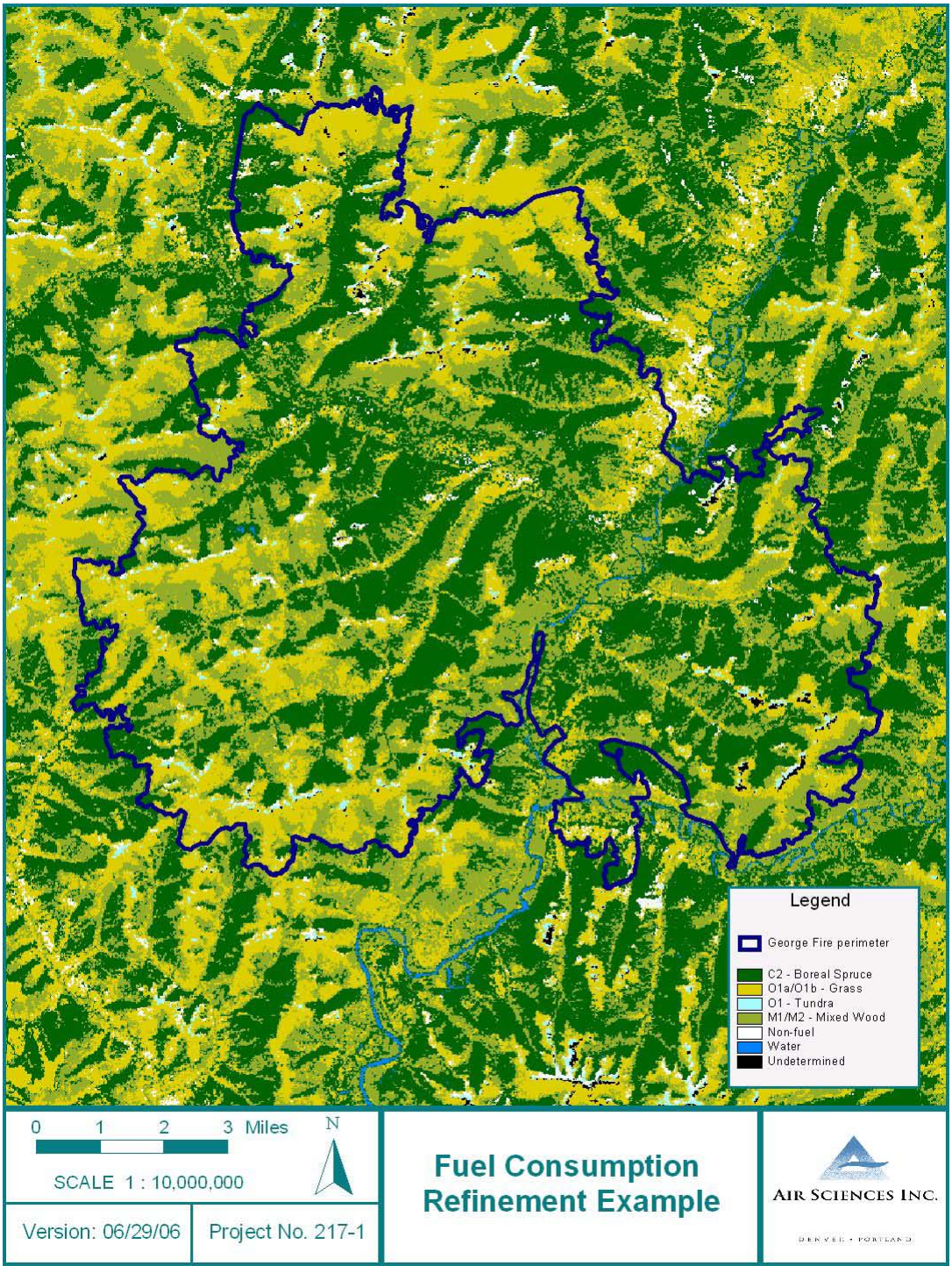
B.1.1 Fuel Consumption Refinement

For fires greater than 100 acres, GIS-based fire perimeters were available from an Alaska fire history spatial layer (Alaska Geospatial Clearinghouse web site). The shape file with individual fire perimeters was used to refine the fuel loading assignment by calculating an area-weighted fuel loading based on the distribution of the CFFDRS fuel models within a fire perimeter. The area-weighted fuel loading was determined by using GIS to overlay the fire perimeters on the CFFDRS fuel model map and calculating the area of a fire in each fuel type. For some events, the CFFDRS fuel model map, which has a resolution of 30 meters, shows a portion of the event on areas with zero fuel loading (e.g., rock, water, or snow). The percent area of each fuel type within each fire perimeter was calculated for the entire area of the fire, including these areas of zero fuel loading. This calculation technique of the weighted fuel loading method eliminates a potential source of over-estimation fuel loading for large fires. The fuel consumption refinement method is illustrated in Figure 1.3.

The 2006 fire emission inventory calculations are based on the more refined weighted fuel consumption for all fires greater than 100 acres and on the point-base fuel consumption (either from the description from raw data or in CFFDRS) for the smaller fires. This method improves the accuracy of the estimated fuel consumption of individual fires and therefore improves the accuracy of the distribution of emission estimates. This is particularly relevant should the 2006 emissions inventory be used as input for atmospheric smoke dispersion modeling, a process sensitive to the temporal and spatial accuracy of the input information.

Figure B.3: Fuel Consumption Refinement Example

A fire perimeter overlain on the CFFDRS fuel map. The table below shows the areas associated with each fuel model within the perimeter, used to calculate the weighted fuel consumption.



	Percent Area in Fuel Model						
Fire Key	C2	O1a/O1b	O1	M1/M2	Non-fuel	Water	Undetermined
