

Butte Site Relocation

Study Report

November 2020 – March 2021

June, 2021

Air Quality Division

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&
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Program

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Table of Contents

Table of Contents	3
List of Figures	3
List of Tables	4
Introduction.....	4
Background.....	5
Study Design.....	7
Results.....	8
Conclusion	12
Next Steps	13
Appendix A.....	14

List of Figures

Figure 1:	Neighborhood monitor locations	5
Figure 2:	Topographic map showing the complex terrain surrounding Butte	7
Figure 3:	A graph showing the 24-hour concentration for each NHM and the Butte PM _{2.5} BAM	10
Figure A-1:	Pre study collocate: individual NHMs vs. the average NHM	14
Figure A-2:	Post study collocate: individual NHMs vs. the average NHM	15
Figure A-3:	Photos of the 2-1 Fire Station site from the cardinal directions looking towards the sensor.	17
Figure A-4:	Photos of the Elementary School site from the cardinal directions looking towards the sensor.	18
Figure A-5:	Photos of the Maintenance Shop site from the cardinal directions looking towards the sensor.	19
Figure A-6:	Photos of the Alaska Raceway Park site from the cardinal directions looking towards the sensor.	20
Figure A-7:	Photos of the Plant Material Center site from the cardinal directions looking towards the sensor.	21
Figure A-8:	Photos of the Pyrah Farm site from the cardinal directions looking towards the sensor.	22



Butte Relocation Study 2020-21

List of Tables

Table 1:	Summary of how many days fell into each AQI Category for the NHMs and Butte PM _{2.5} BAM	9
Table 2:	The daily AQI category, concentration, and 98th percentile recorded at each site.	11
Table A-1:	Pre study collocate summary of Individual NHMs vs the average NHM and the Butte PM _{2.5} BAM	14
Table A-2:	Post study collocate summary of Individual NHMs vs the average NHM and the Butte PM _{2.5} BAM	15
Table A-3:	NHM sensor flow checks	16

Introduction

The Department of Environmental Conservation (DEC) Division of Air Quality conducted a study from 11/10/20 to 3/4/21 in the Butte area to identify an alternative site for the Harrison Court regulatory monitoring station. The study was initiated in response to planned construction in the area that may impact data collection at the current Butte site and in response to complaints from the neighboring property owners.

DEC designed a saturation study using a network of six low-cost fine particulate matter (PM_{2.5}) monitors throughout the central Butte area as shown in **Figure 1**. The Air Monitoring and Quality Assurance Program (AMQA) of the Air Quality Division chose the Met One Neighborhood Particulate Monitor (NHM) for measuring PM_{2.5}.



Butte Relocation Study 2020-21

Butte Relocation Study Map (Public Parcels Highlighted)



Figure 1: Neighborhood monitor locations. Red pins are NPM site locations, and the yellow star indicates the current SLAMS site. The yellow borders represent public parcels of land.

Particulate Matter (PM) is one of six primary air pollutants designated as harmful by the United States Environmental Protection Agency (EPA) in the Clean Air Act. PM less than 2.5 microns in diameter ($PM_{2.5}$) was selected for the study because it is the primary pollutant of concern at the Butte State and Local Air Monitoring Station (SLAMS) site. However, because the sensor used in the study does not meet the regulatory requirements needed to officially compare to the National Ambient Air Quality Standard (NAAQS), the Division is only able to qualitatively conclude the trends of the pollutant at the sampling sites and not a specific concentration. The monitors were chosen to compare the trends and 24-hour averages to determine if a similar number of days within the same EPA Air Quality Index (AQI) Classifications were observed between the current Harrison Court site and the prospective new site location.

Background

DEC placed a monitoring station at Harrison Court in 1998 to monitor PM. EPA regulates two fractions of particulate matter (PM_{10} and $PM_{2.5}$) based on health impacts and has established health-based air quality standards for these pollutants. The NAAQS for $PM_{2.5}$ was lowered from



Butte Relocation Study 2020-21

65 $\mu\text{g}/\text{m}^3$ to 35 $\mu\text{g}/\text{m}^3$ in 2006. EPA requires a regulatory site to be in an area of the Anchorage Metropolitan Statistical Area (MSA) with the highest concentrations of $\text{PM}_{2.5}$. The Anchorage MSA includes the Municipality of Anchorage and the Matanuska-Susitna Borough. The Butte regulatory site is currently considered the site with the highest $\text{PM}_{2.5}$ concentrations in the Anchorage MSA and as a result, the Butte regulatory site cannot simply be removed from the Butte area without an appropriate substitute site. In 2018, residents near the Butte regulatory site informed DEC they were planning to develop plots of land to the west of the current site, and requested the site be removed or relocated.

$\text{PM}_{2.5}$ is typically generated by combustion processes like motor vehicles, industrial stack emissions, and wood smoke from forest fires, slash burning, or home heating. Butte has experienced elevated levels of $\text{PM}_{2.5}$ due to wood fired home heating devices and burning of slash piles. On days with strong temperature inversions, a layer of cold air is trapped closer to the ground under a layer of warmer air. Typical weather systems have a layer of warm air at lower altitudes that rise and mixes with the colder air at higher altitudes; this mixing allows for pollutants to be dispersed and diluted over a larger geographic area, resulting in lower concentrations. During an inversion, cold air at ground level does not mix with air at higher altitudes trapping particulates near ground level altitudes and increasing the public's exposure to pollutants, including $\text{PM}_{2.5}$.

