

RUBY ROAD DUST  
PM<sub>10</sub> MONITORING  
2015-2016  
RUBY, ALASKA



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August 2017

## Table of Contents

<b>TABLE OF CONTENTS</b> .....	<b>2</b>
<b>LIST OF FIGURES</b> .....	<b>2</b>
<b>PROJECT SUMMARY</b> .....	<b>3</b>
<b>BACKGROUND</b> .....	<b>4</b>
<b>RUBY LOCATION AND DEMOGRAPHICS</b> .....	<b>4</b>
<b>PUBLIC HEALTH</b> .....	<b>5</b>
<b>MONITORING PURPOSE</b> .....	<b>5</b>
<b>SITE DESCRIPTION</b> .....	<b>5</b>
<b>SAMPLING PROCEDURES</b> .....	<b>10</b>
<b>MONITORING RESULTS AND DISCUSSION</b> .....	<b>12</b>
<b>CONCLUSIONS</b> .....	<b>14</b>
<b>REFERENCES</b> .....	<b>15</b>
<b>APPENDIX: RUBY METEOROLOGICAL DATA FOR MAY AND JUNE 2015 AND 2016</b> .....	<b>16</b>

## List of Figures

Figure 1. Location of Ruby, Alaska. ....	4
Figure 2. River Road – Billy’s Shop site (on left); Safehouse site (on right) .....	6
Figure 3. Good Time Road – Don Jr’s House site (on left); Church site (on right) .....	6
Figure 4. Map of PM10 monitoring sites. The Safehouse and Billy’s Shop are located on River Road (1&2). Don Jr.’s House and the Church are located on Good Time Road (3 & 4), Katherine’s House is located on Airport Road (5), and the Clinic is located on Mosquito Street (6). ....	8
Figure 5. Dust palliative application route: Durasoil shown in blue and Envirokleen shown in red. ....	9
Figure 6. (a) Tribal staff member changing filter at Church site. (b) Filter run for 24-hours with PM10 deposited on surface. ....	10
Figure 7. 2015 Sample Season Results.....	12
Figure 8. 2016 Sample Season Results.....	13

## PROJECT SUMMARY

This report provides an analysis of particulate matter (PM<sub>10</sub>) data measured and reported by the Alaska Department of Environmental Conservation (DEC) in support of a two-year joint pilot project between the Native Village of Ruby, DEC, the University of Alaska, Fairbanks (UAF), the Federal Highway Administration (FHWA), and the Environmental Protection Agency (EPA). Air monitoring efforts for this project were designed by DEC to study the effectiveness of synthetic-fluid dust palliatives applied to unpaved roads in Ruby, Alaska in reducing airborne road dust, measured as PM<sub>10</sub>. The intent was to collect pre and post application PM<sub>10</sub> concentrations at several locations alongside treated and untreated sections of roads to determine if a measurable improvement to air quality could be associated with the dust palliative application.

In early May 2015, DEC established five roadside Hi-Volume (Hi-Vol) PM<sub>10</sub> air monitoring sites in Ruby to be operated by employees of the Native Village of Ruby. Ruby tribal staff initially collected periodic roadside PM<sub>10</sub> samples between May 30<sup>th</sup> and August 22<sup>nd</sup> of 2015. Most of the summer 2015 PM<sub>10</sub> sampling events preceded the mid-July 2015 treatment of Ruby's roads with synthetic-fluid dust palliatives. The palliative treatments were applied by UAF researchers and the Ruby road maintenance crew between July 20<sup>th</sup> and 23<sup>rd</sup> of 2015. To evaluate the long-term effectiveness and duration of the dust palliative treatments, Ruby personnel resumed periodic PM<sub>10</sub> sampling between May 26<sup>th</sup> and June 23<sup>rd</sup> of 2016 at the same sampling locations along the treated road sites.

Although DEC intended for the collection of Hi-Vol PM<sub>10</sub> samples at a minimum of every third day from June - August of 2015 and 2016, sample schedules were shortened due to the interference of wildfires from late June through most of July, 2015; and were again shortened in 2016 due to shortages of trained staff available to operate the PM<sub>10</sub> samplers beyond June 23<sup>rd</sup>, 2016.

Due to the small size of the valid dataset, and large variations in precipitation and road surface dryness within the pre and post - treatment datasets, DEC was not able to adequately control for the effects of weather when attempting to quantify PM<sub>10</sub> reductions achieved via the July, 2015 application of synthetic-fluid dust palliatives to roads in Ruby. As a result, DEC was not able to quantify the overall effectiveness of the palliative application in reducing PM<sub>10</sub> concentrations or develop a comparison of the effectiveness of each type of palliative used in the study. Data collection could be improved in future studies by using continuous PM<sub>10</sub> samplers that report hourly data.

In February 2017 UAF finalized a report titled Ruby Dust Management Demonstration Project which details their summer, 2015/16 performance and cost evaluation study. The full report can be found on DEC's website at: <http://dec.alaska.gov/AIR/anpms/projects-reports/PM-proj-repts.htm>. In summary, the UAF report concluded that the expected performance life of the palliatives was one season.

## Background

In 2014, the Native Village of Ruby received funding to apply two synthetic-fluid dust palliatives to local roads. The pilot project between the UAF, FHWA, EPA, and DEC; and the Native Village of Ruby was intended to test the application methods, effectiveness, and durability of two polymer dust palliatives, Envirokleen and Durasoil on several road sections in the community of Ruby.

## Ruby Location and Demographics

The village of Ruby (centered at 64°44'14"N and 155°29'16"W) is situated on the south bank of the Yukon River, approximately 225 air miles west of Fairbanks, Alaska (Fig. 1).



Figure 1. Location of Ruby, Alaska.

The population is approximately 200<sup>1</sup>. None of the roads in the community are paved. These dirt roads are the main source of airborne particulate matter in Ruby on dry days in summer, and in winter if the ground surface is lacking snow cover.

Ruby's roads, are used by passenger cars and trucks, pedestrians and numerous all-terrain vehicles (ATVs) commonly referred to as "4-wheelers". Road dust in Ruby typically results from the disturbance of dry road surfaces by vehicle traffic - especially when traveling at elevated speeds. Ruby road maintenance staff have historically applied water to local roads via water truck as needed to suppress excessive road dust. However; according to Ruby Tribal Staff and residents, such applications are effective for only an hour or so on dry summer days.