551	43%	23%	1.0%	31%	1.7%	0.15%	0.38%

B.1.2 Fuel Consumption Seasonality

Deriving fuel consumption using cross-walked CFFDRS fuel loadings in Table B.1 assumes 100 percent consumption over the entire year, which does not account for seasonal differences such as fuel moisture, soil moisture, or frozen soil. Air Sciences and the AWFCG Air Quality Committee explored several ways to account for seasonal differences in fuel consumption. The method that was agreed upon and implemented for this project relied upon some relatively resolved fuel consumption estimates prepared for a separate project performed by Air Sciences (Inter-RPO 2002 National Wildfire Emission Inventory [Air Sciences and ECR, 2007]).

In the Inter-RPO project, the Fire Emissions Production Simulator (FEPS) was used to develop seasonal fuel consumption estimates for each NFDRS class under multiple moisture regimes (from very wet to very dry). For this project, these fuel consumption estimates were cross-walked to CFFDRS in the same manner as presented in Table B.1. Further details of the process implemented for the 2006 Alaska Fire EI are provided in Appendix C.

With the help of several Alaska FMOs (Fire Management Officers that work for AK DNR – Division of Forestry), a seasonality matrix was created for Alaska based on six fuel moisture regimes: Very Dry, Dry, Moderate, Moist, Wet, and Very Wet[1]. For each month of the year, a moisture regime was assigned for the Interior and all other regions, shown in Table B.2. In addition, Fire Management Zones were classified as Interior or Other, shown in Table B.3.

Table B.2: Monthly Moisture Regimes for the Alaskan Interior and All Other Regions

Month	Interior	Coastal
January	Very Wet	Very Wet
February	Very Wet	Very Wet
March	Moist	Very Wet
April	Moderate	Moist
May	Dry	Moderate
June	Very Dry	Dry
July	Very Dry	Very Dry
August	Very Dry	Very Dry
September	Dry	Dry
October	Moderate	Moist
November	Very Wet	Wet
December	Very Wet	Very Wet

[1] See Appendix C, Table C.1, for a list of fuel consumption values associated with each moisture regime.