As the development to the west of the current Butte site progresses, slash burning, construction, and other activities may impact the $\text{PM}_{2.5}$ values recorded at the regulatory site, resulting in a non-representative sample of the greater Butte area air quality. Successful relocation of the regulatory monitoring site will minimize impacts to sample validity and remove any spatial conflicts that may arise due to the construction project.

The Butte area is located to the southeast of Palmer. Butte is bordered on the west by the Matanuska River which is oriented north to south-southwest. The Knik River borders Butte to the south and is oriented east to west. There are mountains to the northeast and immediately south of the Knik river. There is an eponymous butte located in the western central area of Butte. The predominant winds travel from the east and southeast up the Knik river valley. On days with exceptionally high winds, elevated levels of PM_{10} are detected from windblown dust and glacial silt from the Knik riverbed. $\text{PM}_{2.5}$ pollution levels vary depending on meteorological conditions with higher levels expected to occur during clear, low wind periods in the winter, with the formation of cold weather inversions, and in the presence of wildfires during the summer. Lower levels of $\text{PM}_{2.5}$ pollution are expected with warmer weather, moderate winds that disperse air pollutants, and rain or snow that precipitate particulate matter to the ground surface.



Butte Relocation Study 2020-21

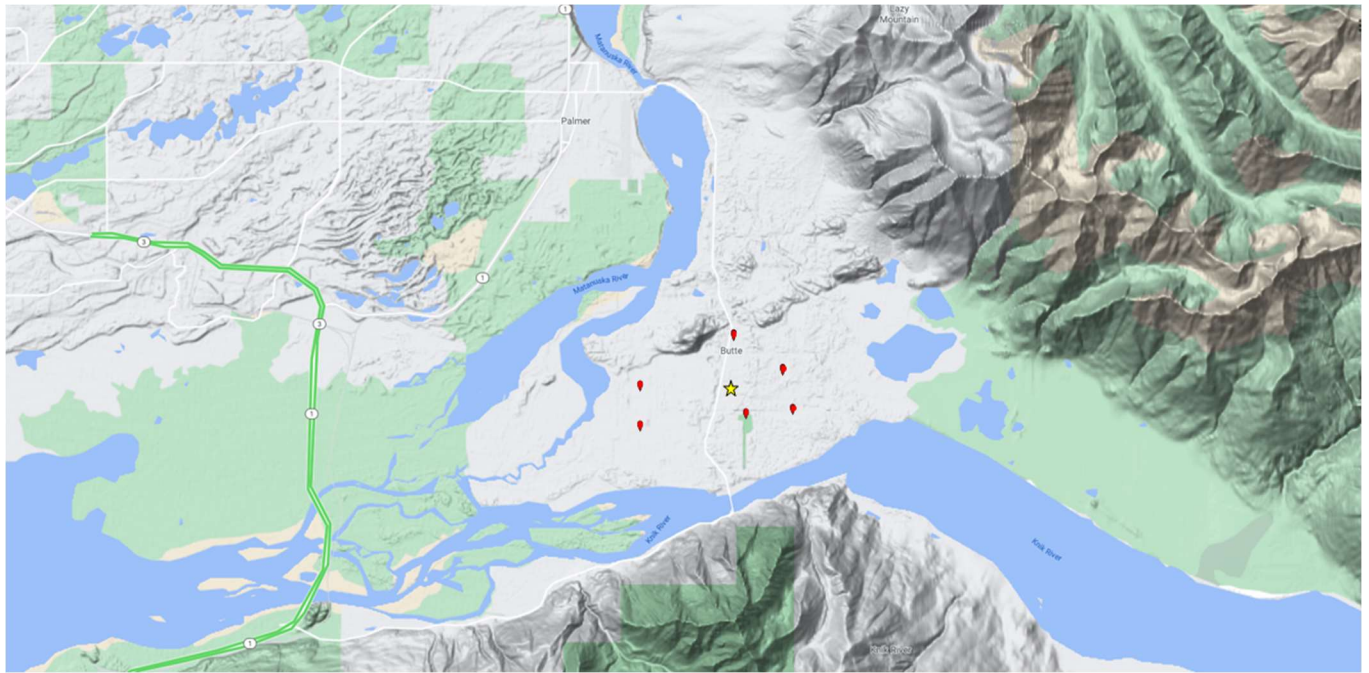


Figure 2: Topographic map showing the complex terrain surrounding Butte. The neighborhood monitor locations are marked with red pins and the yellow star indicates the current SLAMS site. Note the mountains to the northeast and south of Butte, as well as the Knik river to the south, and the Matanuska river to the west and northwest.

The complex terrain shown in **Figure 2** results in slow swirling airflow in the Butte airshed on days with an inversion or poor mixing. Due to this, ambient concentrations during elevated particulate levels may take many hours to over a day to propagate through the Butte community. Additionally, there may be unique localized sources at each site that behave differently on a short time scale, but when compared over a season or year may indicate a similar air quality impact. Because of this, AMQA is not looking to directly mimic the concentrations at the current Butte site but is instead looking for a similar number of days in each AQI category to determine a representative sample of the ambient air quality over time.

Study Design

AMQA used six Met One NHM-CDMA Sensors distributed to the north, east, south, and west of the Harrison Court site in Butte to identify areas of similar impact and general trends of PM_{2.5} levels in the community; a seventh NHM sensor was collocated with a Federal Equivalence Method (FEM) PM_{2.5} BAM 1020 at the regulatory site on Harrison Court.

