PM North 2020
What were we breathing in 2019?

An examination of ambient particle measurements along Highway 16 and in the Peace.

Acknowledgements: thanks to

All sensor host organizations and individuals
BC Ministry of Environment and Climate Change Strategy
Town of Smithers
BC Lung Association
Village of Telkwa
Glasswaters Foundation2018
Bulkley Valley Credit Union
Bulkley Valley Research Centre
District of Houston
Board of Directors and members of BVLD Airshed Management Society (the AMS)
Peter Jackson
Susan Brookes
Dennis & Julia Strain
Janet Walford

In each of the previous two years I have written reports early in the year about concentrations of particulate matter in the air in various places in northern BC, covering data for the previous year. This report is along the same general lines but quite late, I would rather have written it in January; I was too much taken up with other matters.

But better late than never.

The information on which this report is based derives first from Ministry of Environment monitors and then from Purple Air monitors and is specific to measurements of particles – **PM2.5** specifically. Gases are not considered[1]. At the end I'll have a page of explanation of terms and acronyms with links. The numerous MoE monitors newly included have inflated the size of this document so I've moved all statistical tables and charts into an appendix. See page 9 and following. There are two summary tables with discussion in the first part of this report.

The Purple Air stations noted here are quite similar to those in previous editions and where there are differences they are mostly additions. This report's geographic scope is from Valemount to Prince Rupert and north to Fort St. John. Several new options have become available and that has led to changes, especially in the trend charts. If the charts are not readily comprehensible please let me know and I'll try to clarify. I want to continue including charts as data visualization tools, basically because of considerations such as those set out in the Wikipedia commentary on the Anscombe quartet. The original paper is linked in the references below the article and is brief and well written.

The Purple Air monitors referenced here have had their raw readings amended with a correction factor that takes our climate into account and gives better agreement with colocated MoE monitors. These factors have been developed by Peter Jackson at UNBC, from whose archive this report takes its data.

This edition reports on MoE stations and includes comments and analysis - mine, not theirs.

This report has benefited from review by my colleagues; any remaining mistakes are my own. This is intended as a living document – errors or omissions pointed out will be corrected and incorporated. A current .pdf will be web posted.

While we're on the subject of errors, a useful illustration can be seen of the value of independent scrutiny comparing automated reports to manual ones. Rio Tinto in Kitimat has an obligation under their emissions permit to report annually on their environmental effects monitoring (EEM) plan, this includes reporting of PM. But the report misreports. The actual measured levels and those given in their writeup don't match. It remains to be seen whether their EEM report is also a living document. Makes the case for transparency and citizen scrutiny.

Is it worthwhile to build out a network of low cost monitors when the MoE monitors are already in place and give more accurate readings? It seems so; the issue of representativeness can be addressed in part by a geographically denser network of observations and regionally specific correction factors can improve the data to give quite good correlation with MoE gear. Democratization of data may improve relevance to monitor hosts and those nearby and generate useful informed concern about improving emissions and reducing exposure.

1 But see a separate report on Kitimat valley SO2 – here

First, Ministry of Environment monitors

The Ministry of Environment (and Climate Change Strategy – MoE) has northern stations in Fort St. John, Prince George, Valemount, Vanderhoof, Burns Lake, Houston, Smithers, Terrace, Kitimat and Prince Rupert. Some places have more than one monitor. I'll show annual averages and maxima in the table below, one location on each line. All data in Table 1 is for measurements of PM2.5 made throughout 2019 at each station and is as retrieved from the Province's envista data archive. No data validation or adjustment has been done, this is what the database shows as of June 19 2020.

Table 1: Annual average µg of PM2.5 with maxima and capture fractions – Ministry readings from envista

MoE station name	2019 annual average	Maximum value and date	Data %
Attachie	5.3 micrograms	322 on 5-31-2019 at 8:00:00 AM	93
Key Learning Centre	6.8	401.5 on 5-31-2019 at 6:00:00 AM	72
85th Avenue	6.1	346.9 on 5-31-2019 at 9:00:00 AM	85
Old Fort	5.9	362.5 on 5-31-2019 at 11:00:00 AM	94
North Camp	6	185.3 on 5-31-2019 at 10:00:00 PM	93
Valemount	7.7	188.5 on 12/27/2019 at 24:00 AM	33
PG Plaza 400	10.3	81.1 on 3-5-2019 at 2:00:00 PM	53
Vanderhoof Courthouse	7.7	188.5 on 12/27/2019 24:00 AM at 24:00	80
Burns Lake Fire Centre	8.6	108.8 on 1-21-2019 at 1:00:00 AM	97
Houston Firehall	10.5	131.2 on 3-3-2019 at 8:00:00 PM	98
Smithers Muheim	8.5	161.2 on 3-19-2019 at 10:00:00 PM	98
Terrace Skeena Middle School	5.9	121.4 on 3-21-2019 at 8:00:00 PM	99
Kitimat Whitesail	4.4	65 on 3-30-2019 at 11:00:00 PM	98
Kitimat Riverlodge	4.5	153 on 9-1-2019 at 1:00:00 PM	98
Kitimat Haul Rd.	7.1	123 on 3-25-2019 at 9:00:00 PM	98
Kitimat Haisla Village	4	55 on 1-1-2019 at 1:00:00 AM	89
Prince Rupert Fairview	3.2	30.3 on 4-12-2019 at 11:00:00 AM	99

Notes: The rows from Attachie to Vanderhoof show data from stations in the Omineca Peace Region of MoE, those below are in the Skeena Region. The Omineca readings show definitely lower data capture percentages than the Skeena data - 75% vs 97%[2]. This has implications for the usability of the data for measuring attainment of the Canadian Ambient Air Quality Standards. A lot of work and money goes into setting up and monitoring PM2.5 at these stations and if the result is inadequate what return in terms of public interest is there on the money? Compared to 2018 the data collection in Skeena is much improved. The Smithers Muheim station was being commissioned in January 2019 and lost 738 hours there so the 98% figure needs some explaining.

2 See end notes about data capture rate trends and charts for MoE stations

The first 5 stations in the table above are all in or around Fort St. John and all show a yearly maximum value on May 31 2019 pretty much at the same time[3]. This indicates a common source and I don't know what that is. (**NB** – no longer so, see here: https://www.energeticcity.ca/2019/05/smoke-from-alberta-forest-fires-covers-northeast-b-c/ I'm thinking Chuckegg Lake.) Many of the MoE stations show elevated levels at about day 155, see the charts.

High levels were persistent for at least 24 hours. I've included maximum values to contrast with averages and because severe acute maximum value exposure can have definite acute health effects.[4] When I look over the highest maximum values I don't see much correlation to averages. High exposure averages in the most populous places indicate potentially higher risk to lotsa folks and trouble down the road.

Now lets look at the Purple Air monitors

In recent years the Purple Air project begun at the College of Engineering at the University of Utah in Salt Lake City has been quite successful, having by my estimate around 11,400 particle monitors installed worldwide, most of which are publicly viewable. The BVLD Airshed Management Society (the AMS) has installed a dozen of these in the northwest. Most are in fixed locations but three are in public libraries and an effort has been made to place at least some on reserve. The First Nations Health Authority has started installing these on reserves too, a welcome move.

Here I'll comment mostly on AMS monitors, more specifically in: McBride, Prince George[5], Smithers, Witset (Moricetown), the Hazeltons, Gitanyow, Terrace and the Kitimat valley. Various shortcomings make it desirable to apply corrections to raw observations from the Purple Air monitors as used in our area. Different corrections have been developed for different regions, those used here are regionally specific and are from UNBC[6]. Ten minute averages are used here in Table 2.

Table 2: Annual average µg of PM2.5 with maxima and capture fractions – UNBC corrected readings

Where	Average – UNBC corrected	Max and date	Data %
McBride	6.4	99.2 – Nov. 30 – 04:10	~100[7]
Prince George PA-2	8.5	90.1 – May 27 2019 – 15:30	~100
Granisle Fire Dept.	6.7	89 – Jan. 17 – 00:20	50[8]
Telkwa Hankin	8.6	250.6 – Jan. 8 – 14:30	99.9
Telkwa Walnut	nd	nd	nd
Smithers Railway South	8.7	214.5 – Nov. 25 - 00:40	99
Smithers DS	7.5	50.32 - Apr. 2 – 16:10	100
Smithers Gun Club	7.8	526 - Jul. 30 9:20	94[9]

3 North Camp showed this spike too but had a big one in December that isn't reflected in this table. See graph comments below.

4 https://www.sciencedirect.com/science/article/pii/S0160412019326935

5 PG is a special case because of a current study being done by Dr. Peter Jackson of UNBC who has installed about 50 PAs in the area. I've picked one in the bowl for comparison with MoE gear nearby.

6 See correction factor information at the end

7 This monitor was installed in July, the % is of 4902 hours

8 Power issues here and a good sampling location that's hard to reach

Witset Health Centre	12.1	137 – Feb. 16 04:50	97
Hazelton Old Town	8.4	104 – Mar. 10 05:20	98
Hazelton 2 Mile	10.4	587 – Mar. 16 00:00	76[10]
South Hazelton	7.7	121 – Oct.7 02:10	70
Gitanyow Fisheries	12.8	602 – Apr. 8 19:30	100
Kitimat Valley - Lakelse	5.1	277 – Mar. 29 19:00	99
Kitimat Valley Cablecar	4.6	148.3 – Nov. 14 04:50	99

The data capture rate is good with the exception of Hazelton 2 Mile, South Hazelton and Granisle; in all cases power issues caused long outages, in 2 Mile there was a wifi issue as well. So it's a learning curve. In a few cases the maximum levels were very high but of short duration while averages were much lower. Going forward efforts need to be made to chop the tops off the spikes and bring the average down.

Hazelton 2 Mile, Witset and Gitanyow however are real pollution problem areas that warrant a protective intervention. Mitigation is relatively cheap but a more fundamental intervention is needed going forward.

There is a noticeable difference between the UNBC corrected annual average reading from the PG purple air monitor (Prince George PA-2 – Table 2) and the MoE (PG Plaza 400 -Table 1) monitor, respectively 8.5 micrograms *vs* 10.1. It seems from an examination of the data capture that we may reasonably conclude that the part year where readings were recorded by MoE had a higher level of PM2.5 and with that taken into account we can let the figures stand. Their charts may be interpreted as corroborating this situation.

Data capture trends

The data captured by Purple Air monitors are generally of good continuity, 90% even with the problem places. If those are taken out for comparison the average data capture rate pops up to 98.6%.

This contrasts sharply with Ministry results for 2018 in Burns Lake where the data capture was 86% (max. 1695 on Aug. 21st) and Houston with capture of 33% (max. 110 on Dec. 15th). It's especially unfortunate that the entire extremely smoky month of August 2018 was missing in Houston.[11] About Valemount's data capture in 2019 the less said the better – see the chart.

I can not comment knowledgeably on the causes of missing MoE data, no doubt underfunding plays some rôle. A starting point for more detailed inquiry would expand both the history and geographic scope of data capture to include other MoE regions and perhaps for the sake of comparability of data confine the examination to PM2.5, excluding TEOM data. It would be quite an examination and is way out of scope for this inquirer.

9 This monitor was installed early in the year and the percentage shown is of 7027 hours.
10 One extended power outage and one wifi issue
11 Ben Weinstein reports that the issue here was the lack of a qualified technician

The Purple Air monitors are known to not be as accurate as more expensive equipment so their readings have been systematically compared to more accurate monitors in the same place in order to develop a northern BC regionally specific set of correction factors. Peter Jackson of UNBC has done this work.

In this list of correction factors, for each of the PA-II readings (PA) in one of these three ranges the associated formula is applied to get a corrected reading (PM2.5) below.

0-20 µg/m^3 -
PM2.5 = 0.6 x PA +3.4
20-200 µg/m^3 -
PM2.5 = 0.6 x PA + 2.5
200+ µg/m^3 -
PM2.5 = 1.6 x PA – 194

so a raw (PA) reading of 11 µg/m^3 becomes 10.0 µg/m^3 PM2.5

See Sources and references below for a map URL using corrected values.

Data, interpretation and caveats

In viewing the statistical tables in this report it needs to be noted that most of the numbers given are pure gibberish. Sources of error are rife, Purple Air sensors produce only integer values of PM2.5 levels, their real numbers are averages of some sort, including averages of averages reported without note. Data for Purple Air monitors archived here has been used as a good faith best effort data record and spreadsheets were used for the data analysis tables and graphs of data values. Note that the Purple Air data has been amended using the UNBC correction factors. BC MoE envista data has been used for MoE's stations. I have not truncated or rounded spreadsheet generated descriptive values, giving them here as they are produced by the software.

That said however, it needs also to be noted that the South Coast Air Quality Management District of the California Air Resources Board has tested these instruments (model PA-II) and found them to compare very well with US EPA FEM colocated equipment. So pretty good results, especially considering costs. It is unfortunate that the white PVC weather shield traps the waste heat of the 1 watt power consumption of the ESP8266 processor board and so skews the temperature and humidity measurements of the BME280 sensor. This problem is well known and noted on the Purple Air web site as a source of potential error. See my note on page 3 about our use of corrected data.