<sup>1</sup> U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates

## Public Health

The Clean Air Act (CAA) authorizes the EPA to set air quality standards to protect the health and welfare of the public and the environment. The EPA has set National Ambient Air Quality Standards (NAAQS) for seven common air pollutants known as the Criteria Air Pollutants, which includes particulate matter with a diameter smaller than 10 microns (PM<sub>10</sub>). PM<sub>10</sub> is an air quality parameter used to assess health impacts from airborne road dust. The NAAQS for PM<sub>10</sub> is a 24-hour average concentration of 150 µg/m<sup>3</sup>. EPA established the PM<sub>10</sub> NAAQS to protect susceptible segments of the populace, such as infants, children, the elderly, and people with heart or lung ailments. The EPA refers to such individuals as “Sensitive Groups”. The EPA’s criteria for compliance with the PM<sub>10</sub> NAAQS is no more than one exceedance of the standard per year on average, when measured over any three-consecutive calendar year period.

## Monitoring Purpose

The purpose of the 2015 - 2016 PM<sub>10</sub> monitoring in Ruby was to measure ambient airborne road dust concentrations as PM<sub>10</sub> before and after application of synthetic-fluid dust suppressants (completed 20 - 23 July, 2015) to evaluate the short and long-term effectiveness of such treatments for controlling road dust from unpaved roads in Ruby and similar villages in interior Alaska. EPA-approved Federal Reference Method, Hi-Vol, PM<sub>10</sub> samplers were used to measure the concentrations of PM<sub>10</sub> on both sides of River Rd, which was treated with the dust suppressant Durasoil; and on both sides of Good Time Rd, which was treated with the dust suppressant Envirokleen 2800. A fifth PM<sub>10</sub> sampler was set-up at an untreated control site, which was established to evaluate the effectiveness of the two dust suppressant products relative to an un-treated road. Same-day comparisons of treated site data vs. the control site data were intended to account for changes in uncontrollable conditions; such as wind speed, precipitation and sun exposure; which were presumed to equally affect PM<sub>10</sub> levels at the sample sites and the control site.

## Site Descriptions

PM<sub>10</sub> sampler locations were chosen based on the routes where either brand of palliative was to be applied and on the availability of a nearby power sources. Sites were placed on each side of the road to account for days with different predominant wind directions (which are usually from the north or from the south depending on time of day and convective air flow). Samplers were placed on each side of Good Time Rd and River Rd in fairly close proximity to each other to account, and potentially control for the influences of wind direction upon the concentration of PM<sub>10</sub> measured along each side of those east/west routes. Each of the five samples were located on the shoulders of frequently-traveled unpaved routes, and all samplers were placed within three feet of their adjacent traffic lane (Fig. 2).

DEC installed five PM<sub>10</sub> monitors in three different locations in Ruby (River Road, Good Times Road, and the Control site). Two PM<sub>10</sub> Hi-Vol samplers were situated on either side of River Road approximately 65 feet apart from each other.

### River Road: Location of Billy’s Shop and Safehouse samplers

The two site names on River Road are referred to as “Safehouse” and “Billy’s Shop”. The Safehouse sampler was situated on the north side of River Road and the sampler at Billy’s Shop was placed on the south side of River Road.



Figure 2. River Road – Billy's Shop site (on left); Safehouse site (on right)

Good Time Road: Location of Don Jr.'s House and Church samplers

An additional pair of samplers was placed on each side of Good Time Road with a separation distance of approximately 30 feet between them. The sampler on the north side of Good Time Road was named the "Don Jr's House" site and the sampler located on south side of Good Time Road was named the "Church" sample site.



Figure 3. Good Time Road – Don Jr's House site (on left); Church site (on right)

Control Sites: Katherine's House (2015 Control Site) and Clinic (2016 Control Site)

The original control site was located near Katherine's house on Airport Road from May 30<sup>th</sup>, 2015 through August 22<sup>nd</sup>, 2015. The control site was intended to remain next to an untreated roadway so that it could be used as a benchmark to measure the effectiveness of the palliative on the treated roads. The "Katherine's House" site was originally chosen as the control site because its proximity to Airport Rd (a high traffic route) as well as being a location where children frequently play. It was moved in late August 2015 to a new untreated roadway location on the east side of Mosquito St, adjacent to the parking lot of the Ruby Health Clinic, after DEC learned that the application of palliative had been extended just beyond Katherine's house. The new "Clinic" control site sampler was re-calibrated upon relocation. See Figure 4 below for locations of the control site at the Katherine's House site during 2015 and the new Clinic control site location used for the 2016 sample season.