- 2-1 Fire Station, a Mat-Su Borough operated fire station to the north of the Harrison Court site



Butte Relocation Study 2020-21

- Butte Elementary School (Elem. School), a Mat-Su Borough operated school to the northeast of the current site
- MSB Parks and Recreation Maintenance Shop (Maint. Shop), located southeast of the Harrison Court site
- Alaska Raceway Parks (ARP), a privately owned business southeast of Harrison Court
- Plant Material Center (PMC), a site owned by the Department of Natural Resources, located to the southwest of Harrison Court
- Pyrah Farm, a privately owned farm located to the west of the Harrison Court site

These sites were chosen based on location relative to the current site, ease of access, security, power availability, and with respect to the siting requirements listed in 40 Code of Federal Regulations (CFR) Part 58 Appendix E for a neighborhood scale site, as was practical.

The NHMs were collocated from October 9th to November 9th, 2020, before the study was conducted, and a post study collocate was performed from March 5th to March 22nd, 2021. A summary of the pre study collocate can be found in **Figure A-1** and **Table A-1**; similarly, a summary of the post study collocate can be found in **Figure A-2** and **Table A-2** in Appendix A. Flow checks and cyclone cleanings were performed monthly in accordance with the MetOne NHM sensor manual's recommendations and the values for the flow checks are listed in **Table A-3**.

The NHM sensors reported data in 15-minute increments to a cloud-based database via a cellular modem. The data was downloaded weekly and averaged into one hour and 24-hour bins to compare with the FEM PM_{2.5} BAM and daily average concentrations respectively. Photos of each sensor from the cardinal directions and an evaluation of the siting requirements can be found in **Figures A-3 through A-8**.

Results

The flow checks were consistently 15 -27% high compared to the target 2.0 liters per minute (lpm) flow rate and showed good agreement between the sensors. All flow checks passed the flow acceptance criteria, with measured flow rates between 1.8 lpm and 2.7 lpm. The higher flow rates may have biased the cut rate low across all sensors due to the measured flow being higher than the sensor's sharp cut cyclone designed cut rate of 2.0 lpm for PM_{2.5}. As a result, particles slightly below the PM_{2.5} range may have been omitted from the sample pathway. However, the higher flow rate may also indicate more particles were measured during the sensor's sampling period. As a result, the reported concentration may be biased high overall; as shown in **Table 1**, the collocated NHM at Harrison Court reported more "Moderate", "Unhealthy for Sensitive Groups" (UHSG), and "Unhealthy" days than the Butte PM_{2.5} BAM.



Butte Relocation Study 2020-21

Based on the particulate matter measurements from the Neighborhood Monitors in **Table 1**, the air quality was considered “Good” using the AQI classifications for a majority of the days during the study. The NHMs also recorded days with “Moderate”, “Unhealthy for Sensitive Groups” (UHSG), and “Unhealthy” classifications.¹

AQI Category	Fire Station U19468	Maint. Shop U19469	ARP U19471	Harrison Ct. U19072	PMC U19473	Pyrah Farm U19074	Elem. School U19075	Butte PM2.5 BAM
GOOD	84	74	61	61	77	74	88	89
MODERATE	13	22	28	27	22	23	9	17
UHSG	1	4	4	4	1	1	2	2
UNHEALTHY	0	1	2	3	1	1	0	1
VERY UNHEALTHY	0	0	0	0	0	0	0	0
HAZARDOUS	0	0	0	0	0	0	0	0
Total Valid Sample Days	98	101	95	95	101	99	99	109

Table 1: Summary of how many days fell into each AQI category for the NHMs and Butte PM_{2.5} BAM for each site. Please note the “U#####” refers to the NHM serial numbers and the AQI categories refer to the classifications designated by EPA.

The ARP monitor closely matched the NHM at Harrison Ct, with nearly the same number of “Good”, “Moderate”, “Unhealthy for Sensitive Groups” and “Unhealthy” days. The Maintenance shop, PMC, and Pyrah Farm monitors recorded a similar spread to each other, while the Fire Station and Elementary School sites had the least number of days with elevated PM levels recorded. Additionally, The Fire Station and Elementary school are the only two sites that did not record a day in the “Unhealthy” range.

In terms of siting, the Elementary school may have recorded lower values during particulate matter events as it was located on a second story rooftop and may have sampled above trapped particulates on days with a strong inversion. All the other sites were located at or near ground level.

¹ AQI classifications are based on more accurate regulatory grade sampling equipment but are often used in the context of sensor measurements to describe air quality in general terms.