A little glossary

The PM references are to **p**articulate **m**atter. Some terminology is probably in order. PM is basically little chunks of stuff (but not water) floating around in the air that have several relevant aspects. If a particle can be suspended in the air it's a suspendable particle, if it can be inhaled it's a respirable particle. A smaller particle has, all else being equal, a couple of salient characteristics – it can travel further from its source and it can be inhaled deeper into the lungs. The relevant mass units for PM are micrograms - millionths of a gram – and the useful size units are microns – millionths of a metre.

The Greek letter mu[12] - μ - is used for a millionth so μg for microgram. A common reference would be to a concentration of 25 μg/m^3 of PM2.5. If you think of particles small enough to fit through a round hole 2.5 microns in diameter that would be about the right size fraction. A particle smaller than that is PM2.5 too, *everything* that fits through the hole. As a matter of experience in health effect estimation, PM10, PM2.5 and really small stuff at PM0.1 are commonly used, as is total PM, all suspendable particles.

Sources and references

For a map of Purple Air monitor readings, especially in the northwest: NW BC Purple Air
An analogous MoE map is here.

A map of corrected Purple Air readings per UNBC correction factors, together with Ministry readings, here

CAAQS, Canadian Ambient Air Quality Standards:
https://www.ccme.ca/en/current_priorities/air/caaqs.html

BC Air zones: air zones

Data downloads from Purple Air see here, scroll down to DATA ACCESS and pull down the relevant howto text.

UNBC archive of corrected readings, here.

For lots of Ministry of Environment information, readings and data archive https://bcairquality.ca

NB data downloads require close attention to ensure you get what you want. Purple Air zoom and get is the easiest.

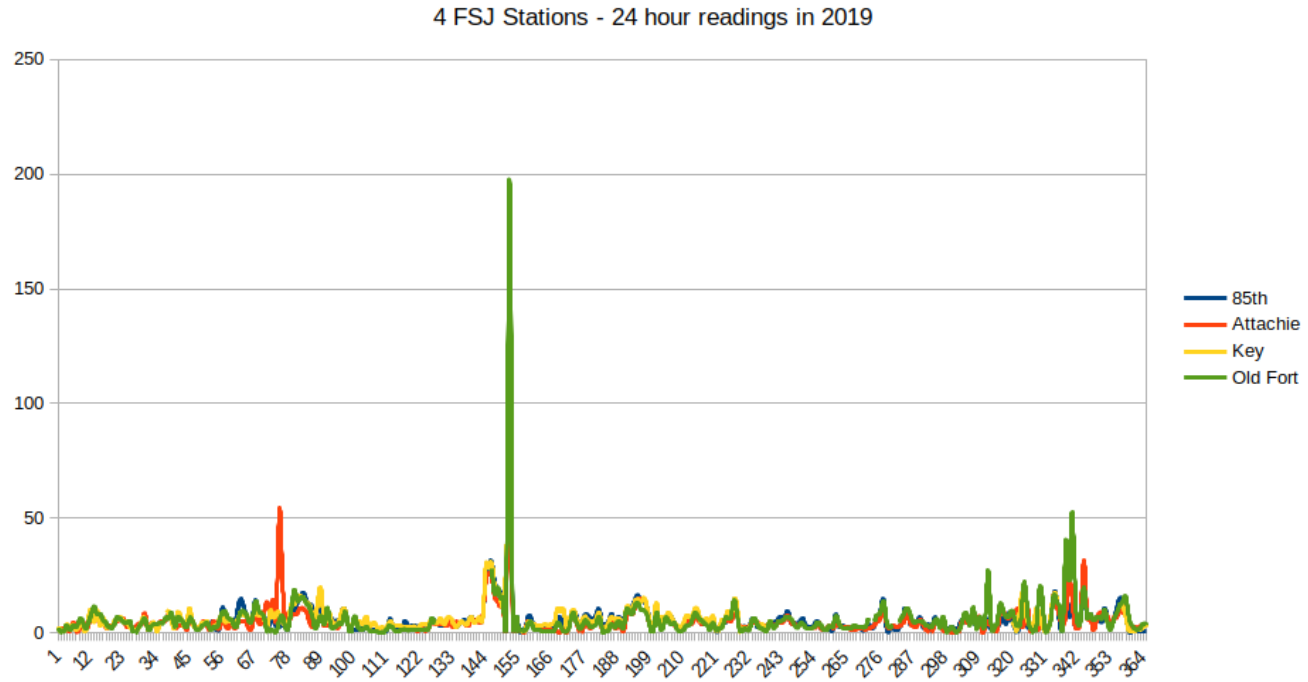
See next pages for more specific MoE and Purple Air details - charts and statistical tables.

12 A learned young curate in Kew
Kept an aged tomcat in a pew
To teach it to speak
Alphabetical Greek
But it never got further than mu!

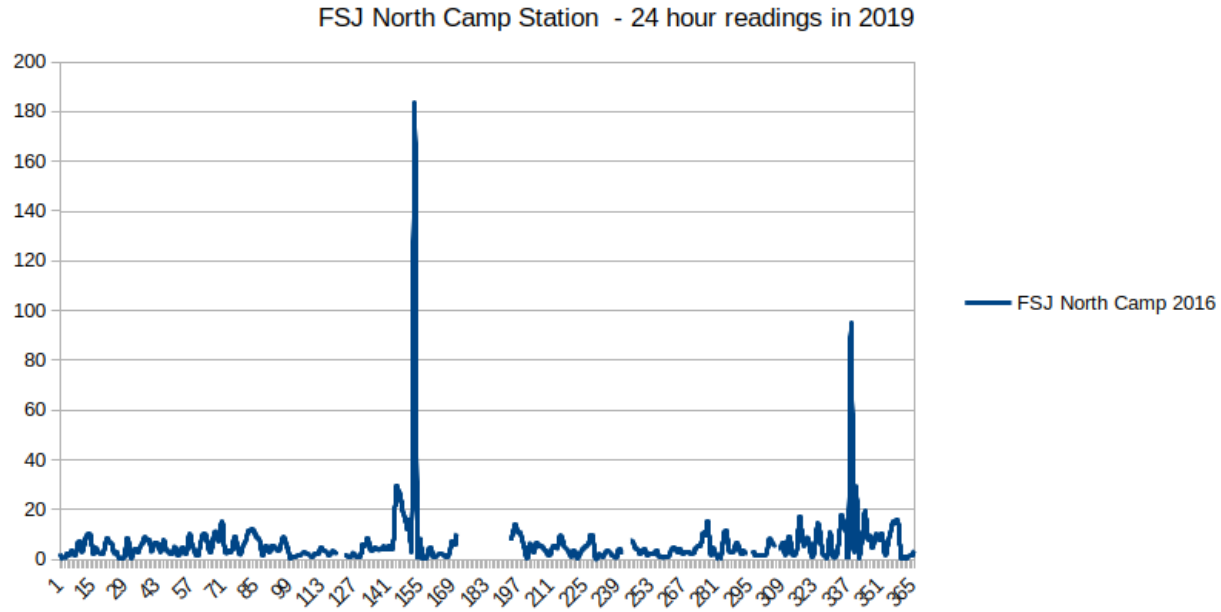
It seems best to relegate the gory details to a non-narrative part of the doc, to keep the data geeks happy and leave the narrative alone. See overleaf.

Following are 2019 charts for MoE stations from Table 1. Statistical tables later in this appendix.

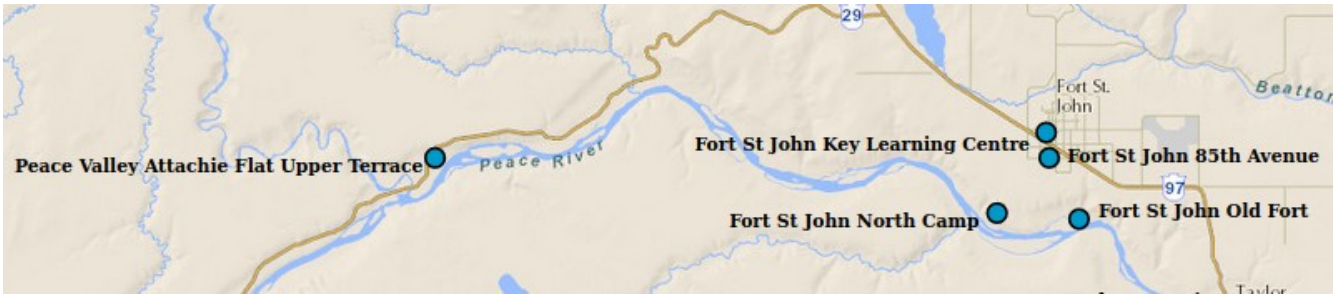
The 4 stations charted first are in arbitrary order, the chart was getting pretty busy so North Camp is separate.



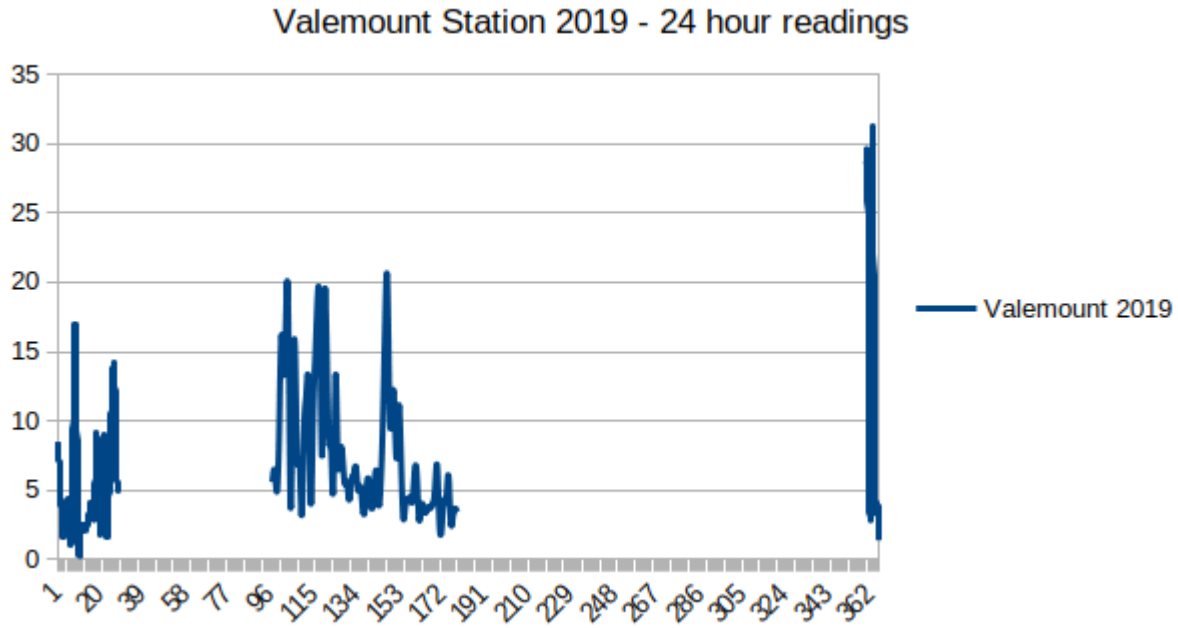
Four northeast stations – Attachie, Key Learning Centre, 85th Avenue, Old Fort, averaged over 2019