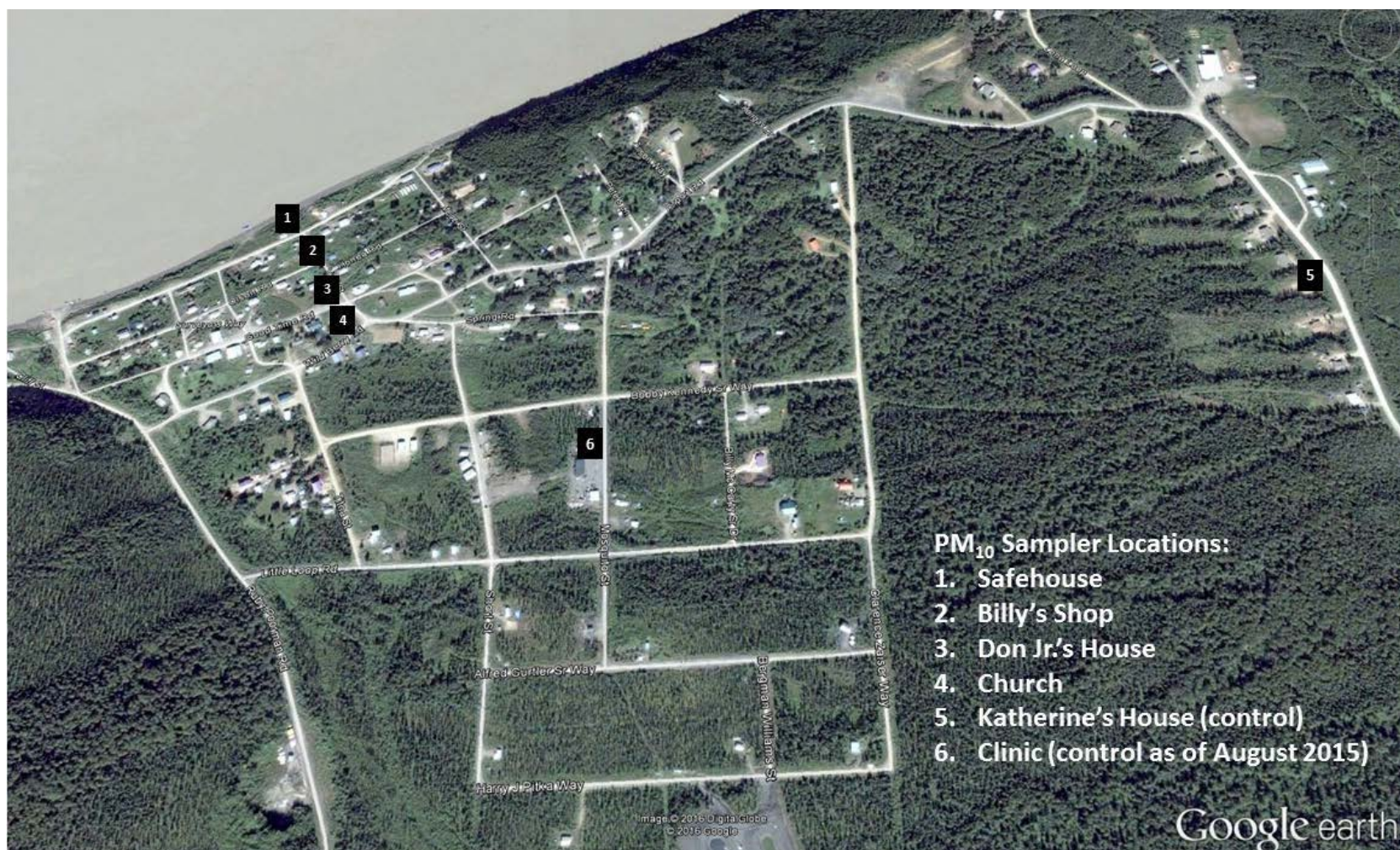


Figure 4. Map of PM<sub>10</sub> monitoring sites. The Safehouse and Billy's Shop are located on River Road (1&2). Don Jr.'s House and the Church are located on Good Time Road (3 & 4), Katherine's House is located on Airport Road (5), and the Clinic is located on Mosquito Street (6).



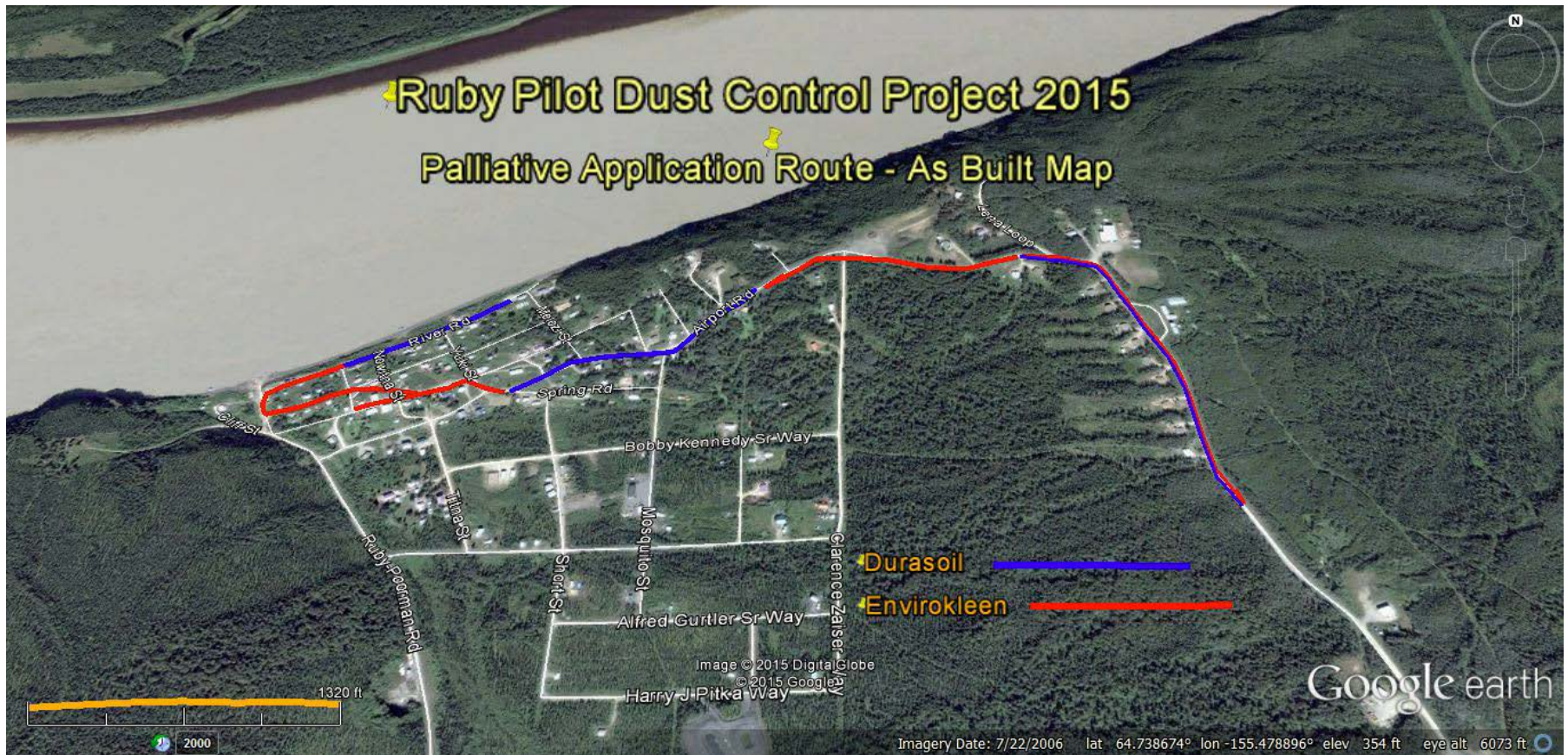


Figure 5. Dust palliative application route: Durasoil shown in blue and Envirokleen shown in red.

