

APPENDIX H – GRAPHS OF NEPHELOMETER SCATTERING & PM2.5 CONCENTRATIONS AT TEOMS ON SAMPLING NIGHTS

December 9/10, 2009 - Foothills:

The route starts at direction #1. Over the night, the On-Route scattering seems to not follow the same PM2.5 pattern as either Plaza or Gladstone. Therefore, it is not worth using either of the two sites to adjust the data. The meteorology of the night is fairly constant with temperatures increasing by about 2 degrees between 6pm-3am.

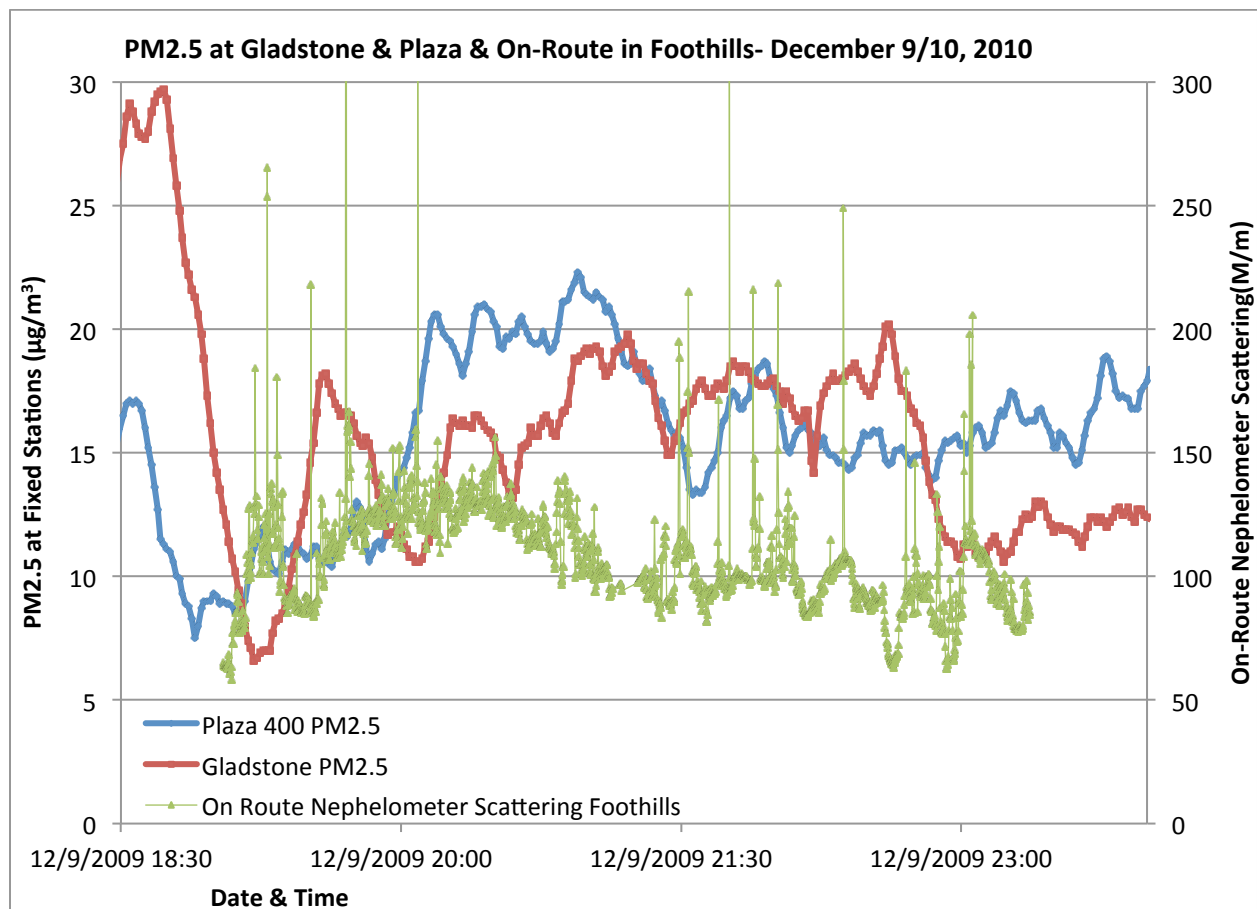


Figure H-1: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Foothills Division of Prince George– December 9/10, 2009

January 3/4, 2010 - Greater South Fort George:

This route was done from the beginning until the end. Levels of PM2.5 at both fixed sites do not vary much in absolute terms. The highest PM2.5 value at Gladstone is $9.3\mu\text{g}/\text{m}^3$ and the lowest is $0.9\mu\text{g}/\text{m}^3$. The highest PM2.5 value for Plaza is $7.3\mu\text{g}/\text{m}^3$ and the lowest is $-0.3\mu\text{g}/\text{m}^3$. However, in relative terms they do vary quite a bit, as the highest value for Gladstone is 10 times the lowest value. At Gladstone, I would consider the levels to be fairly constant throughout the night, whereas at Plaza I would consider that the levels go down around 9pm from an average of approximately $53\mu\text{g}/\text{m}^3$ to $1\mu\text{g}/\text{m}^3$. Topography appears to be somewhat of a factor for this particular route. The east side near the river tends to have lower topography than other areas. The area that shows overall the highest levels are the blocks between 17th-20th between Victoria and Queensway. This area was done around 7:30-9pm, the time of day where peak woodsmoke is expected. Based on topography there would be no reason to believe that this area would have higher values than the rest of the division. There are also no trailer parks in this area. The overlapped area, at the beginning and the end seems to be fairly close, supporting the hypothesis that there was very little nightly variation. The overlapping area in this case was on main streets and not in a residential area. These overlapping values may not give an accurate description of the variation that may have gone on in residential areas. The fact that the overlapping values show similar results around 7pm and 1am may also

Because the times of highest emissions appear to be affected by the time that the nephelometer went down a certain street I think the best approach for these nephelometer values would be to divide them by an averaged version of the Plaza 400 values, which appear to be lower after 9pm. Perhaps a half hour time delay should be applied on the Plaza 400 results because on stagnant nights it takes time for particulate matter to rise.

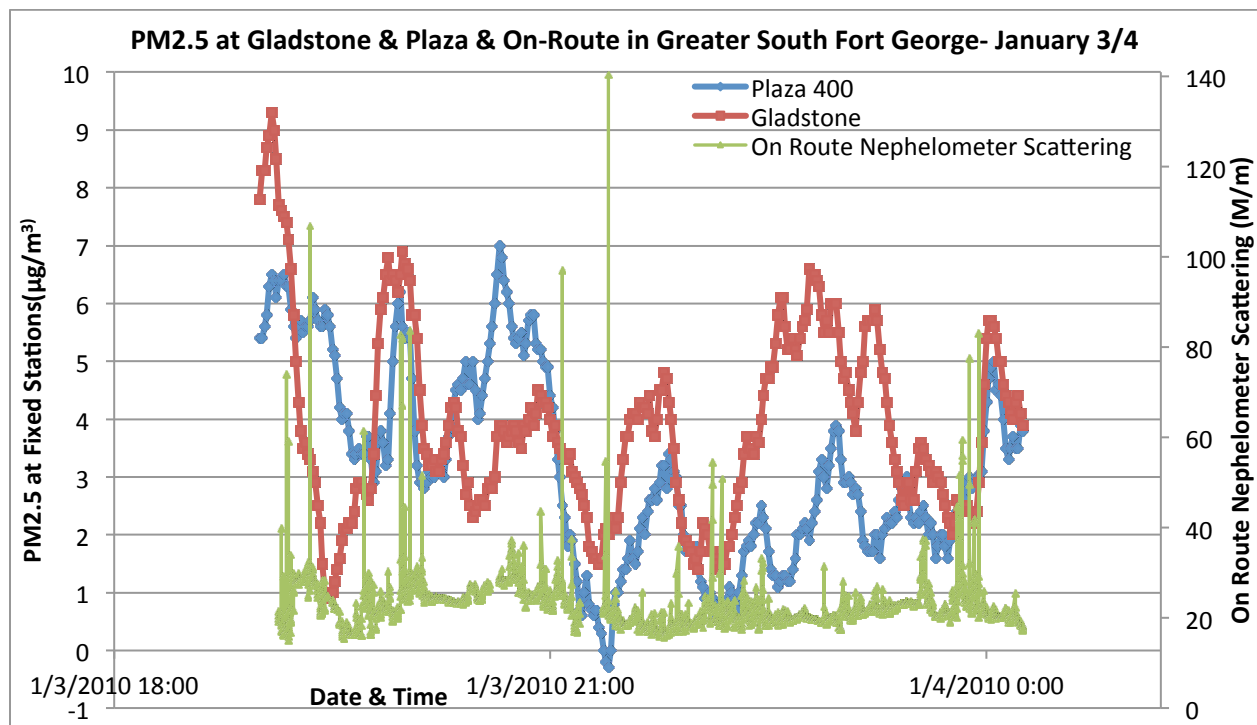


Figure H-2: PM2.5 at Gladstone & Plaza & On-Route in the Greater South Fort George Division of Prince George – January 3/4, 2010

January 6/7, 2010 - Westwood:

This area is about half industrial, yet these emissions were also able to be captured. The overlap areas seem to indicate similar levels at the beginning and end of the route.