Butte Relocation Study 2020-21

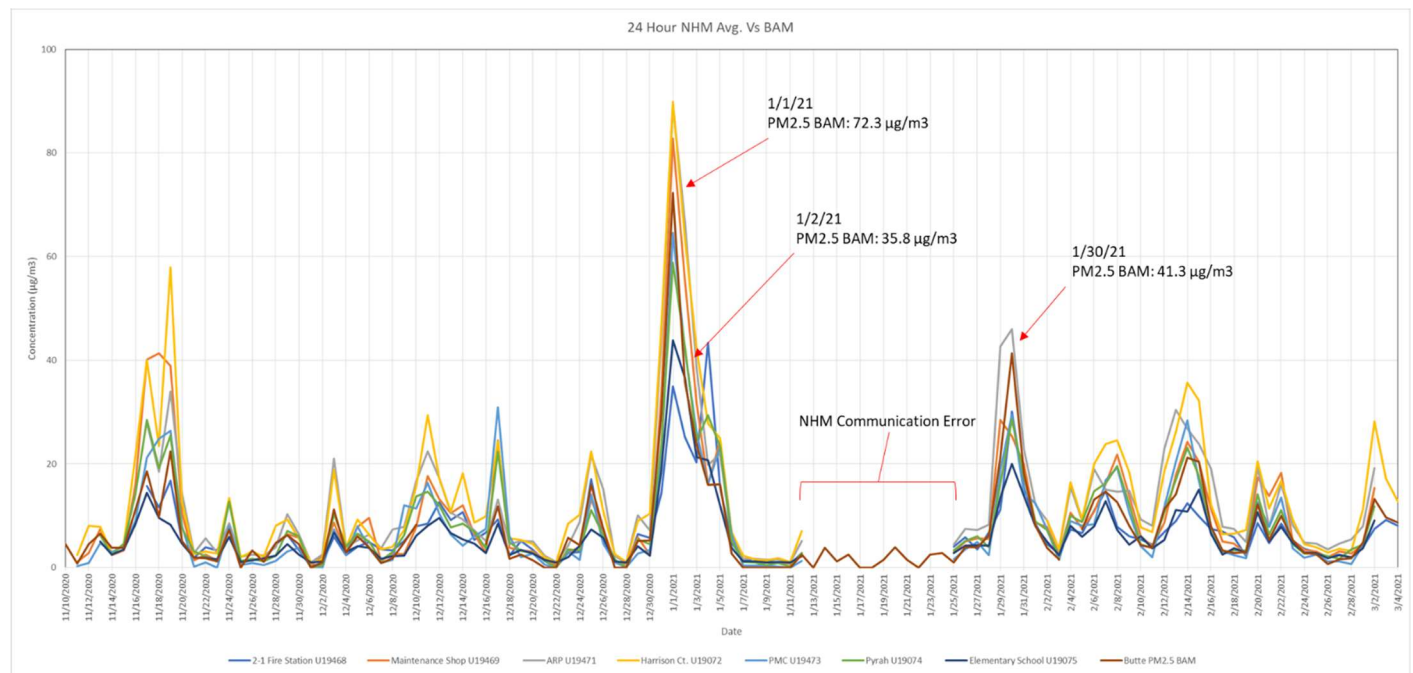


Figure 3: A graph showing the 24-hour concentration for each NHM and the Butte PM_{2.5} BAM. The red arrows point to peaks recorded during the exceedances. The red bracket shows a period where communication between the NHMs and cloud database was lost due to a cellular disruption.

As shown in **Figure 3**, all sites generally responded to elevated PM_{2.5} levels on the same day, to varying degrees. The Harrison Ct. NHM routinely recorded the highest concentrations. Three exceedances of the PM_{2.5} 24-hour standard were recorded on the Butte PM_{2.5} regulatory BAM during the study period: 1/1/21, 1/2/21, and 1/30/21. The exceedance on January 1st was primarily caused by fireworks being ignited on New Year’s Day. This was coupled with cold weather and a strong inversion that resulted in elevated levels of PM being recorded until 1/3/2021. During the study there was a communication issue between the cellular modem on the NHMs and the Butte cell tower. The NHMs lack the ability to manually download data and as a result, a majority of the data was lost from 1/13/2021 to 1/24/2021. The PM_{2.5} BAM recorded a maximum 24-hour average of 3.9 µg/m³ during this period, so it is unlikely that any of the monitors would have recorded a 24-hour average above “Good” during this time. The Harrison Court NHM was being analyzed for communication issues during the 1/30/21 exceedance. **Table 2** shows the daily AQI breakdown for each monitor during these events. Note that while the Harrison Ct. NHM was not recording on 1/30/21, the ARP monitor was the only site to register “Unhealthy for Sensitive Groups”, while the rest of the sites registered “Moderate” PM_{2.5} levels.