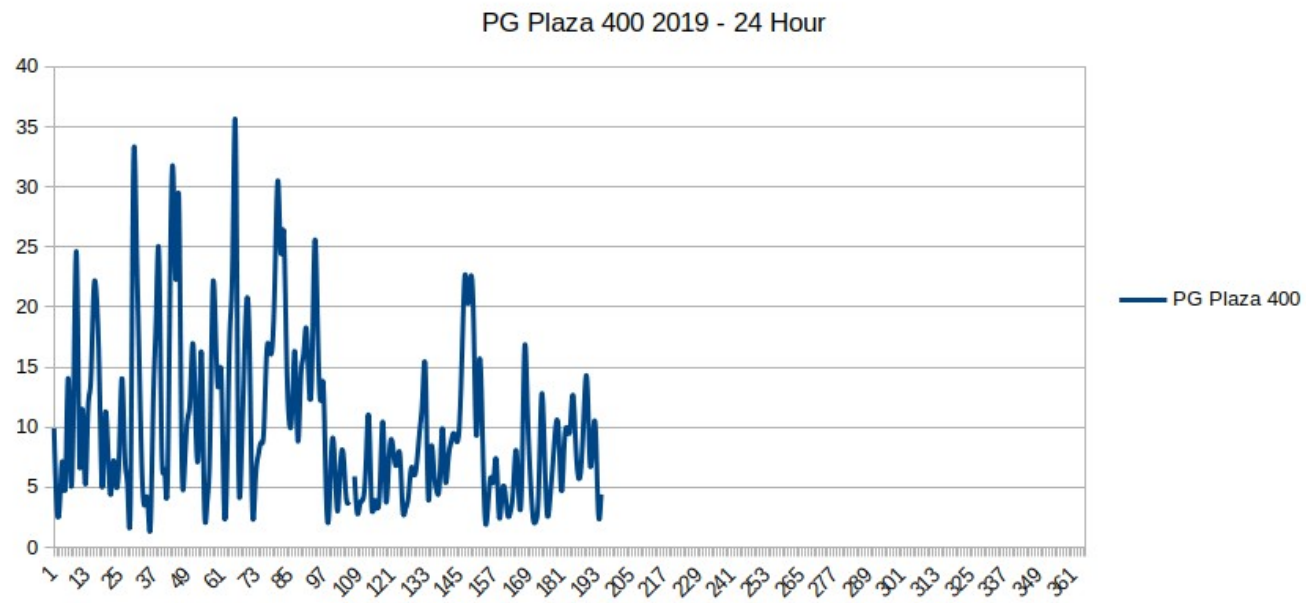


Map of Fort St John MoE stations as of Sept. 9, 2020

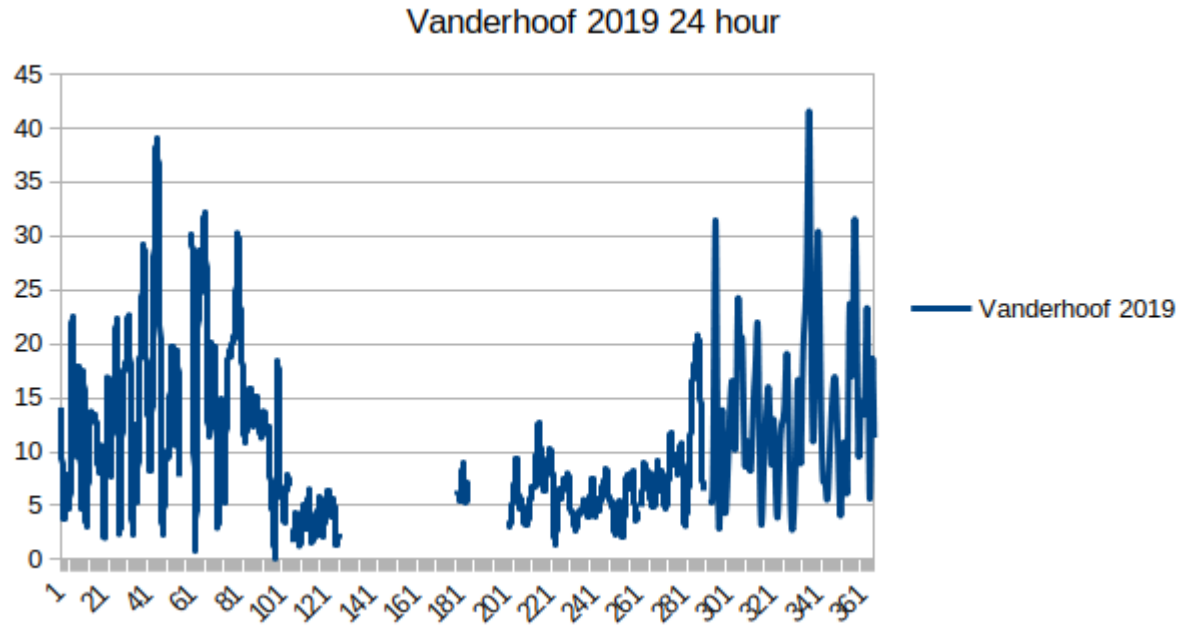


Note gaps reflecting data capture percentages and previous comments about data capture trends.

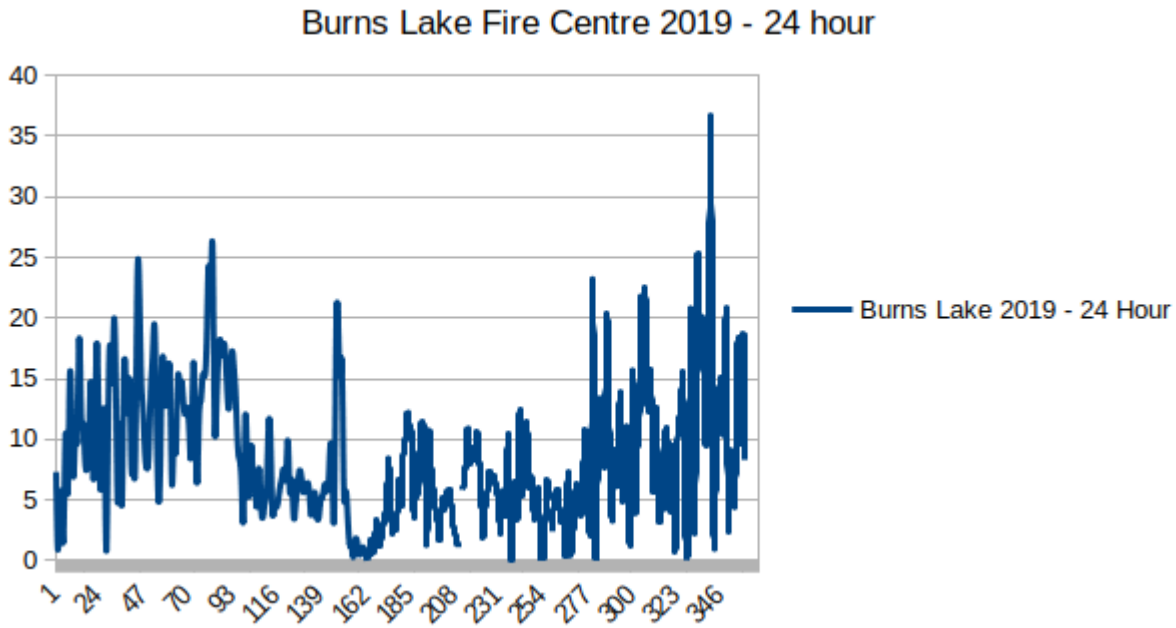




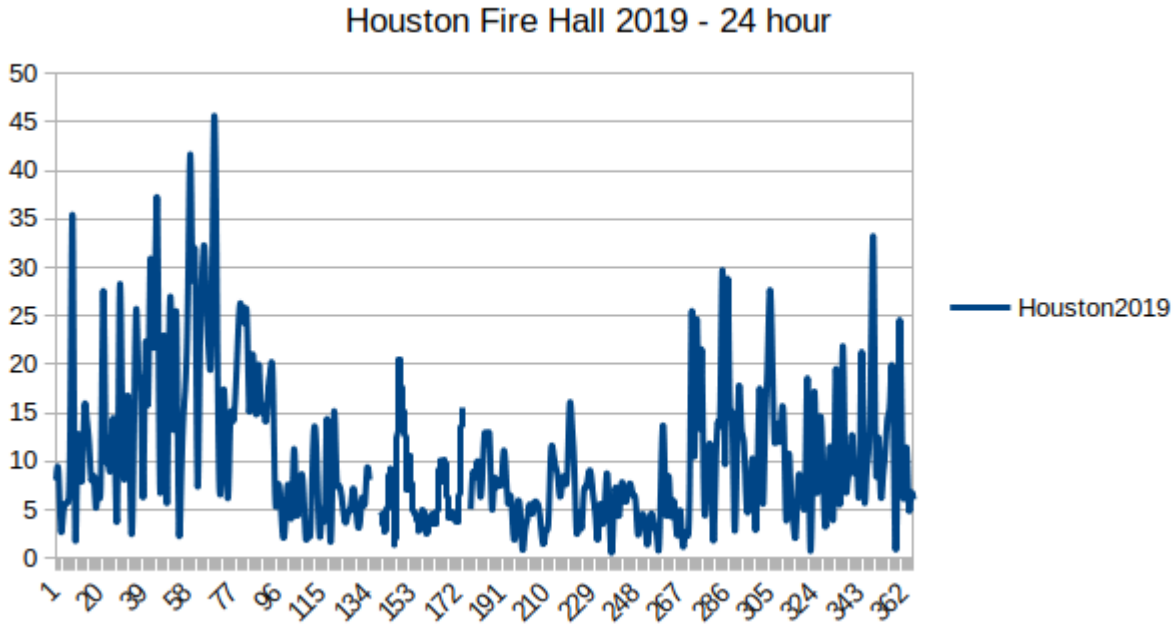
PG Plaza 400, capture comments as above



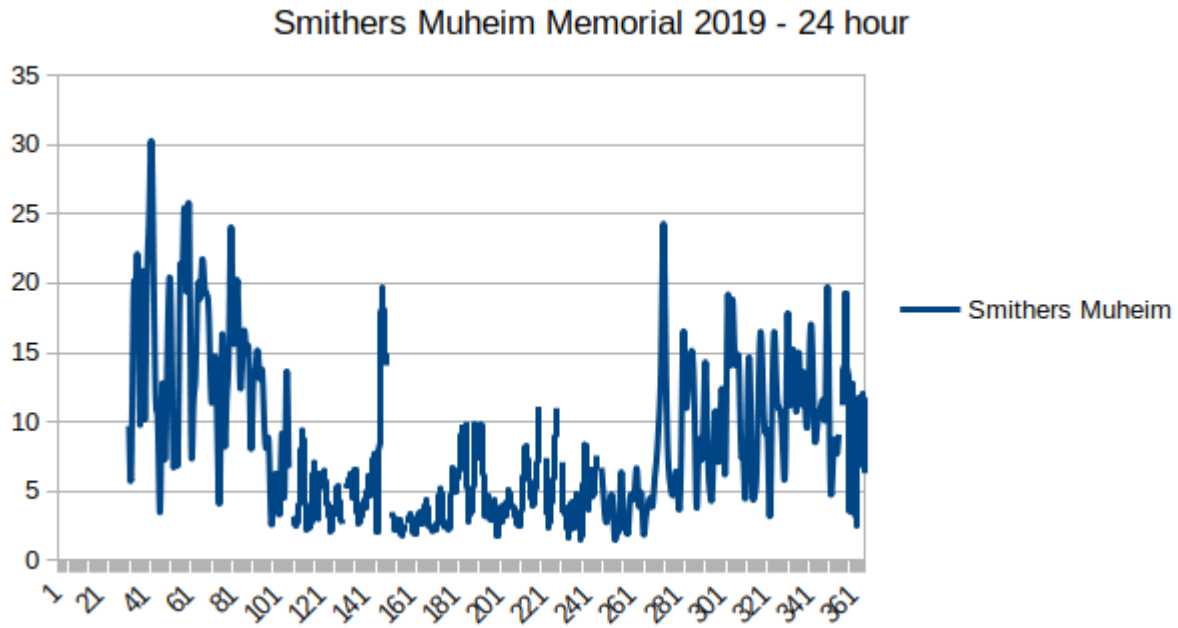
Vanderhoof Courthouse, note missing data