It is best not to make adjustments on the mobile monitoring data as TEOMs show different patterns.

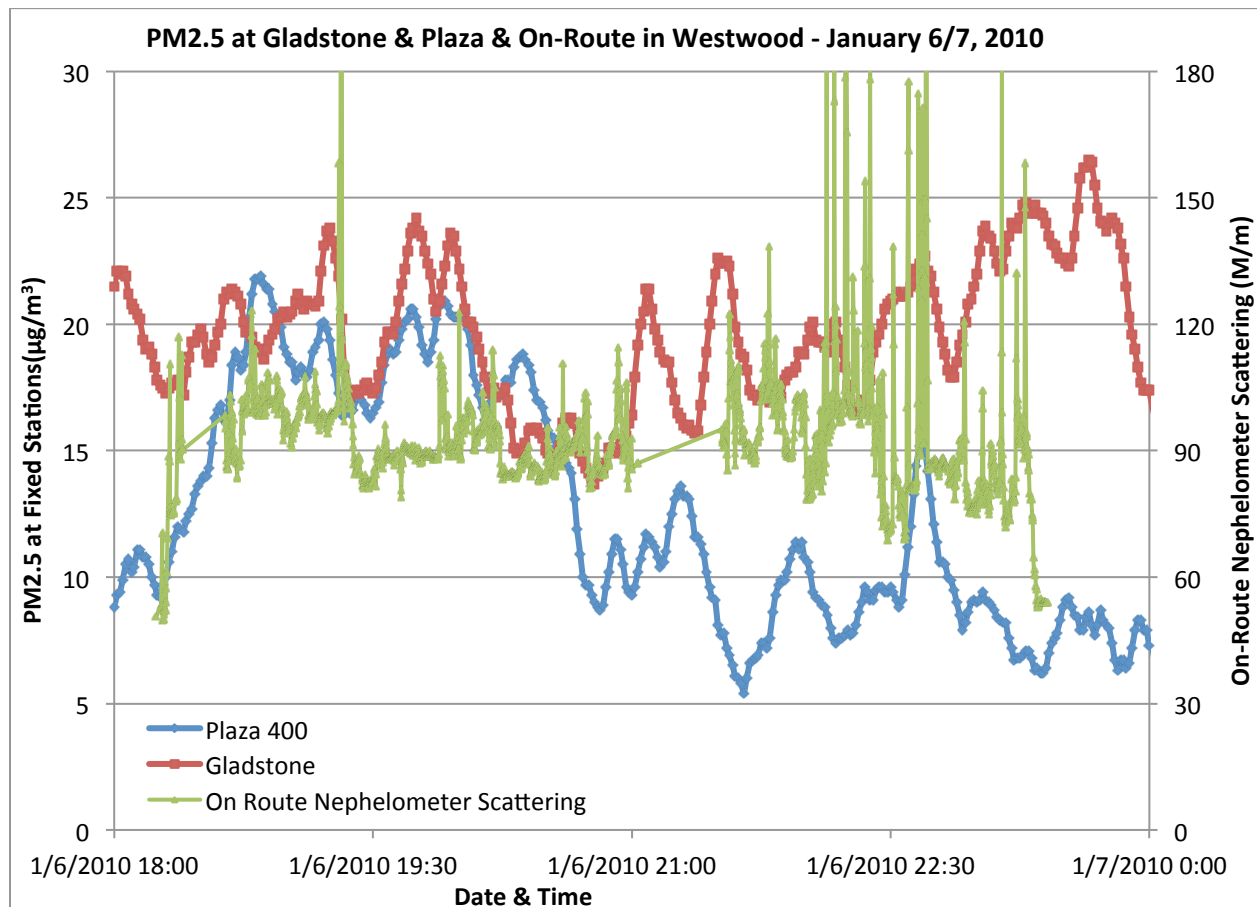


Figure H-3: PM2.5 at Gladstone & Plaza & On Route in Westwood Division of Prince George– January 6/7, 2010

January 7/8, 2010 - North Nechako:

This route started at direction #1. The night ended early because it started to rain at 9:08pm. Therefore, it is not possible to compare results from the beginning and end of the night (overlap). After approximately 8:35pm the results the mobile results appear to decrease. PM2.5 & PM10 both decrease significantly between 8-9pm. Therefore, it seems a bit questionable whether meteorological variables were influencing the decrease between 8-9pm. We should proceed with more caution when looking at results between those times.

It is a difficult to decide which set of results is most valid. However, because neither Plaza nor Gladstone results seem to conform adequately to the mobile results and because the base values seem to be lower at the beginning of the night than at any point up until when the rain starts. Also, throughout the night base results seem to go up and down quite a bit.