Table B.3: Location Classification of Fire Management Zones in Alaska

Fire Management Zone	FMZ Abbr.	Location Class
Galena (AFS)	gad	Interior
Tanana (AFS)	tad	Interior
Upper Yukon (AFS)	uyd	Interior
Military (AFS)	mil	Interior
Fairbanks (DOF)	fas	Interior
Delta (DOF)	das	Interior
Tok (DOF)	tas	Interior
Copper River (DOF)	crs	Interior
Matanuska-Susitna (DOF)	mss	Coastal
Kenai-Kodiak (DOF)	kks	Coastal
Southwest (DOF)	sws	Interior
Haines (DOF)	hns	Coastal
Chugach National Forest (USFS)	cgf	Coastal
Tongass National Forest (USFS)	tnf	Coastal

The following steps assigned a seasonal fuel loading to each fire event:

1. Each fire event in the inventory is assigned a month based on the reported start date.
2. A GIS overlay is done to assign each fire to the proper fire management zone (FMZ).
3. Each fire is assigned a moisture regime based on month and FMZ.
4. A lookup routine assigns a seasonal fuel loading to each fire based on CFFDRS class (previously assigned) and moisture regime.

This procedure was executed for all fires event in 2006. Appendix B explores the effect of introducing seasonal fuel consumption on the emissions results.

APPENDIX C

Technical Discussion of Modifications from, excerpted from the 2005 Emission Inventory

APPENDIX C

TECHNICAL DISCUSSION OF MODIFICATIONS

C.1 Seasonal Fuel Loading Derivation

Seasonal fuel consumption values used in this inventory were originally derived in the Inter-RPO 2002 National Wildfire Emission Inventory (Air Sciences and ECR, 2005). The Inter-RPO fuel consumption values were derived using the FEPS Version 1.0 (USDA – Forest Service, Pacific Northwest Research Station, Fire and Environmental Research Applications Team). Fuel *loadings* by the WRAP-modified NFDRS fuel model as shown in Table A.3 were used as input to FEPS, which then provided estimates of fuel *consumption* values for each of six moisture regimes (very dry, dry, moderate, moist, wet, very wet). FEPS was used to calculate fuel consumption values (in tons-per-acre) for each of the six FEPS moisture regimes for each NFDRS fuel model, shown in Table C.1. The output from FEPS includes flaming fuel consumption and smoldering fuel consumption. Total fuel consumption (tons consumed per acre) is the sum of flaming and smoldering consumption, applied as described in Section B.1.2 and Section 1.7.

The Inter-RPO emission inventory only compiled estimates for wildfire. Therefore, for the purposes of the 2005 Alaska inventory, seasonal prescribed fire fuel consumption needed to be interpolated from wildfire values. To do this, FEPS-derived wildfire fuel consumption for each moisture regime and NFDRS class was divided by the WRAP-modified fuel loading (upper half of Table A.3) for each NFDRS class to obtain a "percent of original". The "percent of original" values, one for each moisture regime and fuel class, were then multiplied by the WRAP-modified prescribed burning fuel loadings for each NFDRS class (lower half of Table A.3) to obtain the "PRESCRIBED" values in Table C.1. The same procedure was performed for smoldering fuel consumption values.

Figure C.1 compares the total fuel consumption estimates from FEPS (flaming and smoldering) with the original WRAP-modified fuel loadings (wildfire values in Table A.3 + 17% to account for smoldering – see method described in Section 1.7). NFDRS classes not applicable to Alaska are presented as this methodology was originally applied to the entire WRAP region. In some cases, total fuel consumption decreases significantly from the original fuel loading, while class Q (black spruce) is slightly greater than the original for the Very Dry class.