Butte Relocation Study 2020-21

NHM 24-Hour Averages and AQI Category									
Date	2-1 Fire Station	Maintenance Shop	ARP	Harrison Ct.	PMC	Pyrah	Elementary School	Butte PM2.5 BAM	
12/30/2020	5.7	2.5	7.1	10.4	3.4	4.5	2.3	5.2	
12/31/2020	14.3	33.8	44.3	46.6	21.7	23.6	18.8	29.6	
1/1/2021	35	82.8	89.4	89.9	64.6	58.8	43.9	72.3	
1/2/2021	25.2	55.3	66.6	63.4	41.9	42.6	36.6	35.8	
1/3/2021	20.3	31.9	38.7	42.4	26.2	24.6	21.3	23.8	
1/4/2021	43.4	16.1	19.8	27.8	16.1	29.4	20.7	16	
1/5/2021	15.5	24.6	21.9	25	23.2	23.3	12	16.1	
1/6/2021	4.8	6.7	5.8	6.8	6.4	5.2	3.8	2.7	
1/7/2021	1.6	1.2	1.7	2.3	0.4	1.1	1.2	0	
1/28/2021	6.7	5.5	8.3		2.4	3.9	4.2	6.1	
1/29/2021	11.2	28.5	42.7		18.9	16.2	13.5	21.3	
1/30/2021	30.1	25.4	46		29.5	28.6	20	41.3	
1/31/2021	15.4	19.9	22.8		14.3	17.5	13.8	18.2	
2/1/2021	8.4	8.6	12.1		12.4	8.9	8	8.1	
2/2/2021	4.5	7.9	9.1	9.2	7.3	7.2	5	3.8	
2/3/2021	2.7	2.5	3.4	3.6	1.5	2.3	2.4	1.6	
2/4/2021	7.4	10.6	15.5	16.5	9	10	8.1		
2/5/2021	6.6	7.6	9.1	9.3	8.1	8.8	5.9	7.3	
2/6/2021	11	10.8	19	20	8.4	14.7	8	13.1	
2/7/2021	14.7	16.2	15	23.8	16.9	16.3	12.8	14.6	
2/8/2021	7.9	21.8	14.6	24.6	19.3	19.6	7.2	12.6	
2/9/2021	6	13.8	14.8	18.4	10.6	12.2	4.4	8.1	
2/10/2021	5.4	6	9.3	7.8	4.1	4.4	6	4.3	
2/11/2021	4.4	4.1	8.1	6.8	2	3.8	3.7	3.8	
2/12/2021	6.8	8.7	22.9	18.6	11.7	10.7	5.3	11.3	
2/13/2021	9	17.9	30.4	26.2	20.4	17	11.1	14.1	
2/14/2021	12.4	24.2	26.8	35.7	28.4	23.1	10.8	21.2	
2/15/2021	9.9	20.4	23.8	32.2	16.7	17.7	15	20.4	
2/16/2021	7.5	11.3	19.1	12.1	6.8	7.9	6.5	8	
2/17/2021	6.9	5	7.9	6.4	3.1	3	2.5	3.3	
2/18/2021	5.8	4.6	7.5	6.5	2.4	3.3	3.7	2.8	
2/19/2021	2.2	2.6	4.9	7.2	1.8	3.3	2.9	3	
2/20/2021	8.6	17.4	19.4	20.5	12.6	14.1	10.7	12.2	
2/21/2021	4.7	13.8	7.9	11.4	7.9	6.3	5	5.3	
2/22/2021	8.5	18.3	16.2	16.8	13.5	11.1	7.9	10	
2/23/2021	5.2	5.2	8.2	9.3	3.7	4.5	4.7	5.3	
2/24/2021	3.6	3.4	4.8	4.5	1.9	2.7	2.9	2.8	
2/25/2021	3	3.1	4.6	3.9	2.5	2.7	2.8	2.6	
2/26/2021	2	2	3.5	2.9	1.2	2.2	1.8	0.7	
2/27/2021	2.5	3.1	4.6	3.6	1.2	1.7	2.4	1.6	
2/28/2021	1.9	2.7	5.4	3.2	0.7	3.5	2	1.8	
3/1/2021	3.9	4.4	8	11.2	4.3	4.4	3.7	4.8	
3/2/2021	7.5	15.3	19.2	28.2	13.1	11.8	9.1	13.2	
3/3/2021	9.2			17.2				9.7	
3/4/2021	8.1			12.7				8.7	
98th Percentile	30.4	41.3	48.9	58.7	30.9	29.9	21.9	34.8	

Table 2: The daily AQI category, concentration, and 98th percentile recorded at each site. The color of a cell represents its AQI category, while the number inside the cell represents the concentration. Note there is a time skip due to the missing NHM data during the cellular modem communication issue.



Butte Relocation Study 2020-21

Conclusion

While multiple sites did record similar values to the Harrison Ct. sensor during the study, each site has its own advantages and disadvantages. ARP matched the Harrison Ct. sensor the best with respect to number of days in each AQI category, reacting similarly to the current Butte site, and best matched the 98th percentile to the Harrison Ct. monitor. However, Alaska Raceway Parks is privately owned and hosts high traffic generating drag races and festival events during the summer. Additionally, the area around ARP is largely undeveloped, and it would be difficult to find a place for a monitoring shelter that is far enough away from the roadway and tree dripline without significant cost and effort. There is a small gravel quarry on the west side of the property that may be a significant microscale source of PM₁₀ that could impact representativeness of a SLAMS site. Finally, Sullivan Avenue (the access road to Alaska Raceway Parks) has moderate ATV traffic during the summer with gravel trails along the roadway that generate PM₁₀ when traversed.

From a data standpoint the Maintenance Shop looks like the second-best option, but it is located in a large, popular recreation parking lot that is unpaved and sees extremely high ATV and off-road traffic during the summer and snow machine traffic during the winter. Additionally, there are two campgrounds with recreational firepits nearby that are extensively used during the summer. These microscale sources would negatively impact the representativeness of PM₁₀ and PM_{2.5} measurements at a SLAMS site during the summer. Concerns of vandalism and theft were expressed by the maintenance shop workers, and their site uses an electrified, barbwire fence to protect equipment and facilities.

The Pyrah Farms sensor did not match as well as ARP or the Maintenance shop, but it did record elevated PM_{2.5} levels on the same days as the Harrison Ct. Monitor. The site was located on private property and would not be available for a long-term SLAMS site. There are cul-de-sacs in the area and power access points, but the site may not be well-received moving from one cul-de-sac to another in the Butte area. Additionally, if construction commences at the new cul-de-sac a similar situation requiring relocation of the monitoring site may occur.

The Plant Material Center is operated by the Department of Natural Resources. Despite being the furthest away from the current Harrison Ct. site, it tracked similarly to the Pyrah Farm sensor; the sensor did not record as high of peaks as the S. Harrison Ct. sensor, but it tracked well during days with elevated PM_{2.5}. The site is regularly maintained, low traffic, and relatively secure. There is a gate that blocks after hour access. The PMC is the furthest site from the current SLAMS site and is surrounded by farmland to the south and west. A subdivision is currently being developed approximately 300 meters to the east.