## Sampling Procedures

In May 2015 DEC installed five Anderson/GMW-1200 series, PM<sub>10</sub> high-volume air samplers, which are considered EPA-approved as Federal Reference Method for the collection of PM<sub>10</sub>. Following sampler installation, DEC trained Tribal staff on the operation of the Hi-Vol samplers and provided proper protective sleeves and envelopes for shipment of the filters to DEC for analysis.

Before being placed in the sampler, filters were pre-weighed on a high-precision scale in the DEC air quality laboratory located in Juneau to determine the weight of the filter without any dust deposit. The filter was then installed in the sampler, which used a mechanical timer to turn it on at midnight of the sample day and turn it off after it sampled for 24 hours. Ambient air was drawn in through the sampler head and filter media by a pump, similar to a vacuum cleaner motor so that airborne particulates were trapped on the filter. After sampling, the filter was returned to the laboratory and weighed again to determine how much dust was deposited on the filter. The difference between the two weights divided by the volume of air drawn through the filter is the measurement that is used to determine 24-hour mass concentrations of PM<sub>10</sub>.

DEC was responsible for instrument maintenance, calibrations, and quality control (QC) checks. Ruby Tribal staff completed the day-to-day operation of the samplers, changing the filters after each run, recording the flow reading from the instrument's mass flow controller, and recording the number of minutes elapsed during each sample run. Figure 6a shows a PM<sub>10</sub> high-volume sampler with the sample chamber open. Figure 6-b is an example of an exposed PM<sub>10</sub> sample filter loaded with PM<sub>10</sub> particulate matter.



Figure 6. (a) Tribal staff member changing filter at Church site. (b) Filter run for 24-hours with PM<sub>10</sub> deposited on surface.

In both 2015 and 2016, the samplers were intended to run every third day, from mid-May through mid-September. However, sampling ended prematurely in 2015 due to wildfires<sup>2</sup>, and in 2016 due to unavailability of trained personnel to operate the samplers.

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<sup>2</sup> The smoke from the wildfires overwhelmed the sampler and made measurement of road dust impossible. PM<sub>10</sub> High-Vol measurements cannot distinguish between road dust and smoke as a source of particulate matter. Additional analysis would be necessary.

Ruby tribal staff commenced collection of PM<sub>10</sub> samples via operation of the Hi-Vol samplers May 30<sup>th</sup>, 2015. DEC staff returned to Ruby in June, 2015 to complete monthly QC checks on all five monitors.

Due to heavy wildfire smoke in Ruby during the last week of June and the first three weeks of July of 2015, the sampler motors were unable to pull sufficient air through the instrument as ash accumulated in the inlets of the samplers and on sample filters. Filters from incomplete sample events in July 2015 were voided and sampling was suspended until DEC staff returned in mid-August 2015. DEC staff cleaned all monitors of wildfire smoke and ash residue, and they replaced the motors at the Safehouse, Billy's Shop, Don Jr.'s, and the Church sites. All five monitors were then re-calibrated. The monitors ran once on August 22<sup>nd</sup>, 2015 following recalibration and then sampling was suspended for the remainder of the 2015 sampling season due to onset of the fall rainy season.

DEC staff returned to Ruby again in May 2016, cleaned and re-calibrated the monitors, and prepared them for the 2016 summer sampling season. Ruby tribal staff resumed PM<sub>10</sub> sampling on May 26<sup>th</sup>, 2016.

## Monitoring Results and Discussion

### 2015 Sampling Season

DEC received 44 sample filters collected by Ruby staff over nine sample days between May 30<sup>th</sup> and August 22<sup>nd</sup>, 2015 for all five sampling sites combined. DEC found 32 of those samples valid according to EPA validation criteria. Eleven samples were void because sample collection duration did not fall within the acceptable range of 23 to 25 hours. One additional sample was void due to a filter weighing error. PM<sub>10</sub> measurement above the NAAQS (150 µg/m<sup>3</sup>) were observed on three of the eight valid sample days during the 2015 sample season. Results from the June 26<sup>th</sup> and 29<sup>th</sup>, 2015 sampling events were likely impacted by wildfire smoke which would indicate that the exceedances recorded on those days cannot be attributed to road dust alone. In each instance, exceedance values were observed concurrently at two or more sampling locations. The 2015 valid sample results appear below in Figure 7 with the full data set included as a Microsoft Excel file attached to this report.