Burns Lake Fire Centre



Houston Firehall


Smithers Muheim Memorial 2019 - 24 hour
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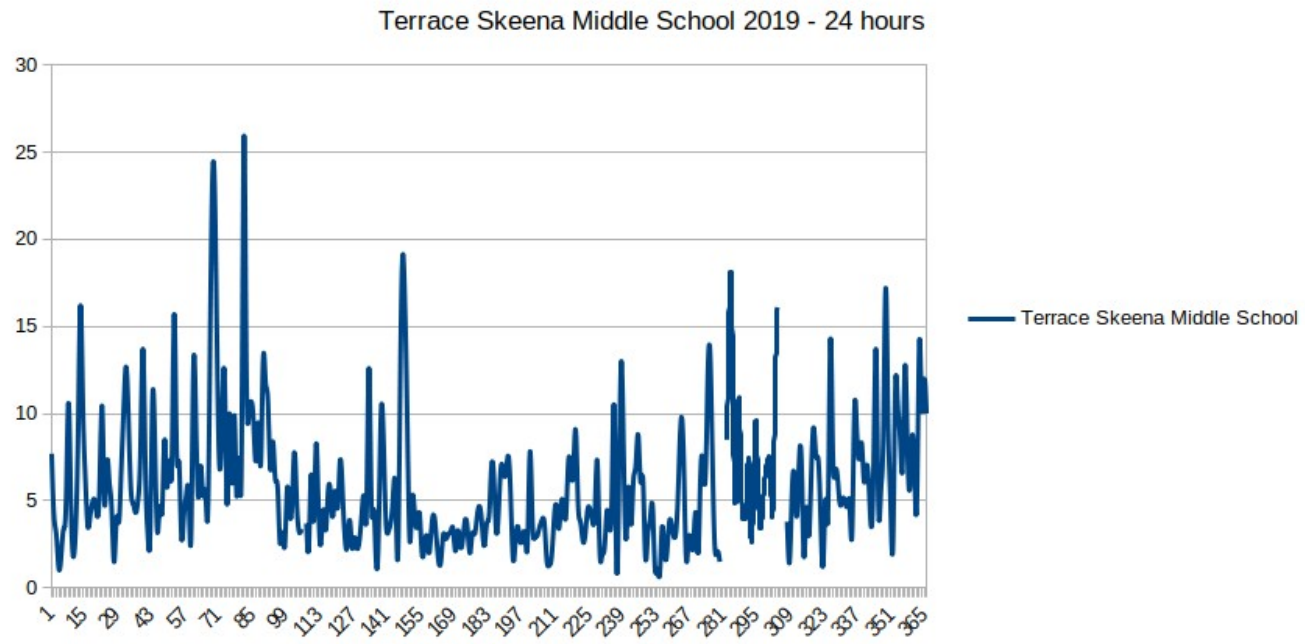
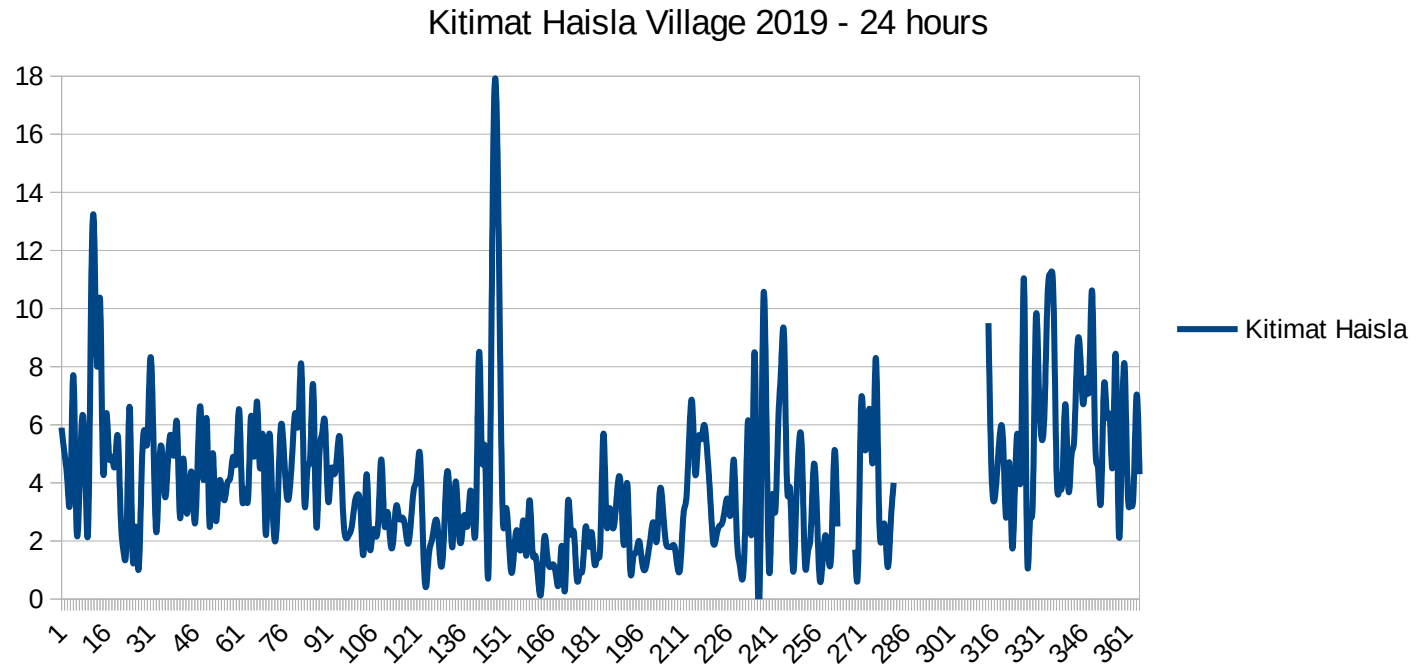
361
Smithers Muheim