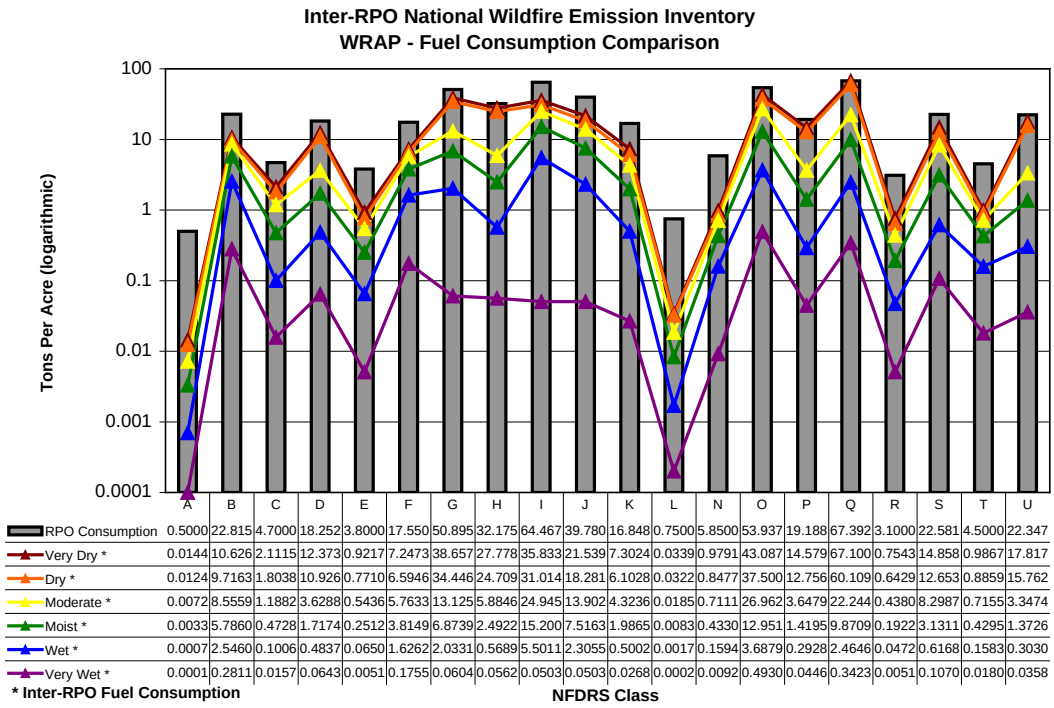
For the 2005 Alaska Emissions Inventory, consumption values were cross-walked to four CFFDRS fuel types available from the 30-meter GIS fuel layer, outlined in Section B.1. This method combines some NFDRS classes into a single CFFDRS classification, which may not accurately reflect available fuel in some cases. In addition, total available fuel values presented in the Alaska Digital Photo Series (http://depts.washington.edu/nwfire/dps/) are significantly higher then those estimated here. Fuel loadings for Black Spruce (NFDRS class Q or CFFDRS class C-2), for example, range from 60 to 180 tons per acre.

Table C.1: Matrix Wildfire, WFU, and Prescribed Fuel Consumption Values for Six Moisture Regimes, Flaming and Smoldering

FLAMING	NFDRS Class	Very Dry	Dry	Moderate	Moist	Wet	Very Wet
WILDFIRE / WFU	A	0.0144	0.0124	0.0072	0.0033	0.0007	0.0001
	F	7.2473	6.5946	5.7633	3.8149	1.6262	0.1755
	G	35.9636	32.3293	11.9972	6.7100	2.0302	0.0604
	L	0.0339	0.0322	0.0185	0.0083	0.0017	0.0002
	Q	58.5322	53.3731	18.6542	9.3496	2.4555	0.3423
	R	0.5915	0.5149	0.3698	0.1823	0.0470	0.0051
	S	10.0342	8.8606	6.2771	2.8376	0.6117	0.1070
PRESCRIBED	A	0.0144	0.0124	0.0072	0.0033	0.0007	0.0001
	F	7.2473	6.5946	5.7633	3.8149	1.6262	0.1755
	G	21.1648	19.0260	7.0604	3.9489	1.1948	0.0355
	L	0.0339	0.0322	0.0185	0.0083	0.0017	0.0002
	Q	49.5750	45.2054	15.7995	7.9188	2.0797	0.2899
	R	0.5915	0.5149	0.3698	0.1823	0.0470	0.0051
	S	9.9042	8.7458	6.1958	2.8008	0.6038	0.1056