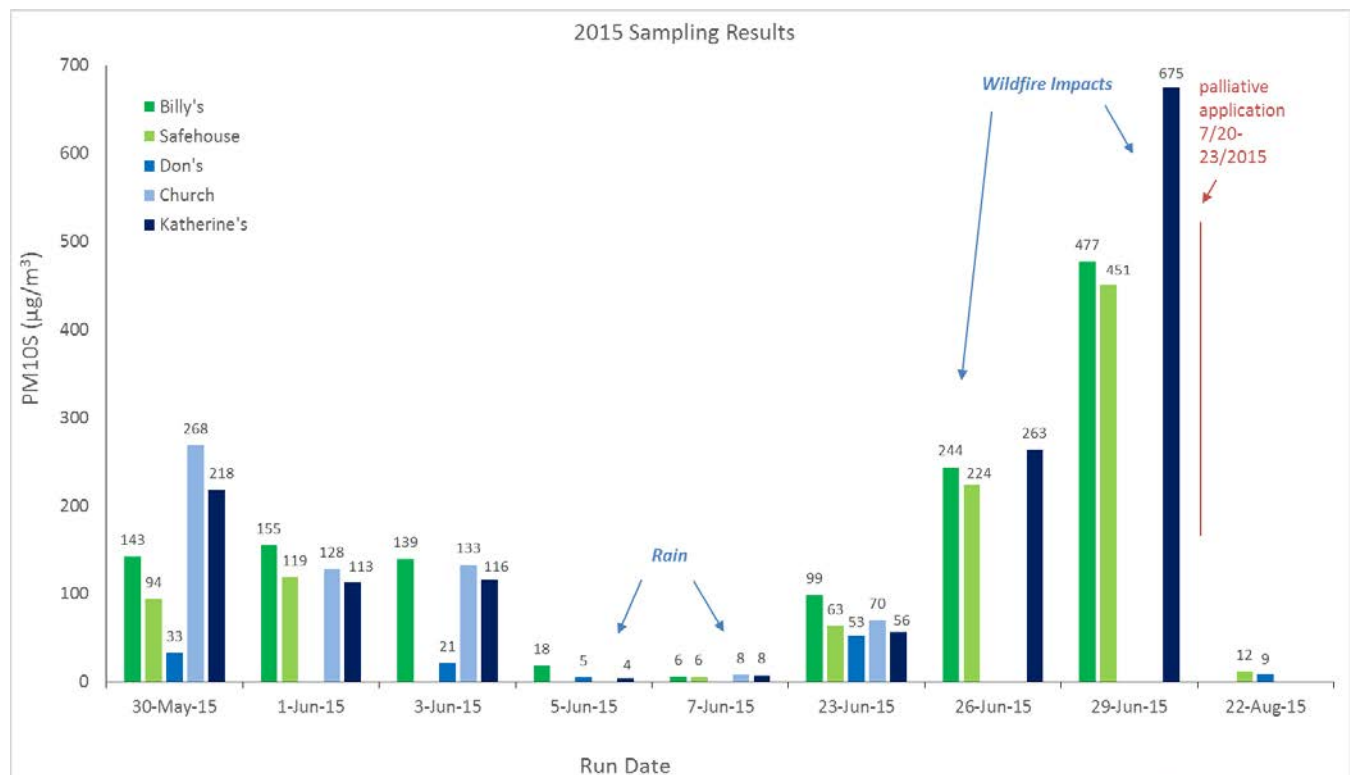


Figure 7. 2015 Sample Season Results

## 2016 Sampling Season

DEC received 55 filters collected by Ruby staff over 10 sample days occurring between May 26<sup>th</sup> and June 23<sup>rd</sup>, 2016 for the five sampling sites combined. DEC was able to validate 32 of those samples via the same EPA validation criteria. Due to instrument malfunction 18 of the sample runs did not meet the required sampling time allowed of 23-25 hours from midnight to midnight. An additional five samples were invalid due to filter weighing errors. PM<sub>10</sub> measurements in excess of the PM<sub>10</sub> NAAQS were observed on five of the 10 sample days during the 2016 sample season; however, all five exceedance values were obtained solely at the Church site. The 2016 valid sample results appear in Figure 8 with the full data set included as an Attachment to this report.

The June 1<sup>st</sup>, 2016 sample had an unusual pre-sample weight, much lower than the other filters from the same batch. No obvious weighing error had been documented, but DEC decided to use the average of the pre-sampling weight from the filters at that site to estimate the concentration for that day. The concentration would calculate to 2152 µg/m<sup>3</sup> if the pre weight from the lab was used, versus an estimated concentration of 178 µg/m<sup>3</sup>, which seems more reasonable compared to the other measurements for this site. While the Church site results for 2016 seem to be in the range of the 2015 pre-palliative application values, they appear significantly higher than the concurrent sample results from all other sampler locations. No procedural or calibration error was found to account for the uncommonly high PM<sub>10</sub> results obtained from the Church sampler. The Church site and Don Jr's House site are approximately 25 feet apart from each other, on either side of Good Time Road. While the Church site results in themselves might be consistent, they do not match all the other sites, which all have generally similar values for the 2016 sampling period. The high concentration may be a result of some systematic error, some measurement inaccuracy or another unknown issue. Due to lack of sufficient data and information to compare the results or another study to investigate specific site issues, DEC cannot determine if the measurements at the Church site should be considered valid.