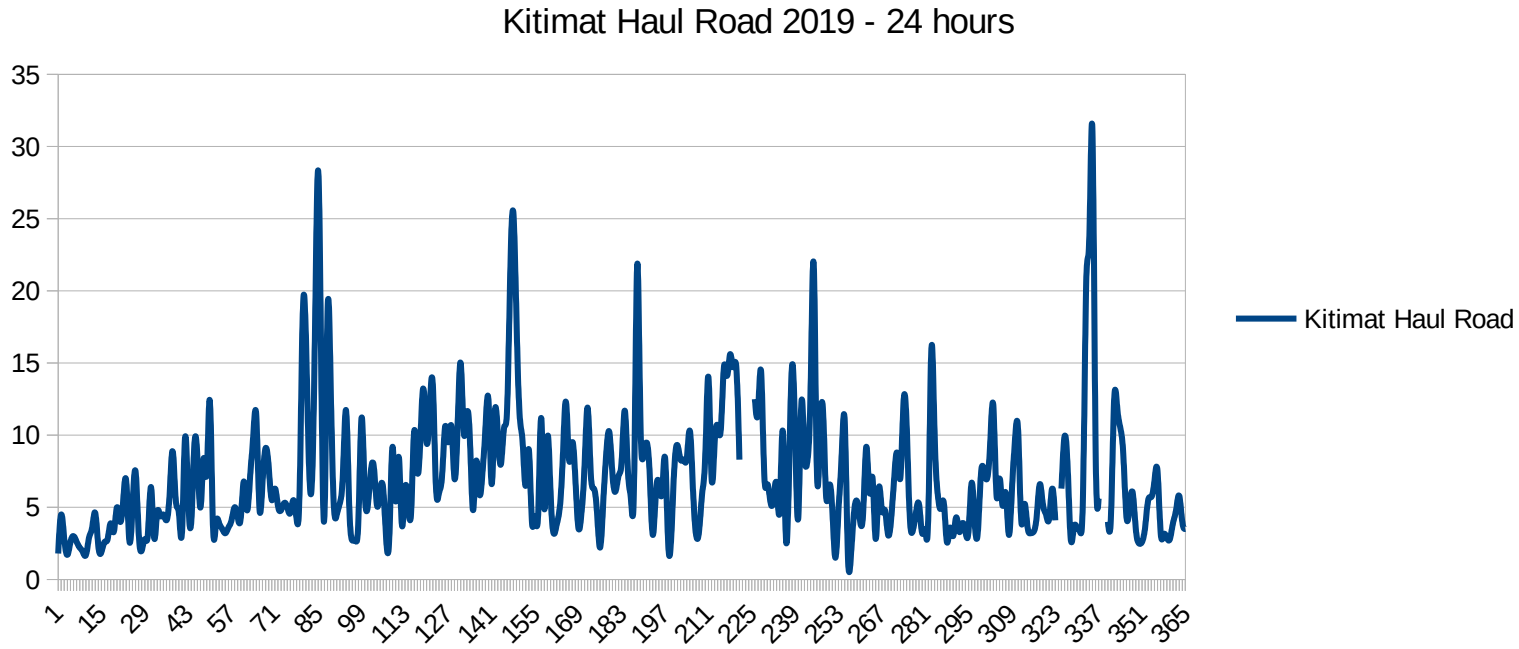


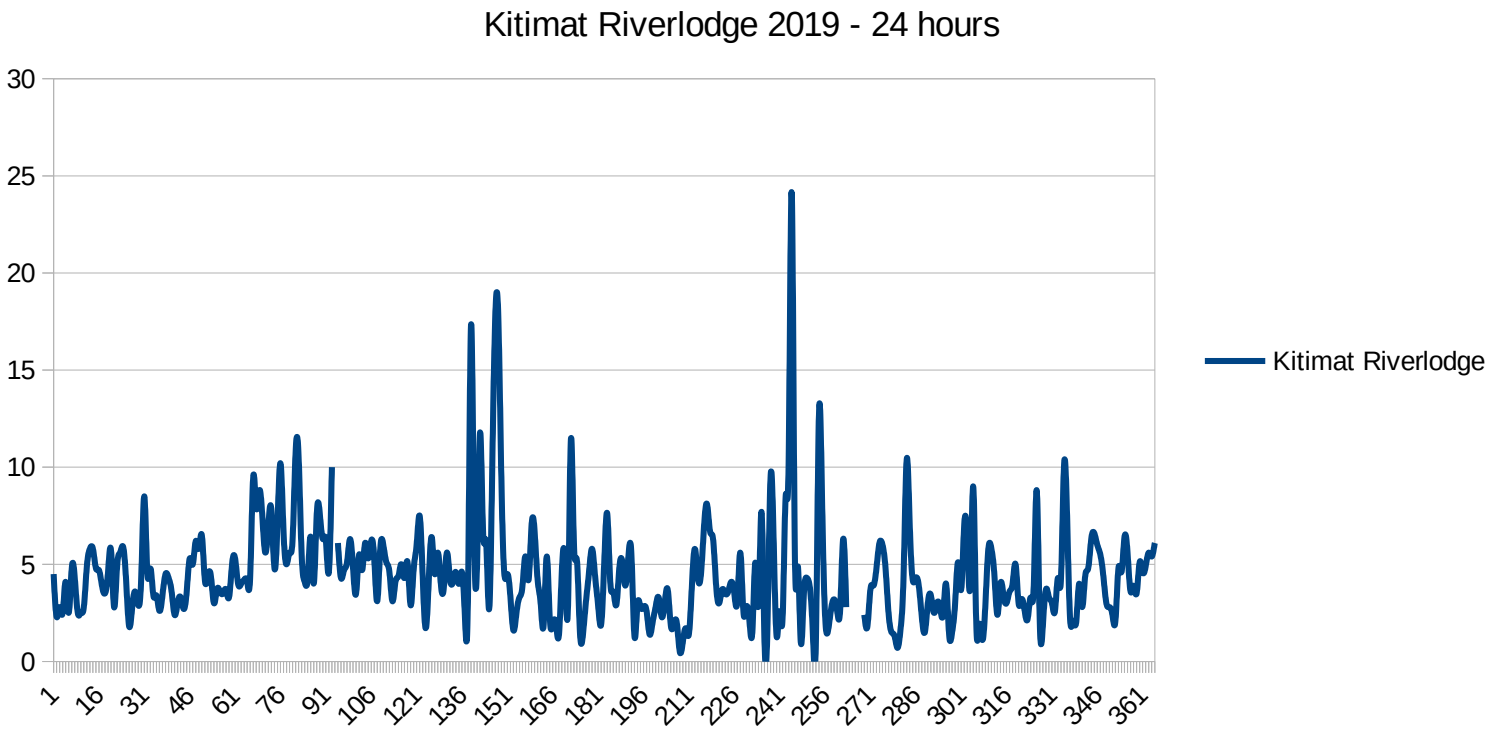
Terrace Skeena Middle School

Kitimat Stations next

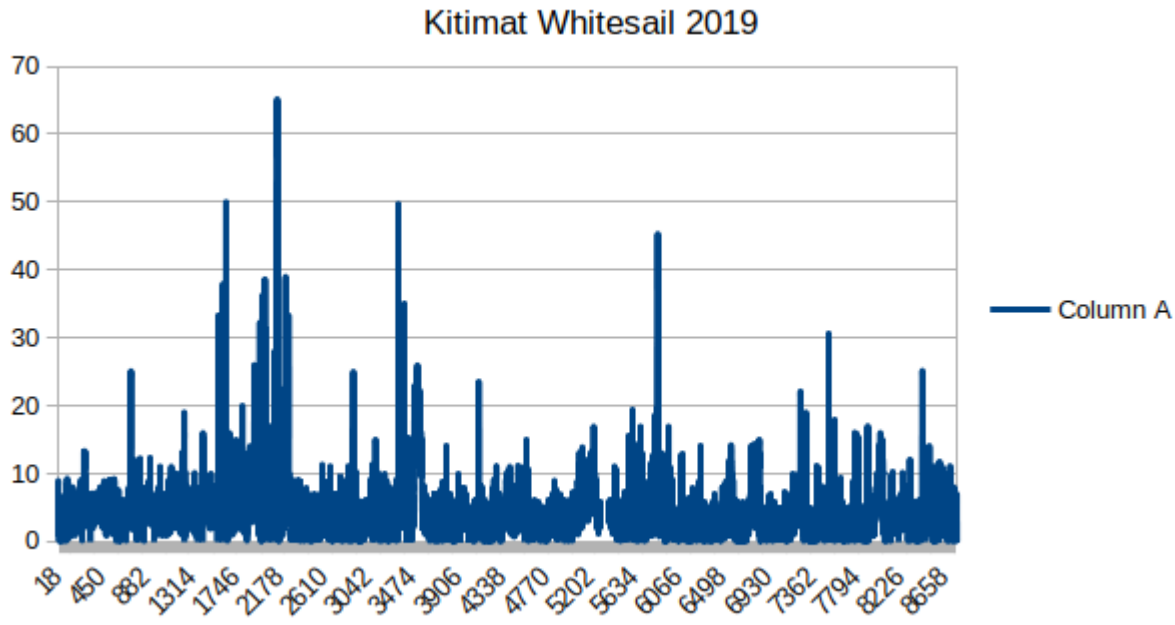


Kitimat Haisla Village

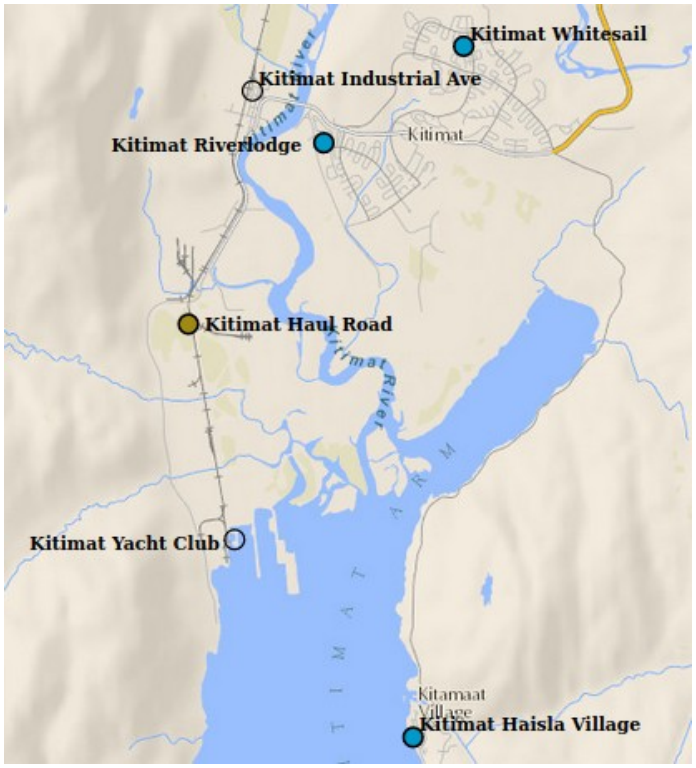




Kitimat Riverlodge



Kitimat Whitesail


Kitimat Whitesail
Kitimat Industrial Ave
Kitimat Riverlodge
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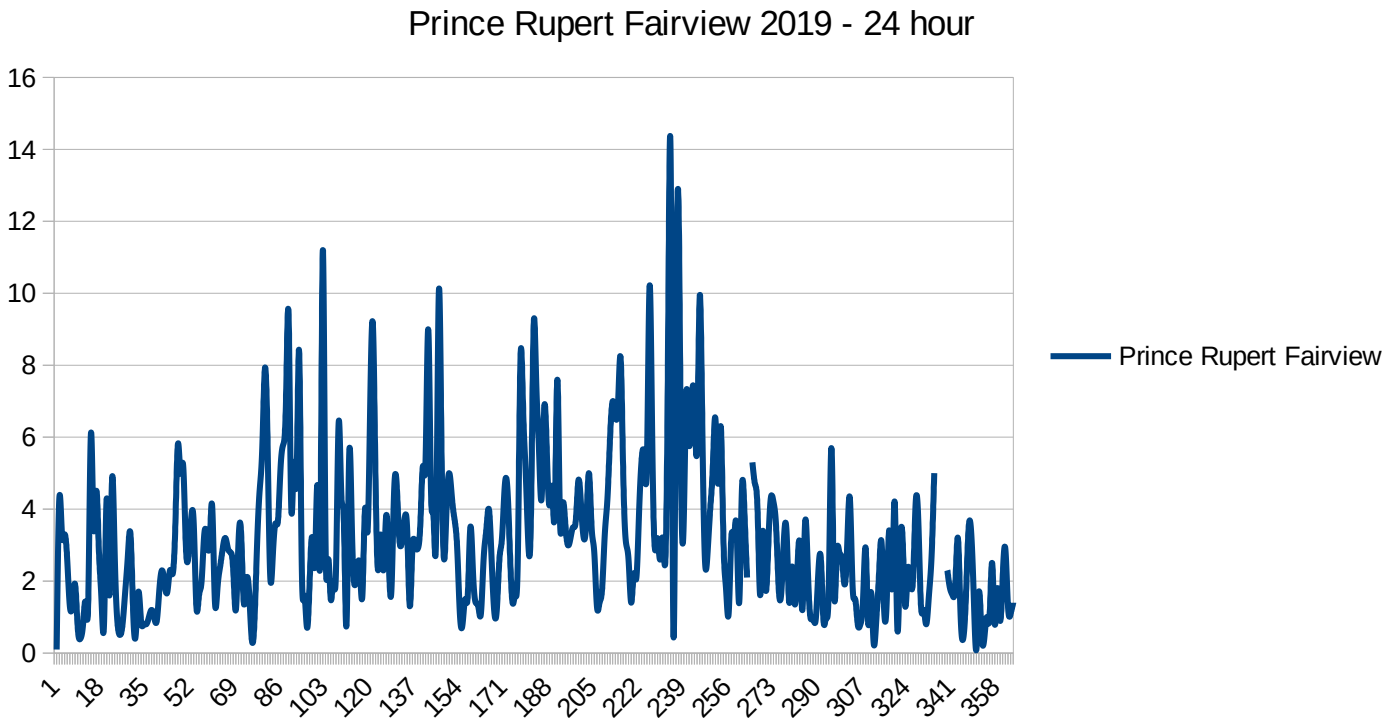
Kitimat Haul Road
Kitimat River
Kitimat Yacht Club
Kitamaat Village
Kitimat Haisla Village


Prince Rupert Fairview 2019 - 24 hour
16
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12
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4
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103
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137
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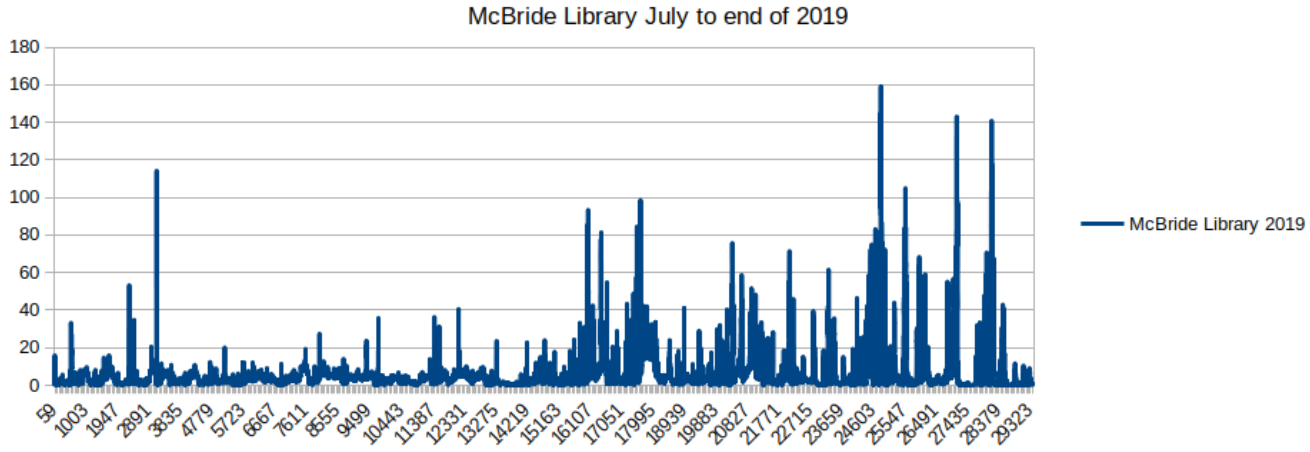
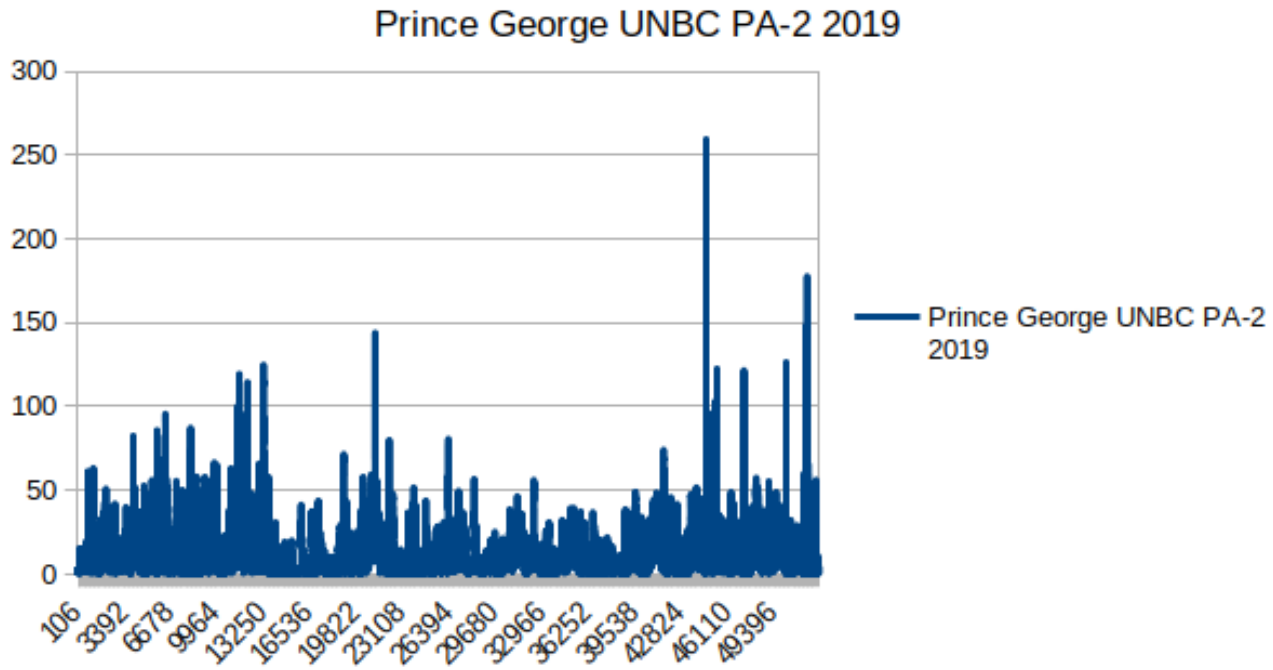
358
Prince Rupert Fairview