SMOLDERING	NFDRS Class	Very Dry	Dry	Moderate	Moist	Wet	Very Wet
WILDFIRE / WFU	A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	G	2.6934	2.1174	1.1286	0.1639	0.0029	0.0000
	L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Q	8.5686	6.7362	3.5905	0.5213	0.0091	0.0000
	R	0.1628	0.1280	0.0682	0.0099	0.0002	0.0000
	S	4.8245	3.7927	2.0216	0.2935	0.0051	0.0000
PRESCRIBED	A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	G	1.5851	1.2461	0.6642	0.0965	0.0017	0.0000
	L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Q	7.2573	5.7054	3.0410	0.4415	0.0077	0.0000
	R	0.1628	0.1280	0.0682	0.0099	0.0002	0.0000
	S	4.7620	3.7436	1.9954	0.2897	0.0050	0.0000

Figure C.1: Comparison of WRAP-Modified and FEPS-Derived Fuel Loadings for Six Moisture Regimes, Flaming and Smoldering



	A	B	C	D	E	F	G	H	I	J	K	L	N	O	P	Q	R	S	T	U
RPO Consumption	0.5000	22.815	4.7000	18.252	3.8000	17.550	50.895	32.175	64.467	39.780	16.848	0.7500	5.8500	53.937	19.188	67.392	3.1000	22.581	4.5000	22.347
Very Dry *	0.0144	10.626	2.1115	12.373	0.9217	7.2473	38.657	27.778	35.833	21.539	7.3024	0.0339	0.9791	43.087	14.579	67.100	0.7543	14.858	0.9867	17.817
Dry *	0.0124	9.7163	1.8038	10.926	0.7710	6.5946	34.446	24.709	31.014	18.281	6.1028	0.0322	0.8477	37.500	12.756	60.109	0.6429	12.653	0.8859	15.762
Moderate *	0.0072	8.5559	1.1882	3.6288	0.5436	5.7633	13.125	5.8846	24.945	13.902	4.3236	0.0185	0.7111	26.962	3.6479	22.244	0.4380	8.2987	0.7155	3.3474
Moist *	0.0033	5.7860	0.4728	1.7174	0.2512	3.8149	6.8739	2.4922	15.200	7.5163	1.9865	0.0083	0.4330	12.951	1.4195	9.8709	0.1922	3.1311	0.4295	1.3726
Wet *	0.0007	2.5460	0.1006	0.4837	0.0650	1.6262	2.0331	0.5689	5.5011	2.3055	0.5002	0.0017	0.1594	3.6879	0.2928	2.4646	0.0472	0.6168	0.1583	0.3030
Very Wet *	0.0001	0.2811	0.0157	0.0643	0.0051	0.1755	0.0604	0.0562	0.0503	0.0503	0.0268	0.0002	0.0092	0.4930	0.0446	0.3423	0.0051	0.1070	0.0180	0.0358

* Inter-RPO Fuel Consumption

C.2 Analysis of Changes in Fuel Consumption Methodology from Draft Report

The methodology for deriving fuel consumption in the draft report utilized the NFDRS fuel model, WRAP-modified NFDRS fuel loadings (see discussion above), and a 1-km resolution NFDRS fuel layer GIS map. Based on feedback received, several major changes were implemented:

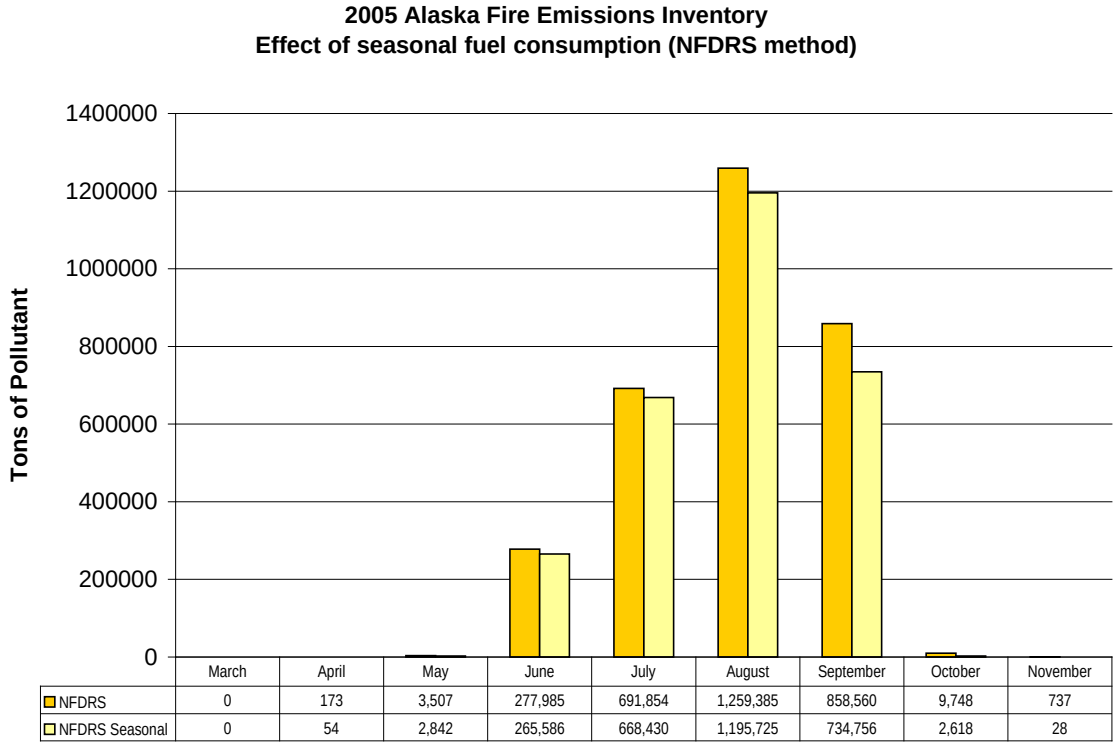
- A 30-meter resolution CFFDRS fuel layer GIS map replaced the NFDRS map.
- WRAP-modified fuel loadings were cross-walked to CFFDRS classes available in the map layer.
- Seasonality was introduced to fuel consumption calculations for fires with GIS perimeter data. The method, outlined in Section 1.4.2 and Section B.1, utilized results from the 2002 Inter-RPO Wildfire Emissions Inventory.
- Seasonal fuel consumption values, originally derived by NFDRS class, were cross-walked to CFFDRS.

These changes together resulted in a significant drop in emissions, from 3.2 million tons of $PM_{2.5}$ to 2.0 million tons, but also increased the precision of the overall results. The relative accuracy between the two methods remains an open question, as the fuel consumption values associated

with the 4 CFFDRS classes used in this inventory may underestimate the total available fuel in many cases. In the future, use of the Alaska Digital Photo Series (http://depts.washington.edu/nwfire/dps/) may provide more reasonable estimates of consumption.