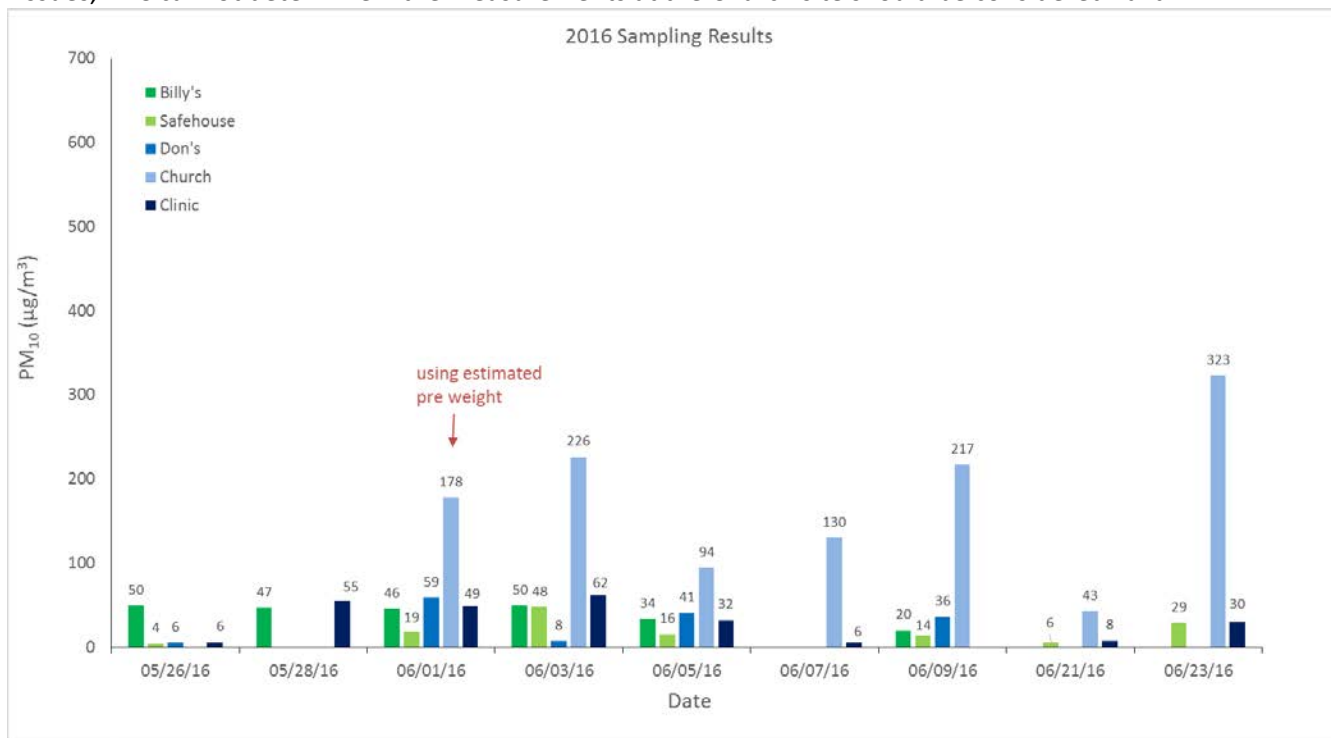


Figure 8. 2016 Sample Season Results

## Discussion

During the two year monitoring period, Ruby Tribal Staff encountered sample collection challenges due to weather, staffing shortages, and wildfires. Smoke odor was first noted in field logs on June 26<sup>th</sup>, 2015 and sampling was suspended after June 29<sup>th</sup> due to a significant quantity of airborne ash. Wildfire smoke and ash continued to impact the Village of Ruby throughout July 2015. Abbreviated sample schedules resulted in fewer than anticipated PM<sub>10</sub> sampling events in both 2015 and 2016. Due to variable precipitation occurring over relatively few sample events DEC staff could not reasonably control for the variation in weather patterns when comparing the data from each sample season. When DEC needed to select a new control site for the Summer-2016 sample season, loss of continuity in the control site between the 2015 and 2016 sample seasons prevented DEC from normalizing treated road data for each sample season relative to the same benchmark control site. Consequently, DEC could not confidently quantify reductions in PM<sub>10</sub> attributable solely to the road dust palliative treatments.

With exception of the high measurement of PM<sub>10</sub> at the Church site in 2016, PM<sub>10</sub> concentrations measured at both treated and control sites alike appear largely reflective of road surface dryness as explained by the amount of precipitation received and cloud cover present during each sample event and the prior day or two. An analysis of the data in respect to wind speed and directions did not yield any conclusive results. Overall, the daily particulate concentration is a function of many factors including wind direction and wind speed, the temperature and precipitation, i.e. dryness of the road, and passing vehicle traffic, both in numbers and in type. Tables of hourly precipitation and daily meteorological conditions at the Ruby airport for each day during May and July of 2015 and 2016 are provided in the appendix of this report. Although wind direction and wind speed at the Ruby Airport may have been different than conditions at each PM<sub>10</sub> sampling location due to topographical differences, observations of sky conditions, such as cloud cover, and the amounts of precipitation measured each day are likely to have been very similar throughout the general area.

## Conclusions

Two different types of dust suppressants were applied on three sections of the most traveled roads in Ruby in July 2015. Unfortunately, due to the 2015 wildfire season in late June and the lack of sample dates, the success of dust suppressant applications was difficult to quantify. Effectiveness of road treatments could not be distinguished from the influence of observed precipitation patterns.

Additionally, too few samples were collected to determine, with confidence, the effectiveness or longevity of dust palliative treatments. Effectiveness and longevity of dust suppressant applications depends on many factors, a discussion of which is beyond the scope of this report. To increase the success of collecting sufficient data for confident statistical analysis, future project planners may want to consider using continuous analyzers versus manual samplers. Continuous samplers would reduce the labor required to conduct the study and provide a more robust dataset of hourly concentrations. Hourly concentrations could be compared to other hourly data such as estimated diurnal road usage, wind data, and precipitation data to better characterize the effectiveness of dust palliative applications at reducing PM<sub>10</sub> concentrations in the ambient air.

## References

Hourly Precipitation Tables for Ruby Airport; May 2015, June 2015, May 2016, June 2016 & August 2016; Data obtained from Quality Controlled Local Climatological Data (QCLCD), National Climate Data Center (NCDC), National Oceanic & Atmospheric Administration, U.S. Department of Commerce. Data accessed via: <https://www.ncdc.noaa.gov/qclcd/QCLCD>

## Appendix-A: Ruby Meteorological Data for May and June 2015 and 2016



**QUALITY CONTROLLED LOCAL  
 CLIMATOLOGICAL DATA  
 (final)  
 HOURLY PRECIPITATION TABLE  
 RUBY AIRPORT (26561)  
 RUBY, AK  
 (05/2015)**

A.M. HOUR(L.S.T) ENDING AT												P.M. HOUR(L.S.T) ENDING AT														
DT	1	2	3	4	5	6	7	8	9	10	11	12	DT	1	2	3	4	5	6	7	8	9	10	11	12	DT
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8												T	8								T	T			8	
9												T	9												9	
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11				T									11												11	
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13													13						T						13	
14				T	T	T	T	0.02	0.01S	T			14				T	T	0.01	0.01	0.01S	T	T		14	
15													15												15	
16								T	T				16												16	
17													17												17	
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19	T	T	T	T	T						T		19			0.02	T	0.03	T						19	
20													20							T	T	T	T	0.01S	20	
21					T	T	T	0.01	0.01S	T			21												21	
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29													29										T	T	T	29
30													30												30	
31													31												31	

*T = trace, S = suspect  
 Rainfall is measured in inches  
 Grey indicates PM<sub>10</sub> sampling occurred on that day*

**QUALITY CONTROLLED LOCAL  
 CLIMATOLOGICAL DATA  
 (final)  
 HOURLY PRECIPITATION TABLE  
 RUBY AIRPORT (26561)  
 RUBY, AK  
 (06/2015)**

A.M. HOUR(L.S.T) ENDING AT													P.M. HOUR(L.S.T) ENDING AT													
DT	1	2	3	4	5	6	7	8	9	10	11	12	DT	1	2	3	4	5	6	7	8	9	10	11	12	DT
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6											T		6													6
7								T			0.01	T	7	T			T	T	T							7
8							T	T			T	T	8			T	0.01	T		0.02	0.01	T	T	T	T	8
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30													30											T	T	30

**QUALITY CONTROLLED LOCAL  
 CLIMATOLOGICAL DATA  
 (final)  
 HOURLY PRECIPITATION TABLE  
 RUBY AIRPORT (26561)  
 RUBY, AK  
 (05/2016)**