Charts for Purple Air PM2.5 in 2019 as per Table 2 list

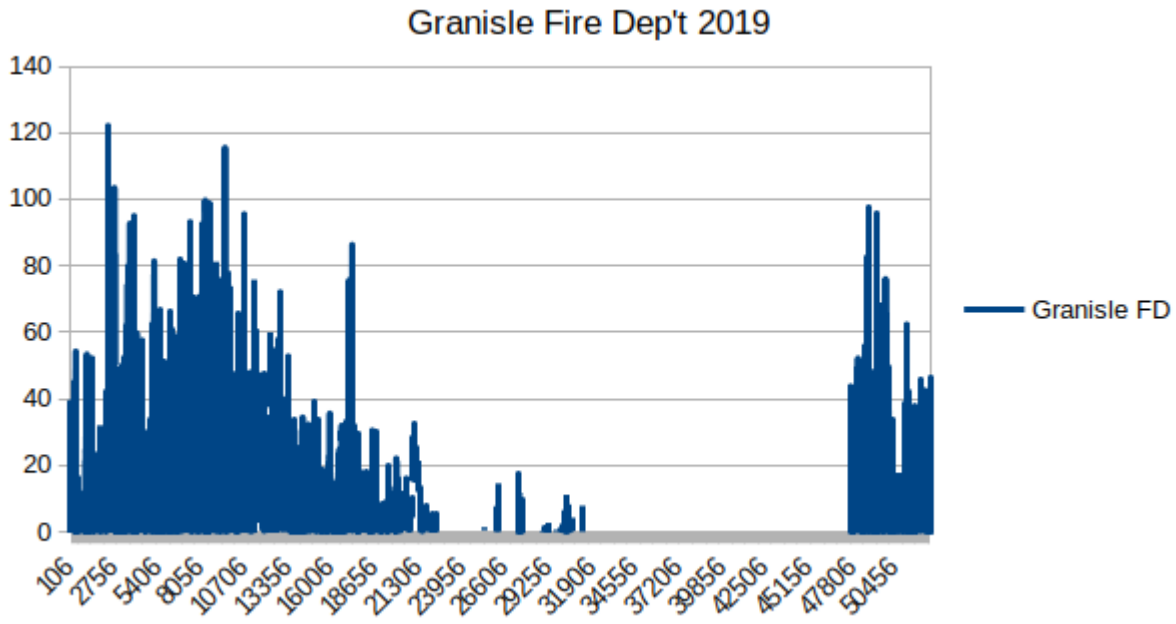
McBride Library July to end of 2019



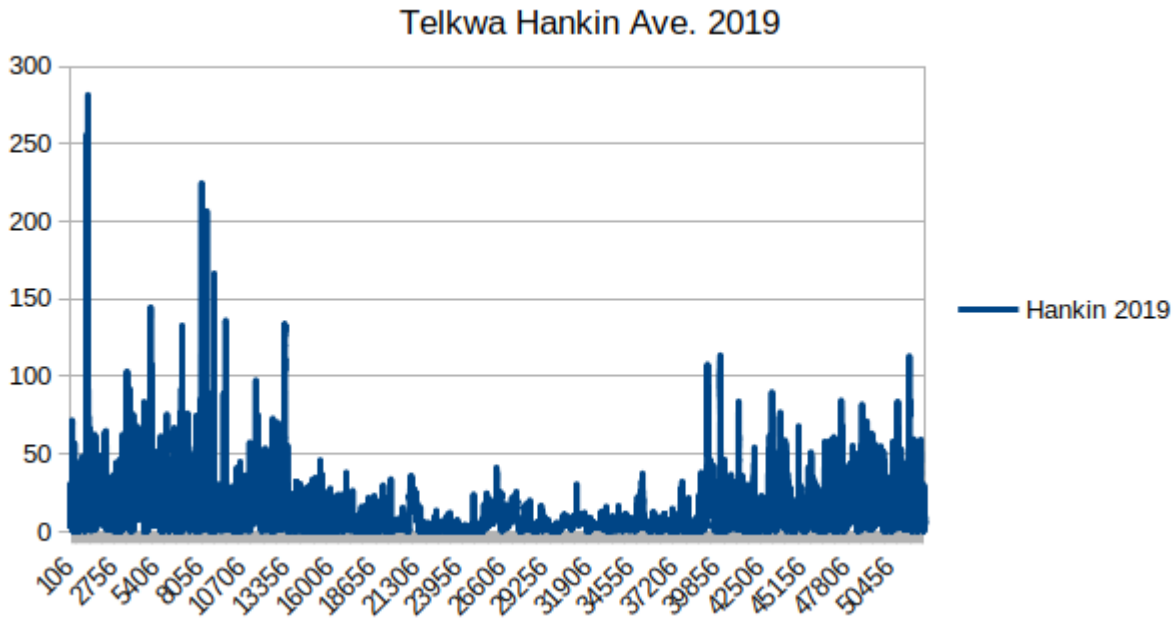
Prince George UNBC PA-2 2019

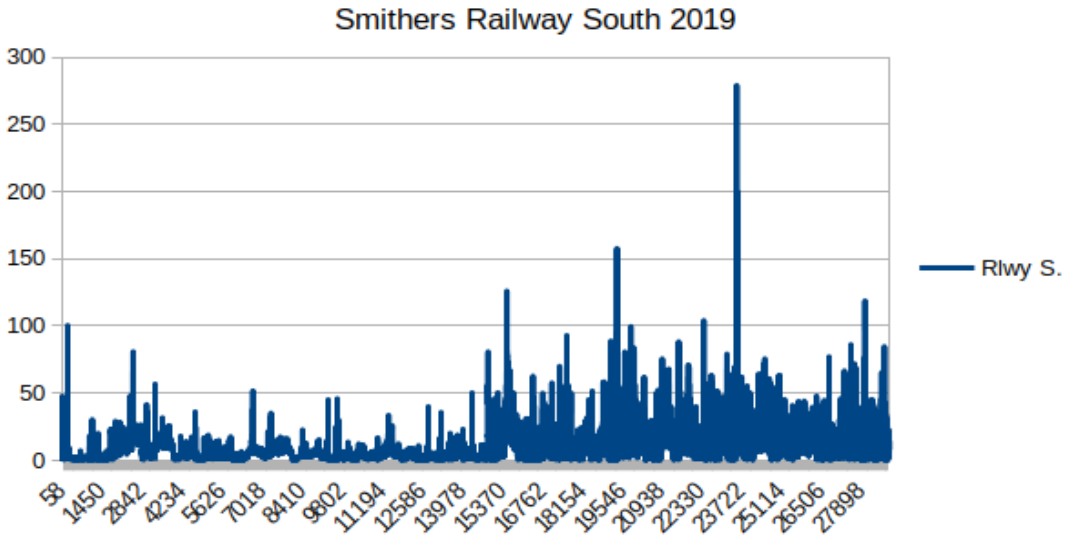


Granisle Fire Department 2019



Telkwa Hankin Ave.




Smithers Railway South 2019
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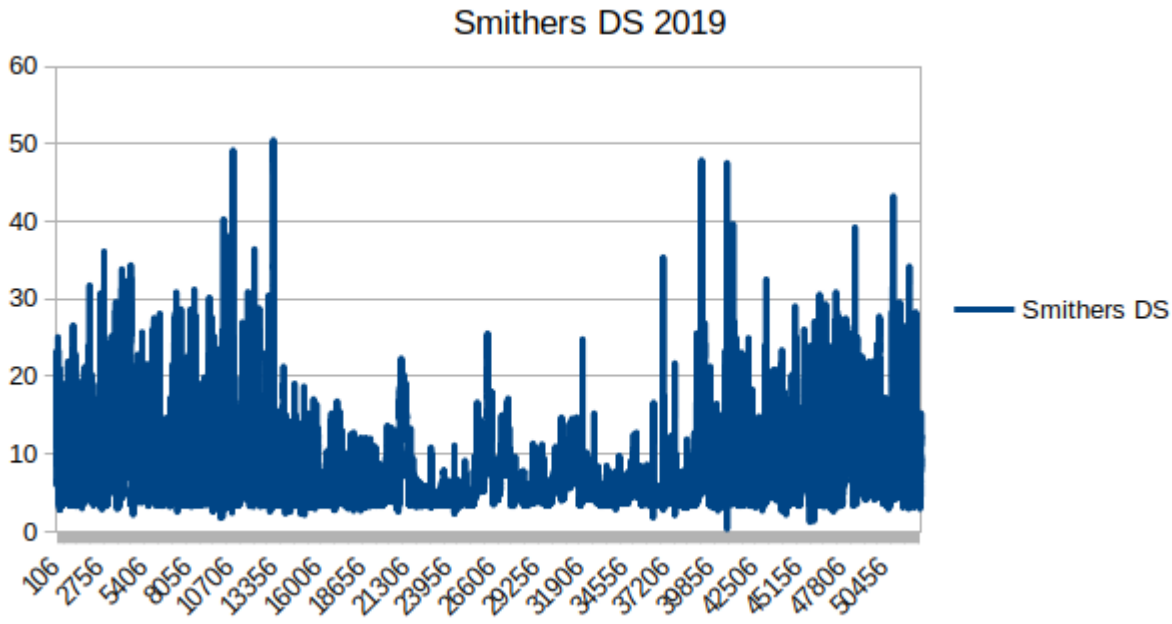
Rlwy S.

Smithers DS


Smithers DS 2019
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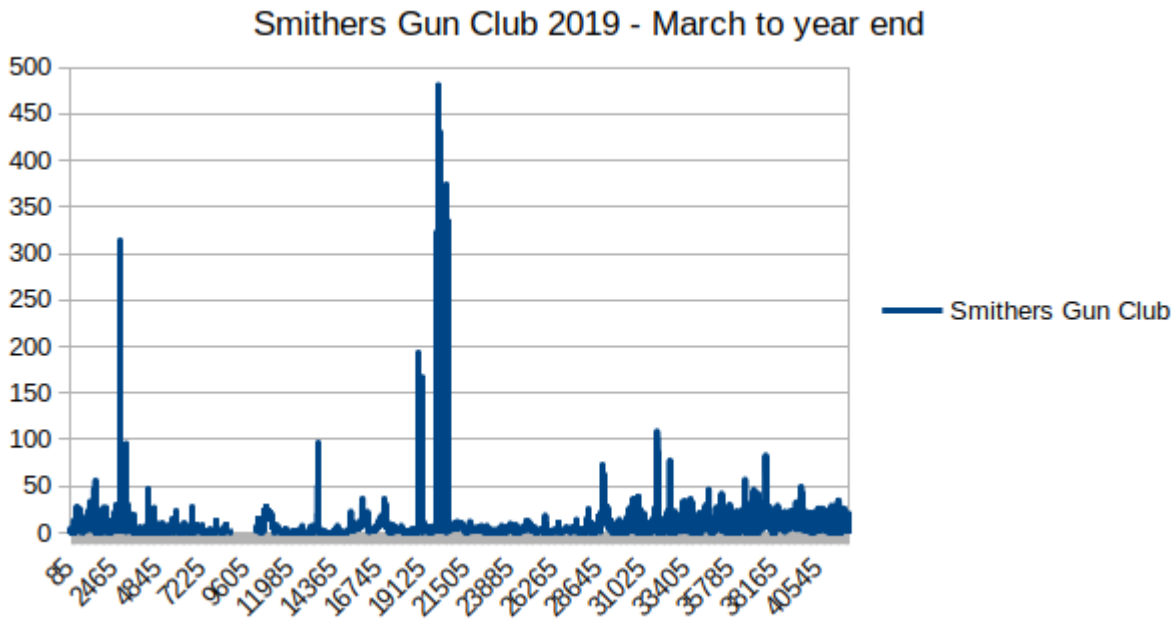
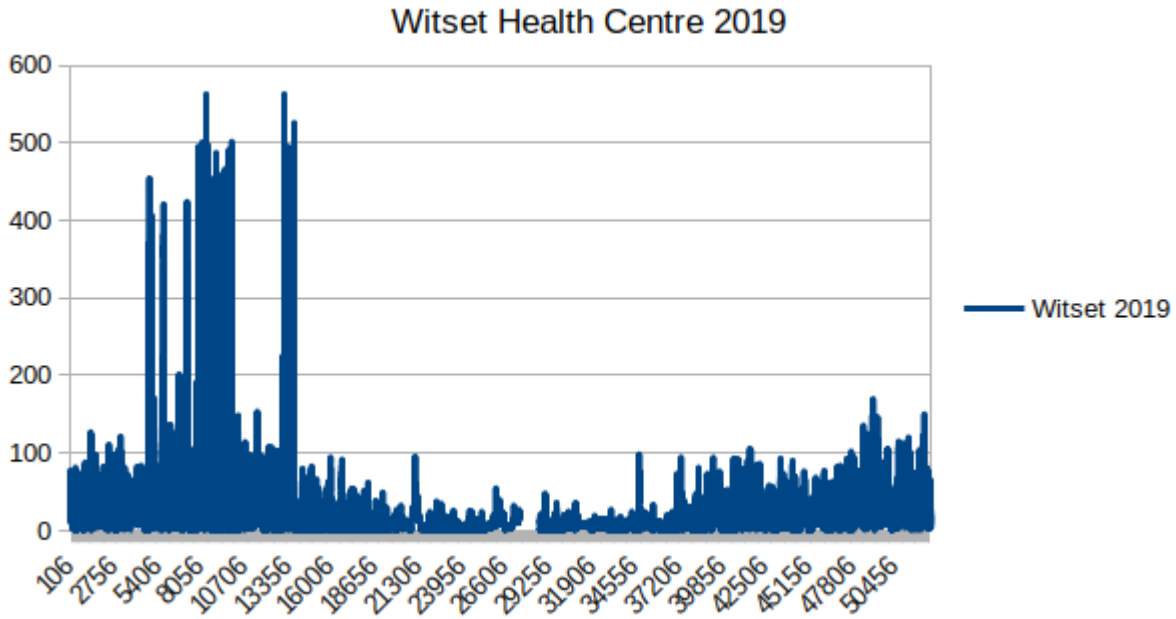
Smithers DS

Smithers Gun Club [13]

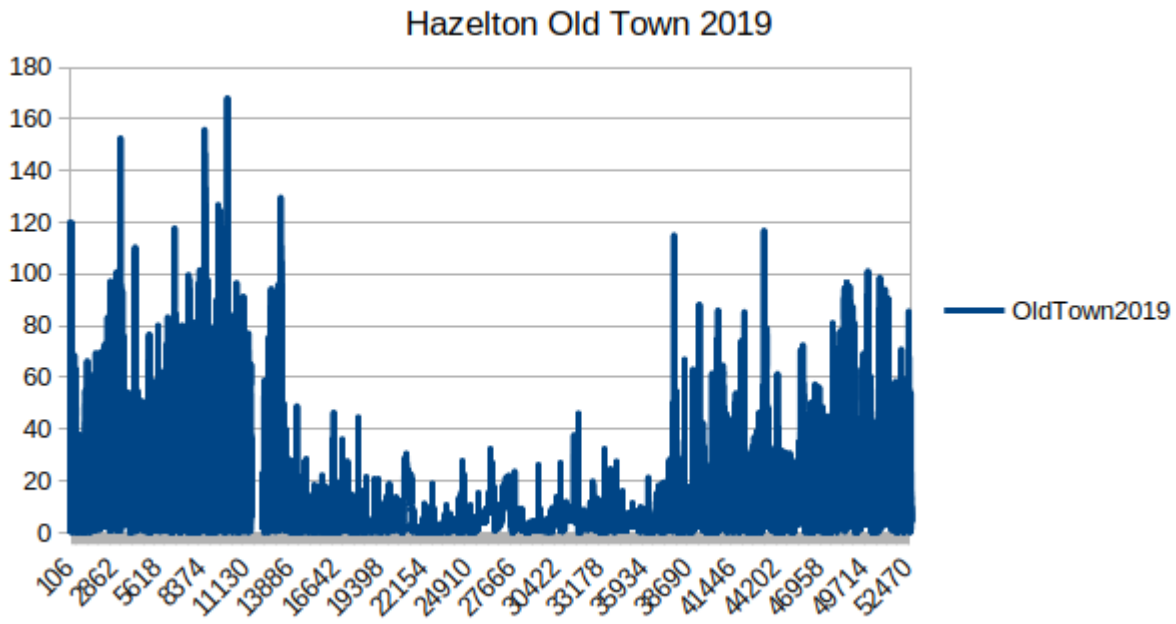


Witset Health Centre [14]