Butte Relocation Study 2020-21

The Elementary School has the advantage of placing a monitor near a sensitive group, however it showed the lowest daily AQI values during the study. The sensor may have been biased low due to its elevated location on the 2nd story roof of the school, but without additional testing we are unable to discern how much of an impact the altitude difference had on the readings. If chosen for an alternative site, the regulatory monitors should be located at or near ground level and not on the roof. The NHM was placed on the roof due to vandalism concerns with the small footprint and non-permanent nature of the sensor.

The 2-1 Fire Station observed the 2nd lowest readings out of the sites. Additionally, the Fire Chief stated their station is regularly used for live burn exercises. While they are willing to provide a schedule of the burns, this may negatively impact ambient sampling throughout the year. No live burn trainings were performed during the study. Additionally, the fire engines are routinely left idling during the winter for smooth engine operation and fast deployment to emergencies.

Next Steps

AMQA will deploy two BAM-1020s in the Butte community in the winter of 2021. BAM-1020s are regulatory grade monitors and will allow for precise concentrations to be captured and directly compared to the values captured at the current Harrison Court site; these monitors will run in tandem with the current Harrison Court site for one year. The location of the two additional BAM-1020s will be based on location relative to the current site, data collected during this study, ease of access, security, power availability, and with respect to the siting requirements listed in 40 Code of Federal Regulations (CFR) Part 58 Appendix E for a neighborhood scale site. After a full year of data collection, the data will be analyzed to determine the best alternative location for the Butte monitoring site. DEC will then submit the data to EPA and request the site on Harrison Court be decommissioned and the new location be accepted as the new Butte SLAMS site. In the event that EPA does not accept the relocation proposal, or the data shows there is no acceptable alternative site, the Harrison Court site will be unable to be relocated based on the findings of this study.



Butte Relocation Study 2020-21

Appendix A

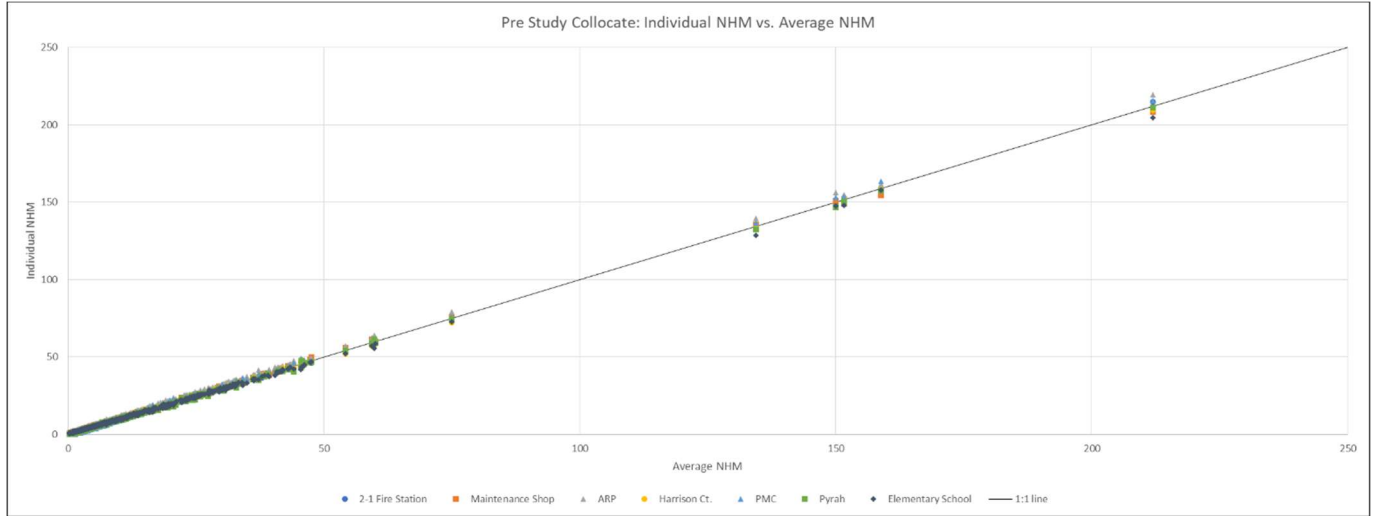


Figure A-1: Hourly data of individual NHMs vs. the average NHM value while collocated at the current Butte site on Harrison Ct. pre-study collocate occurred 10/9/20 – 11/9/20.

Pre Study Collocate (10/9/2020 - 11/9/2020)

Against Average NHM

	2-1 Fire Station U19468 (ug/m3)	Maintenance Shop U19469 (ug/m3)	ARP U19471 (ug/m3)	Harrison Ct. U19072 (ug/m3)	PMC U19473 (ug/m3)	Pyrah U19074 (ug/m3)	Elementary School U19075 (ug/m3)	Average NHM
Slope	0.996	0.993	1.032	0.992	1.029	0.989	0.969	1.000
Intercept	-0.214	0.200	0.735	0.087	-0.767	-0.265	0.184	0.000
R ²	0.999	0.999	0.999	1.000	0.999	0.999	0.999	1.000

Against PM2.5 BAM

	2-1 Fire Station U19468 (ug/m3)	Maintenance Shop U19469 (ug/m3)	ARP U19471 (ug/m3)	Harrison Ct. U19072 (ug/m3)	PMC U19473 (ug/m3)	Pyrah U19074 (ug/m3)	Elementary School U19075 (ug/m3)	Average NHM
Slope	1.368	1.375	1.427	1.370	1.420	1.358	1.335	1.379
Intercept	-0.610	-0.246	0.292	-0.171	-1.158	-0.497	-0.235	-0.448
R ²	0.554	0.562	0.561	0.551	0.559	0.553	0.556	0.558

Table A-1: Pre study collocate summary of Individual NHMs vs the average NHM and the Butte PM_{2.5} BAM.