A.M. HOUR(L.S.T) ENDING AT												P.M. HOUR(L.S.T) ENDING AT														
DT	1	2	3	4	5	6	7	8	9	10	11	12	DT	1	2	3	4	5	6	7	8	9	10	11	12	DT
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2													2							T					2	
3											T	T	3	T	T	T	0.03	0.02	0.01S			T			3	
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5													5							T					5	
6													6							T					6	
7													7					T							7	
8												T	8	T	0.05	T	0.04	T	0.02	T	T	T			8	
9		T	T	T	0.01	0.01S	0.01	T	T			T	9			T		T							9	
10													10								T	T		T	10	
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12				T	0.01	0.01S	0.01	T					12		T	T			T			T	T		12	
13			T										13												13	
14													14												14	
15													15												15	
16													16												16	
17													17								T				17	
18			T	0.01	T	0.02	0.01	T	0.01S				18									T	T	T	18	
19								T	T	T	T	T	19	T											19	
20				T	T	T	T		T	T	T	0.01S	20	0.03	T	T	T	0.01	T	0.03	T	T	0.01	T	T	20
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23				T		T	0.02	T	0.01S				23					T	T	T	T	T	T	T		23
24		T	T	T	0.01	T	0.01	0.01	T			T	24		T	T					T	T			T	24
25						T	T	T	T	0.02	T	T	25	0.01	0.01	0.01S	T	0.01	T			T				25
26													26								T	T				26
27													27													27
28													28													28
29													29													29
30													30													30
31													31													31

**QUALITY CONTROLLED LOCAL  
 CLIMATOLOGICAL DATA  
 (final)  
 HOURLY PRECIPITATION TABLE  
 RUBY AIRPORT (26561)  
 RUBY, AK  
 (06/2016)**

A.M. HOUR(L.S.T) ENDING AT													P.M. HOUR(L.S.T) ENDING AT														
DT	1	2	3	4	5	6	7	8	9	10	11	12	DT	1	2	3	4	5	6	7	8	9	10	11	12	DT	
1													1													1	
2													2					T								2	
3													3							T						3	
4													4										T	T		4	
5								T	T	T	T		5			T	T	T	T							5	
6													6					T								6	
7									T	T		T	7	T	T		T	T								7	
8				T	0.02	T	0.02	0.02	0.02	0.01	T	T	8	T	T	T		T	T		0.01S	0.02				8	
9													9													9	
10													10													10	
11													11	0.01	T	T	0.01	T								11	
12													12						T	T	T	T				12	
13													13	T	T	T	T	T			T	T	T	T		13	
14												T	14	T				T				T	T	T		14	
15												0.03S	15													15	
16													16													16	
17												T	17					T				0.01S				17	
18				T	0.02	0.02	T	T	0.03	T			18		T	0.01S		T	T	0.05	0.06	0.03S	0.02	0.01	0.01S	18	
19	T	T	T	T				T	T	T		T	19	T	T			T	T	0.03	T				T	19	
20	0.01	T	0.01S	T	T	T	0.02	0.01	T	T	T		20	0.01	0.01	T	0.03	0.05	0.03S							20	
21			0.02										21	T	T								T			21	
22													22													22	
23				T	T	T	T		T	T			23									T	0.01	0.1	0.07	0.11S	23
24	0.04	0.03	0.05S	0.01	0.01							T	24	T							T	T				24	
25													25		T	0.05S	0.02	0.03	T	T						25	
26													26			T	T									26	
27													27													27	
28													28													28	
29													29													29	
30													30													30	

**QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA**

**(final)**

**NOAA, National Climatic Data Center**

**Month: 05/2015**

**Station Location: RUBY AIRPORT (26561)**

**RUBY, AK**

Lat. 64.727 Lon. -155.469

Elevation(Ground): 653 ft. above sea level

Date	Temperature (Fahrenheit)					Degree Days Base 65 Degrees			Sun		Significant Weather	Snow/Ice on Ground(In)		Precipitation (In)		Pressure (inches of Hg)		Wind: Speed=mph Dir=tens of degrees					Date							
	Max.	Min.	Avg.	Dep From Normal	Avg. Dew pt.	Avg Wet Bulb	Heating	Cooling	Sunrise LST	Sunset LST		1200 UTC	1800 UTC	2400 LST	2400 LST	Avg. Station	Avg. Sea Level	Resultant Speed	Res Dir	Avg. Speed	max 5-second	max 2-minute								
												Depth	Water Equiv	Snow Fall	Water Equiv						Speed	Dir		Speed	Dir					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26					
1					31	38			-	-	RA						29.94	8.3	9						1					
2					29	39			-	-							30.11	3.7	8						2					
3					24	39			-	-							30.15	3.7	6						3					
4					22	38			-	-							30.09	2.9	6						4					
5					24	39			-	-							30.01	1.2	32						5					
6					24	40			-	-							29.95	2.9	6						6					
7					29	42			-	-	RA						29.75	5.1	10						7					
8					36	42			-	-	RA						29.74	1	26						8					
9					38	45			-	-	FG+ BR						29.86	0.9	29						9					
10					42	45			-	-	RA BR						29.89	1.9	11						10					
11					37	45			-	-							29.93	1.3	8						11					
12					34	44			-	-							30.01	2	9						12					
13					33	45			-	-							29.75	6.1	11						13					
14					42	46			-	-	RA BR						29.72	2.3	11						14					
15					39	48			-	-	BR						29.69	2.9	8						15					
16					34	45			-	-	RA						29.89	6.8	21						16					
17					36	46			-	-							30	1	19						17					
18					41	48			-	-	RA						30.04	3.2	21						18					
19					45	50			-	-	RA						30.06	0.6	15						19					
20					40	48			-	-	RA						29.97	3.8	11						20					
21					42	47			-	-	RA BR						30.1	4.5	21						21					
22					41	50			-	-							30.07	6.6	8						22					
23					44	52			-	-	RA						29.88	0.9	15						23					
24					37	47			-	-	RA						29.99	1.6	22						24					
25					42	49			-	-	RA						30.03	0.7	12						25					
26					42	49			-	-	RA						30.09	0.5	10						26					
27					42	51			-	-							30.17	1.5	26						27					
28					42	48			-	-	RA						30.3	2.8	25						28					
29					40	49			-	-							30.26	0.5	25						29					
30					39	51			-	-							30.13	1.2	5						30					
31					36				-	-							30	9.3	8						31					
					36.4	45.5			<-----Monthly Averages   Totals----->															1.6	11	<Monthly Average				

**QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA**

**(final)**

**NOAA, National Climatic Data Center**

**Month: 06/2015**

**Station Location: RUBY AIRPORT (26561)**

**RUBY, AK**

Lat. 64.727 Lon. -155.469

Elevation(Ground): 653 ft. above sea level

Date	Temperature (Fahrenheit)					Degree Days Base 65 Degrees			Sun		Significant Weather	Snow/Ice on Ground(In)		Precipitation (In)		Pressure (inches of Hg)		Wind: Speed=mph Dir=tens of degrees					Date			
	Max.	Min.	Avg.	Dep From Normal	Avg. Dew pt.	Avg Wet Bulb	Heating	Cooling	Sunrise LST	Sunset LST		1200 UTC	1800 UTC	2400 LST	2400 LST	Avg. Station	Avg. Sea Level	Resultant Speed	Res Dir	Avg. Speed	max 5-second	max 2-minute				
												Depth	Water Equiv	Snow Fall	Water Equiv						Speed	Dir		Speed	Dir	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
1					23	40			-	-							29.97	12.2	9						1	
2					24	41			-	-							29.75	7.5	7						2	
3					27	41			-	-	RA						29.59	7.3	7						3	
4					35	42			-	-	RA						29.4	3.8	7						4	
5					41	44			-	-	RA FG BR						29.48	0.3	23						5	
6					38	44			-	-							29.75	1.2	8						6	
7					40	46			-	-	RA						29.79	2.3	20						7	
8					40	45			-	-	RA						29.79	3.5	16						8	
9					40	46			-	-	RA						29.58	3.1	10						9	
10					39				-	-	RA BR						29.55	3.6	24						10	
11					30	38			-	-							29.95	1.1	28						11	
12					36	44			-	-							30.36	4.3	22						12	
13					41	47			-	-							30.57	2.2	21						13	
14					41	53			-	-							30.5	0.9	28						14	
15					39	53			-	-							30.36	1.9	30						15	
16						M			-	-								M	M							16
17					37	52			-	-							30.08	3.8	27						17	
18					44	57			-	-							29.92	0.7	29						18	
19					44	58			-	-							29.89	0.8	9						19	
20					50	59			-	-							29.96	1.4	24						20	
21					53	60			-	-	RA HZ						29.97	1.6	23						21	
22					54	61			-	-	HZ						29.92	2	26						22	
23					53	60			-	-	HZ						29.9	1.8	24						23	
24					48	57			-	-	HZ						29.81	2.2	25						24	
25					42	53			-	-	HZ						29.7	4.5	24						25	
26					42	50			-	-	HZ						29.71	5.4	22						26	
27					45	52			-	-	HZ						29.83	2.5	9						27	
28					48	54			-	-	BR HZ						29.86	0.8	8						28	
29					48	55			-	-	FG+ HZ						29.87	4.8	8						29	
30					47				-	-	RA HZ						29.98	2.9	24						30	
					41				<-----Monthly Averages   Totals----->												0.6	15	<Monthly Average			

**QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA**

**(final)**

**NOAA, National Climatic Data Center**

**Month: 05/2016**

**Station Location: RUBY AIRPORT (26561)**

**RUBY, AK**

Lat. 64.727 Lon. -155.469

Elevation(Ground): 653 ft. above sea level

Date	Temperature (Fahrenheit)					Degree Days Base 65 Degrees			Sun		Significant Weather	Snow/Ice on Ground(In)		Precipitation (In)		Pressure (inches of Hg)		Wind: Speed=mph Dir=tens of degrees					Date		
	Max.	Min.	Avg.	Dep From Normal	Avg. Dew pt.	Avg Wet Bulb	Heating	Cooling	Sunrise LST	Sunset LST		1200 UTC	1800 UTC	2400 LST	2400 LST	Avg. Station	Avg. Sea Level	Resultant Speed	Res Dir	Avg. Speed	max 5-second	max 2-minute			
												Depth	Water Equiv	Snow Fall	Water Equiv					Speed	Dir	Speed		Dir	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1					30	41			-	-	RA						29.59	1.3	7						1
2					32	41			-	-							29.62	2.7	8						2
3					37	40			-	-	RA						29.73	1	23						3
4					34	40			-	-	RA						29.79	0.5	17						4
5					31	40			-	-	RA						29.71	2.5	7						5
6					29	41			-	-							29.52	0.5	4						6
7					34	42			-	-	RA						29.76	0.2	23						7
8					38	42			-	-	RA BR						29.97	1.1	17						8
9					38	44			-	-	RA BR						30.11	1.5	16						9
10					35	43			-	-	RA						30.21	4.4	13						10
11					42	46			-	-	RA						30.24	3.9	12						11
12					44	48			-	-	RA BR						30.36	0.7	9						12
13					44	50			-	-							30.4	0.5	30						13
14					36	47			-	-							30.14	1.1	2						14
15					36	47			-	-							29.86	1.5	8						15
16					32	44			-	-							29.84	14.4	8						16
17					25	35			-	-	RA UP						29.87	12.5	8						17
18					34	39			-	-	BR UP						30.03	9.4	8						18
19					38	43			-	-	RA						30.11	4.7	9						19
20					41	44			-	-	RA						29.81	2.5	9						20
21					42	45			-	-	RA BR HZ						29.76	3.3	21						21
22					37	41			-	-	RA BR						29.88	1	17						22
23					35	39			-	-	RA BR						30.03	6.9	23						23
24					37	41			-	-	RA						30.11	7.6	24						24
25					40	42			-	-	RA BR						30.19	3.9	24						25
26					39	44			-	-	RA HZ						30.31	1.1	27						26
27					41	49			-	-							30.21	1	4						27
28					38	51			-	-							30.13	6.6	8						28
29					33	49			-	-							30.1	13.1	9						29
30					32	48			-	-							30.04	11.2	8						30
31					36				-	-							29.86	1	27						31
					36.1	43.5			<-----Monthly Averages   Totals----->									2.3	10	<Monthly Average					





## Abbreviations Used in Meteorological Data

T	Trace Precipitation (an amount too small to measure, usually <0.005 inches water equivalent)
S	Suspect Value (appears with value)
M	Missing Value (appears instead of value)
Blank	Value is Unreported (appears instead of value)
RA	Rain
FG	Fog
FG+	Heavy Fog
BR	Mist
HZ	Smoke or Haze
UP	Unknown Precipitation

## NOAA Local Climatological Dataset Documentation

Full documentation for the NOAA Local Climatological Dataset (LCD) is available online at:  
[https://www1.ncdc.noaa.gov/pub/data/cdo/documentation/LCD\\_documentation.pdf](https://www1.ncdc.noaa.gov/pub/data/cdo/documentation/LCD_documentation.pdf).