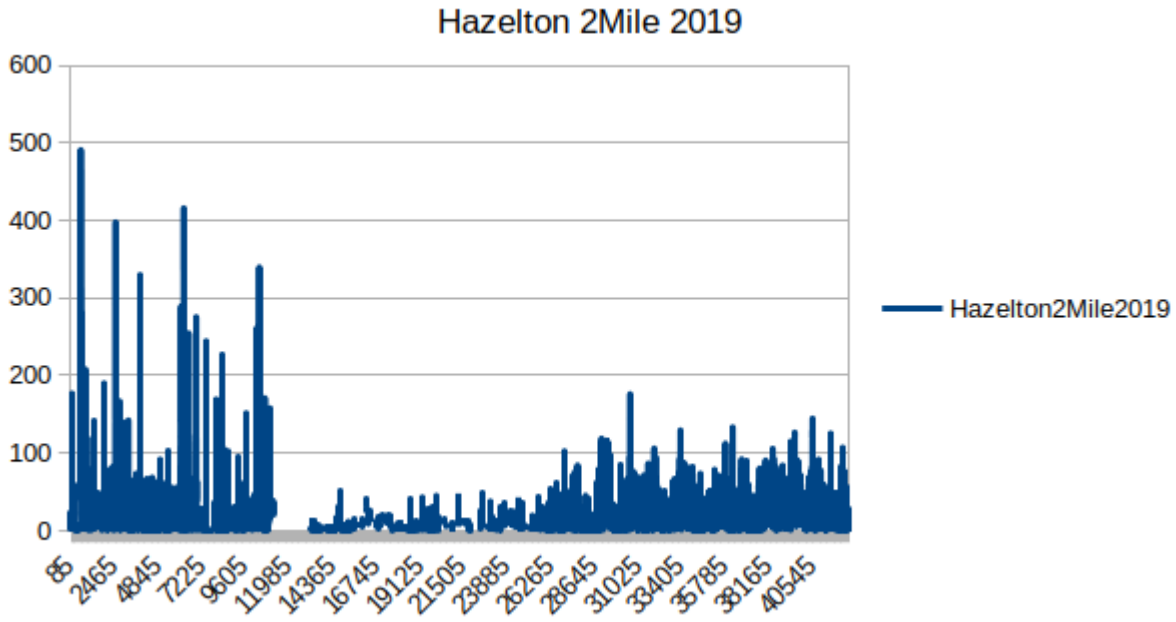


13 A spider web blocked the sensor giving false high readings around point 21505
14 Similar issues here, cleaning restored function

Hazelton Old Town 2019



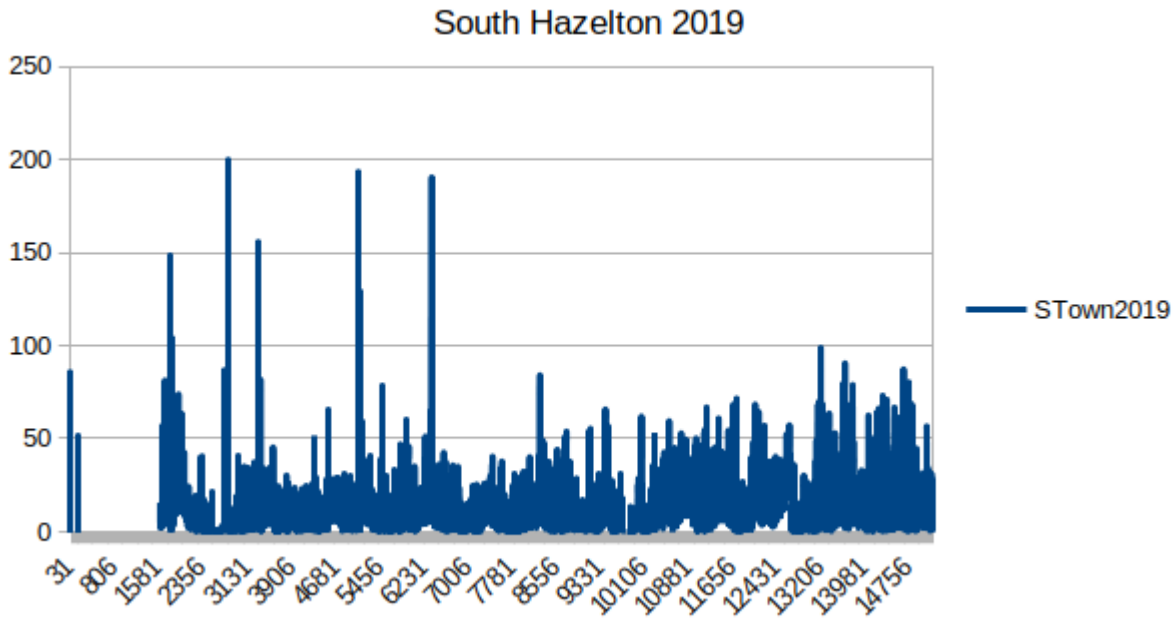
Hazelton 2 Mile 2019 [15]

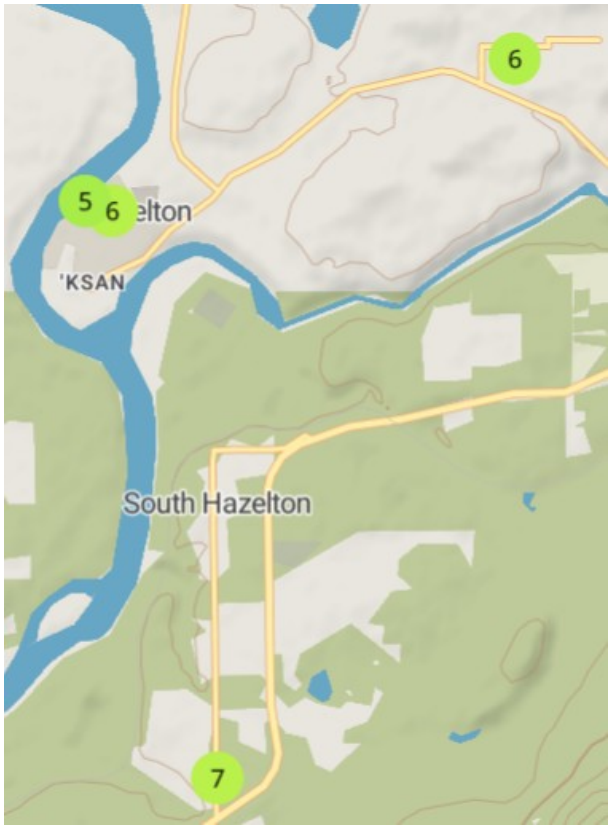


South Hazelton 2019 [16]

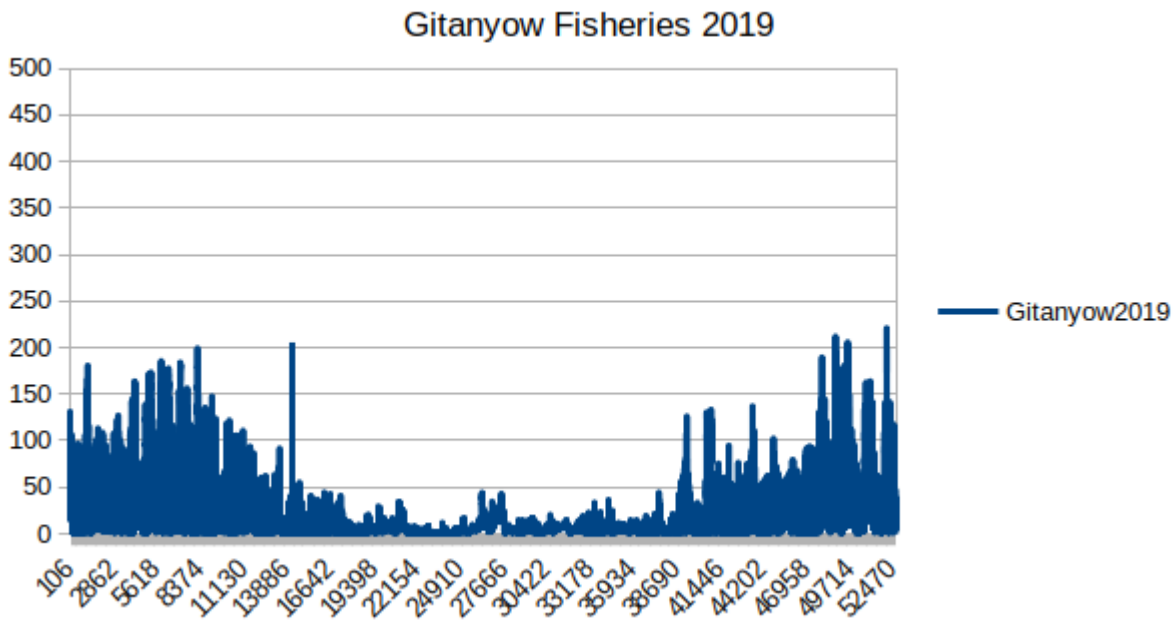
15 Note data collection starts March 11, 2019

16 Data collection starts Sept. 17 2019

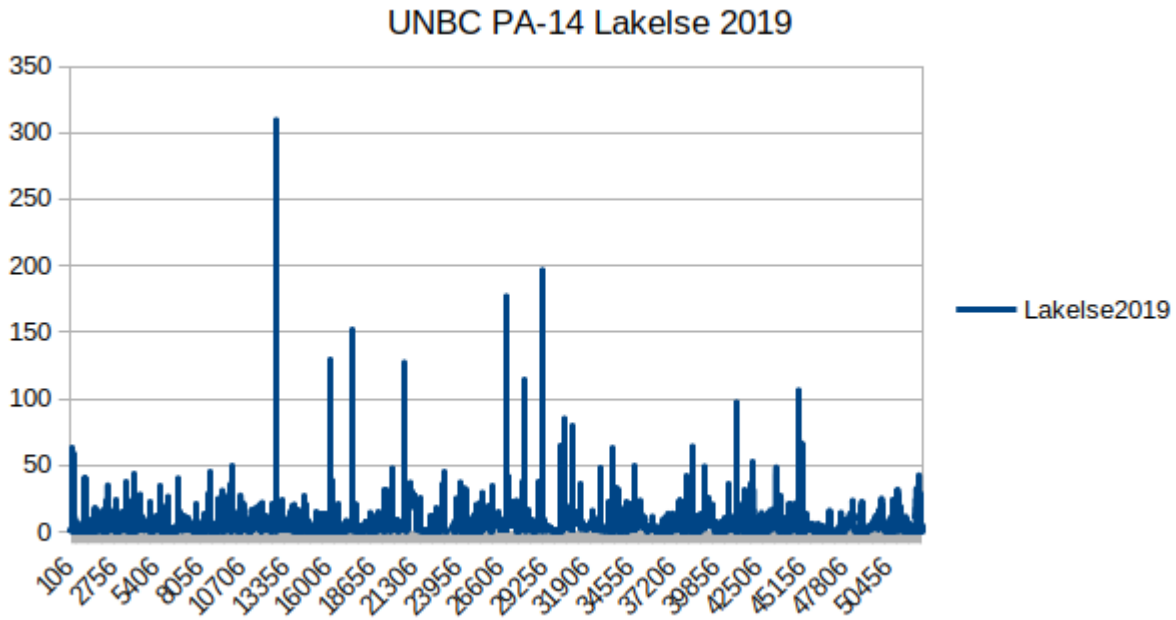

South Hazelton 2019
250
200
150
100
50
0
31
806
1581
2356
3131
3906
4681
5456
6231
7006
7781
8556
9331
10106
10881
11656
12431
13206
13981
14756
STown2019