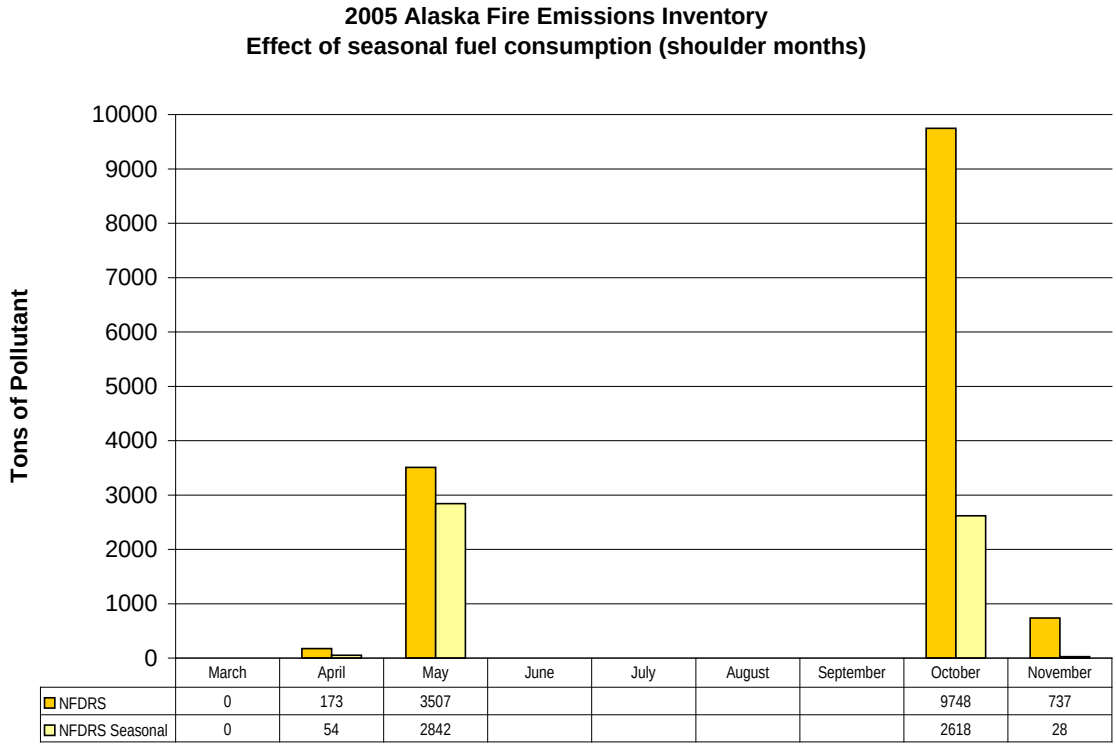
All of the changes made contributed to the drop in emissions. Seasonality contributed a small but significant amount. Figures C.2 and C.3 illustrate the effect of introducing seasonality to fuel consumption estimates. The data presented are from the draft version of the emissions inventory, which used NFDRS fuel classes. In addition, weighted average fuel loadings for fires with perimeter data were not used; instead, a single fuel classification was assigned to each fire. Figure C.3 highlights the "shoulder" months—obscured in Figure C.2—which are (as expected) the most significantly effected by seasonal fuel consumption estimates. In the context of total annual emissions, the influence of seasonal fuel consumption estimates remains small because most fire activity occurs during the driest months. However, for applications using event- or daily-based emissions inventory data the difference can be quite large. Given this significant effect, it is worthwhile—despite being limited to six moisture regimes and not directly tied to moisture conditions of a particular year—to include the seasonal adjustment of fuel consumption outlined here as part of the emissions inventory methods in Alaska.

Figure C.2: Monthly $PM_{2.5}$ Emissions With and Without Seasonal Fuel Consumption



	March	April	May	June	July	August	September	October	November
NFDRS	0	173	3,507	277,985	691,854	1,259,385	858,560	9,748	737
NFDRS Seasonal	0	54	2,842	265,586	668,430	1,195,725	734,756	2,618	28

Figure C.3: Monthly $PM_{2.5}$ Emissions With and Without Seasonal Fuel Consumption, Shoulder Months



The use of CFFDRS fuel classifications and a high-resolution fuels map had a larger effect than seasonal fuel consumption on total annual emissions. Figure C.4 illustrates the effect of using cross-walked CFFDRS fuel classes as well as using the weighted average refinement technique (Section B.1.1) with the 30-m CFFDRS fuel map. Compared here are the draft method using NFDRS classes (with seasonal fuel consumption), cross-walked CFFDRS classes with seasonal fuel consumption but without weight average fuel loading, and the final 2005 emissions inventory method with both seasonal fuel consumption and weighted fuel average refinement. Both CFFDRS methods mainly affect larger fires. The most significant effect due to the high resolution map is only for the largest 17 fires, greater than 100,000 acres. This is possibly due to the difference in vegetation distribution between the NFDRS map and the CFFDRS map (discussed below).

In the draft inventory, a 1-km fuel map was used that does not capture water bodies such as rivers and small lakes, nor does it capture nearly as much detail about the distribution of fuels across the landscape, which can lead to a significantly different estimate of fuel consumed. As an example, Figure B.3 in Section B.1.1 shows the distribution of CFFDRS fuel classes when using the refinement technique. Table C.2 below compares the distribution to that obtained with the 1-km NFDRS data. There is a marked difference in the fuel distribution, especially the percentage

of grass-type fuels and non-fuel areas. The percentage of non-fuel grid cells for all fires was much higher for the CFFDRS layer, as shown in Table C.3. In addition, there was a 73-percent increase in the total area of grass-type fuels for all fires with the CFFDRS fuel map.