Butte Relocation Study 2020-21

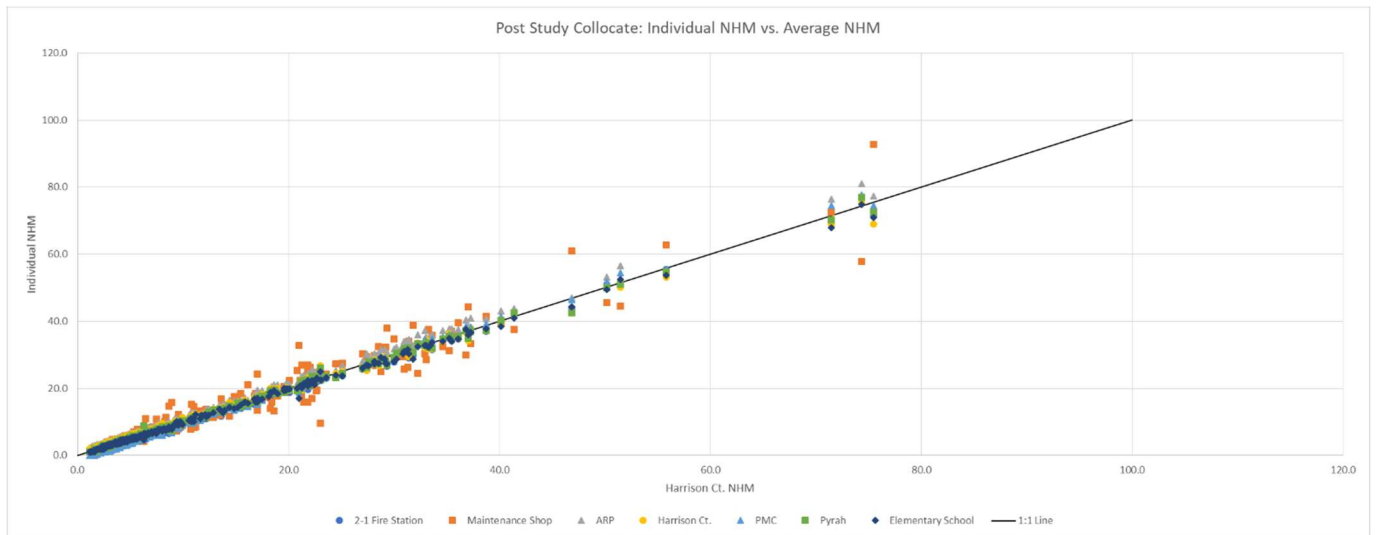


Figure A-2: Hourly data of individual NHMs vs the average NHM value. Collected during the post-study collocate (3/5/21 – 3/22/21)

Post Study Collocate (3/5/2021 - 3/22/2021)

Against Average NHM

	2-1 Fire Station U19468(ug/m3)	Maintenance Shop U19469 (ug/m3)	ARP U19471(ug/m3)	Harrison Ct. U19072 (ug/m3)	PMC U19473(ug/m3)	Pyrah U19074 (ug/m3)	Elementary School U19075 (ug/m3)	AVERAGE
Slope	0.989	1.004	1.038	0.957	1.050	0.986	0.977	1.000
Intercept	-0.598	0.233	0.837	0.905	-1.379	0.055	-0.053	0.000
R²	0.998	0.955	0.998	0.997	0.999	0.998	0.998	1.000

Against PM2.5 BAM

	2-1 Fire Station U19468(ug/m3)	Maintenance Shop U19469 (ug/m3)	ARP U19471(ug/m3)	Harrison Ct. U19072 (ug/m3)	PMC U19473(ug/m3)	Pyrah U19074 (ug/m3)	Elementary School U19075 (ug/m3)	AVERAGE
Slope	1.417	1.458	1.479	1.367	1.501	1.407	1.398	1.432
Intercept	1.026	1.777	2.586	2.496	0.361	1.700	1.558	1.643
R²	0.756	0.744	0.748	0.752	0.754	0.751	0.755	0.758

Table A-2: Post-study collocate summary of Individual NHMs vs the average NHM and the Butte PM_{2.5} BAM.



Butte Relocation Study 2020-21

NHM Flow checks

	Date	2-1 Fire Station U19468	Maintenance Shop U19469	ARP U19471	Harrison Ct. U19072	PMC U19473	Pyrah U19074	Elementary School U19075
Pre Study Collocation	11/9/2020	2.46	2.41	2.41	na*	2.57	2.42	2.48
Butte Relocation Study	12/23/2020	2.52	2.5	2.55	2.6	2.61	2.43	na**
	12/31/2020	2.2	na	2.29	2.44	2.37	2.2	na**
	1/14/2021	2.49	2.49	2.53	2.62	2.6	2.41	2.47
	1/27/2021	na	na	na	2.48	na	na	na
	2/1/2021	na	na	na	2.08	na	na	na
	2/8/2021	na	na	2.17	2.38	2.26	2.01	2.29
	2/11/2021	2.38	2.36	na	na	na	na	na
	2/19/2021	na	na	na	2.48	na	na	na
	3/2/2021	na	2.33	2.33	na	2.46	2.25	2.34
	3/3/2021	na	2.43	2.42	na	2.5	2.32	2.5
3/5/2021	2.45	na	na	na	na	na	na	
Post Study Collocate	3/5/2021	2.43	2.37	2.44	2.48	2.49	2.36	2.44
	3/22/2021	2.41	2.37	2.43	2.6	2.51	2.31	2.41

Table A-3: NHM sensor flow checks for the pre study collocate, relocation study, and post study collocate. All values are in liters per minute (lpm).