6
5
6
South Hazelton
7

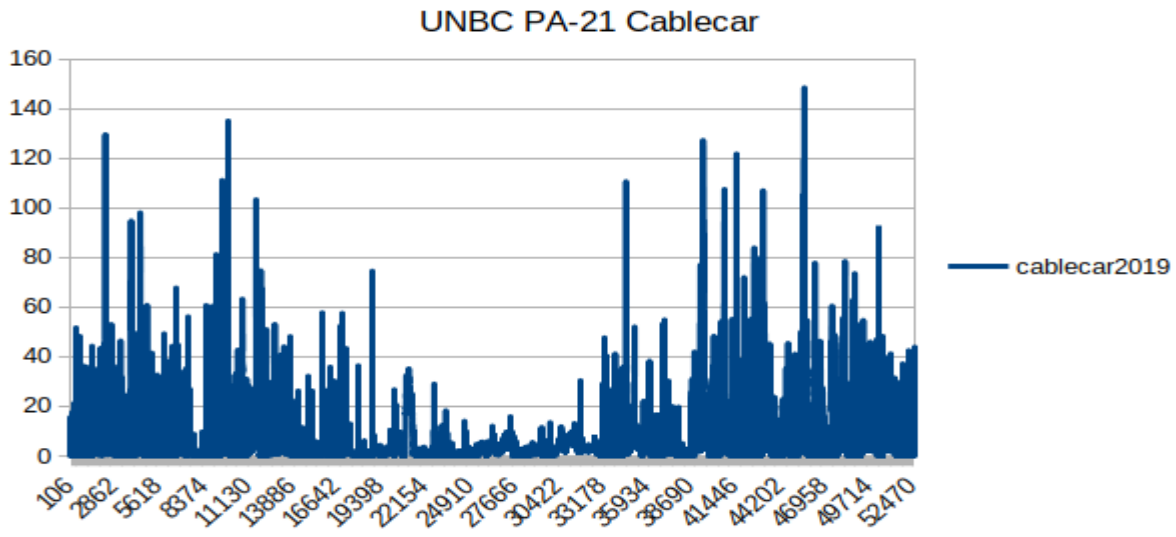
Gitanyow Fisheries 2019



UNBC-PA14 Kitimat Lakelse



UNBC PA-21 Cablecar



Stats for MoE stations in 2019

FSJ 85th Avenue

Mean	6.06466
Standard Error	0.15922
Median	3.7
Mode	1.5
Standard Deviation	13.7206
Sample Variance	188.254
Kurtosis	377.743
Skewness	17.492
Range	346.9
Minimum	0
Maximum	346.9
Sum	45036.2
Count	7426

FSJ Key Learning Centre

Mean	6.76965
Standard Error	0.20403
Median	4.1
Mode	0
Standard Deviation	16.1904
Sample Variance	262.131
Kurtosis	342.334
Skewness	16.8531
Range	401.5
Minimum	0
Maximum	401.5
Sum	42628.5
Count	6297

FSJ Attachie

Mean	5.32463
Standard Error	0.14127
Median	3.2
Mode	0
Standard Deviation	12.7309
Sample Variance	162.076
Kurtosis	321.396
Skewness	15.864
Range	322.9
Minimum	0
Maximum	322.9
Sum	43241.3
Count	8121

FSJ Old Fort

Mean	11.1445
Standard Error	5.26053
Median	2.9
Mode	0
Standard Deviation	478.274
Sample Variance	228746
Kurtosis	8248.22
Skewness	90.7714
Range	43466
Minimum	0
Maximum	43466
Sum	92120.6
Count	8266

FSJ North Camp

Mean	6.02142
Standard Error	0.21863
Median	3.4
Mode	1
Standard Deviation	19.6973
Sample Variance	387.983
Kurtosis	1291.64
Skewness	29.7994
Range	1085.3
Minimum	0
Maximum	1085.3
Sum	48875.9
Count	8117

PG Plaza 400

Mean	10.3322
Standard Error	0.13747
Median	6.7
Mode	3.5
Standard Deviation	9.33894
Sample Variance	87.2158
Kurtosis	5.22332
Skewness	1.98805
Range	80.2
Minimum	0.9
Maximum	81.1
Sum	47683
Count	4615

Valemount

Mean	7.69102
Standard Error	0.24906
Median	3.4
Mode	2
Standard Deviation	13.3495
Sample Variance	178.208
Kurtosis	51.7974
Skewness	5.90349
Range	188.1
Minimum	0.4
Maximum	188.5
Sum	22096.3
Count	2873

Vanderhoof Courthouse

Mean	10.8112
Standard Error	0.13146
Median	7
Mode	6
Standard Deviation	10.9776
Sample Variance	120.508
Kurtosis	36.3492
Skewness	3.28851
Range	246.1
Minimum	0
Maximum	246.1
Sum	75386.7
Count	6973

Burns Lake Fire Centre

Mean	8.601
Standard Error	0.0995
Median	5.6
Mode	0
Standard Deviation	9.18134
Sample Variance	84.2969
Kurtosis	10.8237
Skewness	2.47388
Range	108.8
Minimum	0
Maximum	108.8
Sum	73237.5
Count	8515

Terrace Skeena Middle School

Mean	5.91622
Standard Error	0.07383
Median	3.7
Mode	2.6
Standard Deviation	6.86771
Sample Variance	47.1654
Kurtosis	30.6859
Skewness	4.08159
Range	121.2
Minimum	0.2
Maximum	121.4
Sum	51187.1
Count	8652

Smithers Muheim Memorial

Mean	8.51308
Standard Error	0.10087
Median	5.4
Mode	2.1
Standard Deviation	8.94957
Sample Variance	80.0948
Kurtosis	21.3602
Skewness	3.17641
Range	160.8
Minimum	0.4
Maximum	161.2
Sum	67015
Count	7872

Kitimat Whitesail

Mean	4.38853
Standard Error	0.0406
Median	4
Mode	3
Standard Deviation	3.7686
Sample Variance	14.2023
Kurtosis	31.5708
Skewness	3.72834
Range	65
Minimum	0
Maximum	65
Sum	37816
Count	8617

Kitimat Riverlodge

Mean	4.52505
Standard Error	0.05155
Median	4
Mode	3
Standard Deviation	4.77556
Sample Variance	22.806
Kurtosis	234.468
Skewness	9.90341
Range	153
Minimum	0
Maximum	153
Sum	38834
Count	8582

Kitimat Haisla Village

Mean	4.04199
Standard Error	0.04465
Median	3
Mode	0
Standard Deviation	3.95258
Sample Variance	15.6229
Kurtosis	19.6603
Skewness	2.98024
Range	55
Minimum	0
Maximum	55
Sum	31673
Count	7836

Kitimat Haul Rd.

Mean	7.09854
Standard Error	0.07961
Median	5
Mode	4
Standard Deviation	7.38567
Sample Variance	54.5481
Kurtosis	37.4532
Skewness	4.45755
Range	123
Minimum	0
Maximum	123
Sum	61090
Count	8606

Prince Rupert Fairview

Mean	3.22591
Standard Error	0.03028
Median	2.5
Mode	1.2
Standard Deviation	2.81544
Sample Variance	7.92668
Kurtosis	7.64946
Skewness	2.09655
Range	30.3
Minimum	0
Maximum	30.3
Sum	27897.7
Count	8648

Stats for corrected Purple Air data for 2019[17]

McBride from July

Mean	4.80273289702425
Standard Error	0.051770167460228
Mode	0
Median	2.34
First Quartile	0.78
Third Quartile	4.985
Variance	78.6275675574377
Standard Deviation	8.86721870472572
Kurtosis	46.4253407287393
Skewness	5.59387549374183
Range	159.24
Minimum	0
Maximum	159.24
Sum	140897.775
Count	29337

Granisle Fire Dep't 2019

Mean	6.65162057355112
Standard Error	0.03648068269838
Mode	3.4
Median	4.132
First Quartile	3.526
Third Quartile	6.754
Variance	34.387580189805
Standard Deviation	5.86409244383178
Kurtosis	15.2449100300349
Skewness	3.23485213467282
Range	85.632
Minimum	3.4
Maximum	89.032
Sum	171871.224
Count	25839

PG Plaza 400 PA-2 2019

Mean	8.65965003246637
Standard Error	0.047785234710453
Mode	0
Median	4.675
First Quartile	1.25
Third Quartile	12.37
Variance	119.564891302913
Standard Deviation	10.934573210826
Kurtosis	20.1846865512492
Skewness	2.98185843529335
Range	257.38
Minimum	0
Maximum	257.38
Sum	453436.595
Count	52362

Railway South

Mean	8.72665805133977
Standard Error	0.036661032631138
Mode	3.4
Median	6.814
First Quartile	4.744
Third Quartile	10.744
Variance	38.1691452743973
Standard Deviation	6.17811826322525
Kurtosis	175.643600453427
Skewness	6.20378625762759
Range	286.504
Minimum	3.4
Maximum	289.904
Sum	247828.362
Count	28399

17 Please note that the digits to the right of the decimal are an accurate calculation on the figures in the spreadsheets. Data errors in the sensors are not reflected here.

Smithers DS

Mean	7.49253543696713
Standard Error	0.020808178932653
Mode	3.4
Median	5.572
First Quartile	3.982
Third Quartile	9.616
Variance	22.7505174345595
Standard Deviation	4.76975024865658
Kurtosis	4.30040280805655
Skewness	1.78290455501646
Range	46.92
Minimum	3.4
Maximum	50.32
Sum	393687.782
Count	52544

Smithers Gun Club

Mean	7.82323920048314
Standard Error	0.103980494837865
Mode	3.4
Median	4.75
First Quartile	3.712
Third Quartile	7.204
Variance	429.493635916434
Standard Deviation	20.724228234519
Kurtosis	227.680187879161
Skewness	13.7801189913688
Range	522.664
Minimum	3.4
Maximum	526.064
Sum	310770.354
Count	39724

Telkwa Hankin Avenue

Mean	8.6213812705849
Standard Error	0.031346207845046
Mode	3.4
Median	6.172
First Quartile	4.27
Third Quartile	10.276
Variance	51.6122289670515
Standard Deviation	7.1841651544944
Kurtosis	56.1431167269667
Skewness	4.48238192468273
Range	247.192
Minimum	3.4
Maximum	250.592
Sum	452855.294
Count	52527

Witset

Mean	12.1402594391358
Standard Error	0.046902823132444
Mode	3.4
Median	8.02
First Quartile	4.792
Third Quartile	15.358
Variance	112.334407695798
Standard Deviation	10.5987927470914
Kurtosis	5.99911888928843
Skewness	2.11134781443175
Range	134.2
Minimum	3.4
Maximum	137.6
Sum	619930.208
Count	51064

Hazelton 2 Mile

Mean	10.8970910251785
Standard Error	0.103654923373377
Mode	0
Median	4.895
First Quartile	1.445
Third Quartile	12.87
Variance	387.04347291567
Standard Deviation	19.6734204681258
Kurtosis	102.640130532297
Skewness	7.55075289510052
Range	487.87
Minimum	0
Maximum	487.87
Sum	392545.91
Count	36023

Hazelton South Town

Mean	10.4754210095295
Standard Error	0.098539005822871
Mode	0
Median	7.465
First Quartile	2.765
Third Quartile	14.44625
Variance	130.423855900094
Standard Deviation	11.4203264357939
Kurtosis	26.0815083821661
Skewness	3.26716230994136
Range	199.12
Minimum	0
Maximum	199.12
Sum	140705.855
Count	13432

Hazelton Old Town

Mean	8.57456204663474
Standard Error	0.056923756436466
Mode	0
Median	3.45
First Quartile	0.98
Third Quartile	10.61
Variance	166.620188602459
Standard Deviation	12.9081442741573
Kurtosis	11.8636932098956
Skewness	2.93878928103062
Range	164.875
Minimum	0
Maximum	164.875
Sum	440912.555
Count	51421

Gitanyow Fisheries

Mean	15.4497817722394
Standard Error	0.108656887444586
Mode	0
Median	4.955
First Quartile	1.155
Third Quartile	18.335
Variance	616.750308121766
Standard Deviation	24.834458079889
Kurtosis	10.868479474099
Skewness	2.82006178304223
Range	463.25
Minimum	0
Maximum	463.25
Sum	807081.15
Count	52239

Kitimat Lakelse

Mean	2.85422061019028
Standard Error	0.023306810066229
Mode	0
Median	1.27
First Quartile	0.295
Third Quartile	3.4
Variance	28.3804135833734
Standard Deviation	5.32732705804454
Kurtosis	480.520123000457
Skewness	13.6258667297671
Range	309.545
Minimum	0
Maximum	309.545
Sum	149121.61
Count	52246

Kitimat Cablecar

Mean	4.55755758240492
Standard Error	0.035572548602728
Mode	0
Median	1.7
First Quartile	0.295
Third Quartile	5.37
Variance	65.7618955402221
Standard Deviation	8.10937084737294
Kurtosis	40.9429040775934
Skewness	4.91199327375695
Range	148.31
Minimum	0
Maximum	148.31
Sum	236851.71
Count	51969