Figure C.4: Relative Effect of Using CFFDRS Fuels Classifications and a High Resolution Fuels Map for Weighted Fuel Loading GIS Refinement Technique

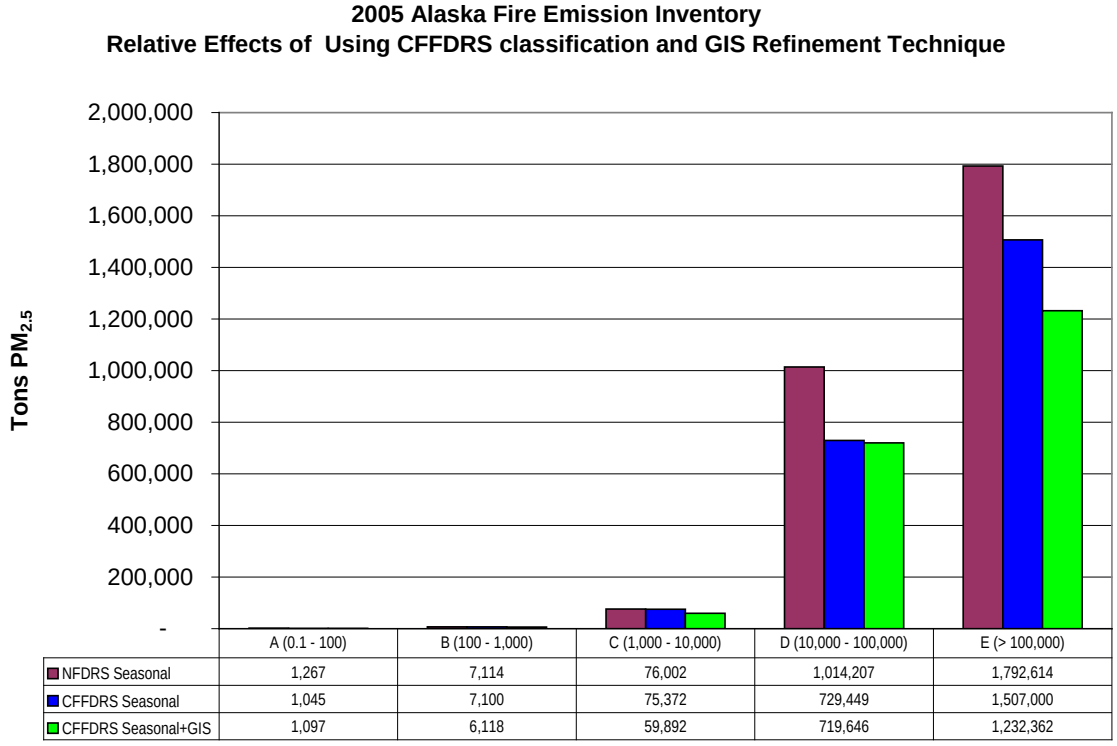


Table C.2: Comparison of Fuel Type Distribution for the George Using 1-km and 30-Meter Data

Fuel Type	NFDRS 1 km	CFFDRS 30 m
Q [C2]	37%	43%
A/L [O1a/O1b]	12%	23%
F/G [M1/M2]	52%	31%
S [O1]	0%	1.0%
Null [Non-fuel]	0%	2.3%

Table C.3: Total km^2 of Non-Fuel Grid Cells for NFDRS GIS Layer and CFFDRS Layer

		Out of Bounds	Non-Fuel	Water	Undet.	Total km^2	Percent of all Fires
CFFDRS	km^2	0.0738	706	200	443	1,350	7.2%
	%	0.01%	52%	15%	33%		
NFDRS	km^2	29.4	80.3			110	0.6%
	%	27%	73%				