The pre study collocate flow check on 11/9/2020 was performed with a reference standard that had an expired certification. The reference standard was shipped to the manufacturer for recertification and recertified on 12/10/2020. The as found check by the manufacturer showed that it passed all tolerances before recertification. As such, the data was accepted as valid without need for further validation or adjustment.

*A flow check was not performed on the Harrison Ct. sensor during the pre-study collocation due to a power malfunction. The power was restored to the sensor and the flow check was postponed to allow the pump to warm up to operating temperature.

**A flow check was not performed on the Elementary school monitor during December 2020 due to the school being closed for winter break, the sensor was not accessible during the break. The Harrison Ct. flow check performed on 2/1/2020 (highlighted green) was a starting bracket QC and performed while the pump was still reaching operating temperatures.



Butte Relocation Study 2020-21

2-1 Fire Station



Figure A-3: Photos of the 2-1 Fire Station site from the cardinal directions looking towards the sensor.

Located approximately 0.8 miles to the north of the current SLAMS site, the fire station was chosen to collect samples to the north, for ease of access, and coordination with the Mat-Su Borough (MSB). Live fire training exercises are performed at the station; however, no live fire exercises were performed during the duration of this study. During winter months, the fire engines are regularly left idling to ensure smooth operation and fast response to emergencies. The NHM site was located on the corner of the property furthest away from the garage bays to minimize impact on the sensor's readings. There were three deciduous trees to the north of the sensor. They were sparsely spaced and did not scavenge particulates in the sample pathway. There were two shipping containers more than 2 m south of the sensor. Scaffolding to the west of the sensor laid below the sample inlet height, and the tree line to the east of the sensor was more than 10 m away



Butte Relocation Study 2020-21

Elementary School



Figure A-4: Photos of the Elementary School site from the cardinal directions looking towards the sensor.

Located approximately 1 mile to the northeast of the current SLAMS site, the Butte Elementary School was chosen due to its proximity to a sensitive group as per AQI classifications, ease of access and coordination with the MSB. The NHM sensor was located on the roof of the school for security purposes to prevent vandalism, tampering, or damaged equipment. There were no obstructions near the inlet. A wall was located more than 2 m to the west of the sensor and laid below the sample inlet; all trees are more than 10 m away from the inlet.



Butte Relocation Study 2020-21

Maintenance Shop



Figure A-5: Photos of the Maintenance Shop site from the cardinal directions looking towards the sensor.

Located approximately 1.2 miles southeast of current SLAMS site, the MSB Maintenance Shop was chosen for its geographic location in relation to the current site, its ease of access and coordination with the MSB, and security. The site was located on a large gravel pad behind an electric fence. There was a campground containing roughly nine campsites to the south of the sensor. The closest campsite and treeline were approximately 25 m from the sensor. To the west of the site there was a large gravel parking lot, and approximately 300 m from the sensor there were 18 RV campsites. North of the sensor was the maintenance shop building. The wall was more than 2 m away from the sample inlet. The gravel pad was frozen and covered with snow for the duration of the study and the campgrounds were out of season.



Alaska Raceway Park (ARP)



Figure A-6: Photos of the Alaska Raceway Park site from the cardinal directions looking towards the sensor.

Located approximately 0.6 miles southeast of the current SLAMS site, the Alaska Raceway Park was chosen due to its southerly bearing to the current site. The nearest trees were more than 10 m to the northwest of the sensor. There was a chain-link fence approximately 4 m to the east of the sample inlet. The sensor was surrounded by a large paved parking lot. The drag race strip and racetrack were closed for the duration of this study. There was a gravel quarry approximately 165 m to the southwest of the sensor, it was covered with snow for the duration of this study.



Butte Relocation Study 2020-21

Plant Material Center



Figure A-7: Photos of the Plant Material Center site from the cardinal directions looking towards the sensor.

Located approximately 1.67 miles to the southwest of the current SLAMS site, the Plant Material Center was chosen due to its geographic bearing in relation to the current Butte site, ease of access, coordination with the State of Alaska Department of Natural Resources, and siting criteria. There was a building wall more than 2 m to the east of the sample inlet, and greater than 10 m to the north. There was one deciduous tree and one decorative shrub approximately 8 m away from the sampling inlet.



Butte Relocation Study 2020-21

Pyrah Farm



Figure A-8: Photos of the Pyrah Farm site from the cardinal directions looking towards the sensor.

Pyrah Farm

Located approximately 1.5 miles to the west of the current SLAMS site, Pyrah farms was chosen primarily for its geographic bearing in relation to the current site and closer proximity to neighborhoods when compared to the Plant Material Center. There was a wall more than 2 m west of the sample inlet. There was a paved parking lot approximately 5 m to the east and south of the sample inlet. The treeline was more than 10 m to the east of the sampling inlet. There was one decorative tractor less than 1 m away from the sensor; The tractor laid below the sampling inlet height.