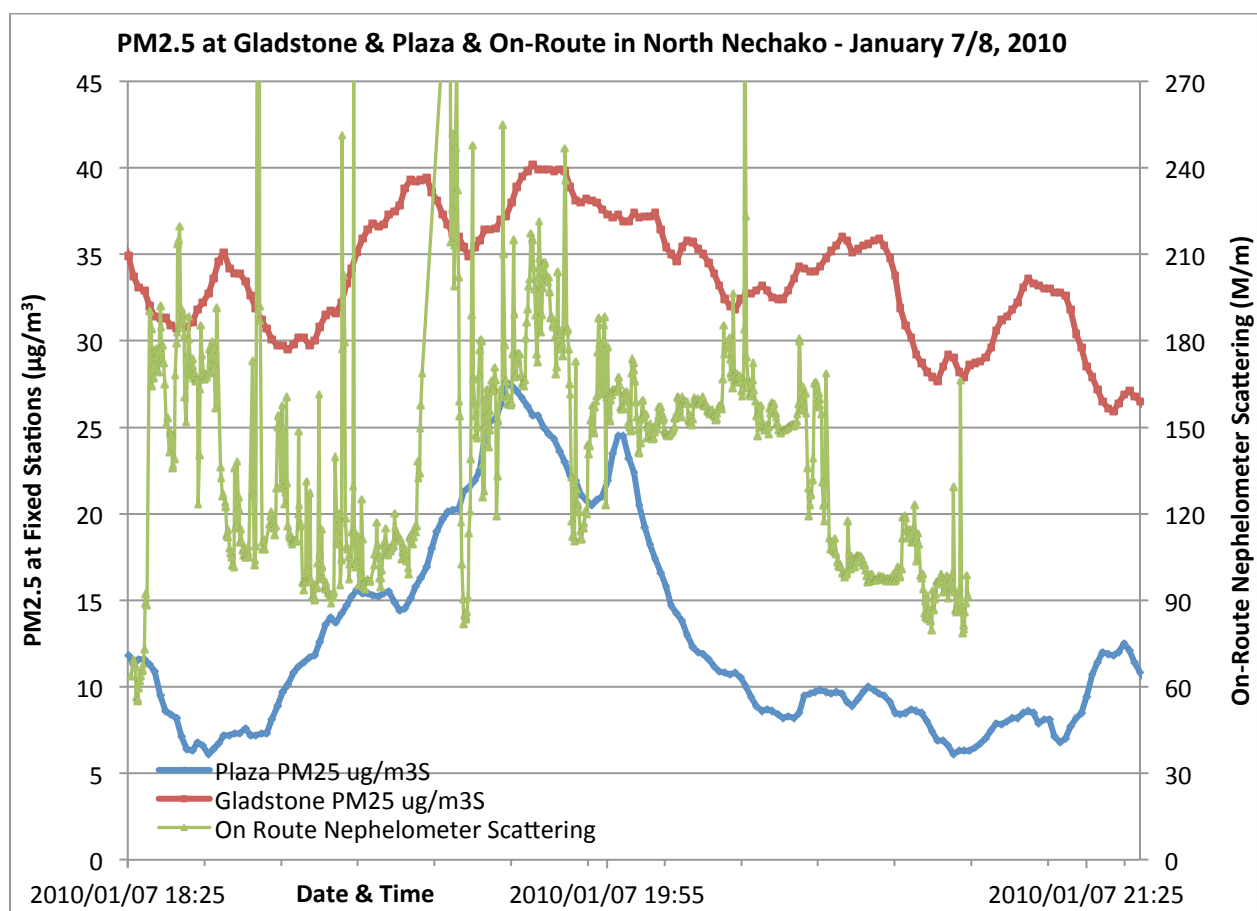


Figure H-4: PM2.5 at Gladstone & Plaza & On Route in North Nechako Division of Prince George– January 7/8, 2010

January 8/9, 2010 - Hart East:

Started the route at direction 1 and ended at direction 230. Overlap at end of route mainly done along highway 97 coming back to the Plaza Building. Around 8:45 the route became more remote which explains the descending values at this time. This remote section was fairly close to the pulpmill. Pulpmill emissions tended not affect the scattering values very much. Around 9:45 the increased scattering is noted as being due to the smell of smoke. The overlapping area was around 150 at the beginning of the night and closer to 50 by the end of the night. Clearly, nightly variation was a contributing factor on this night. Overall, the large scale changes in scattering values seem to be partially due to the area being monitored and partially due to nightly variation. The pattern Gladstone shows seems to explain the nightly variation, therefore I think the scattering for this evening should be averaged using this TEOM.

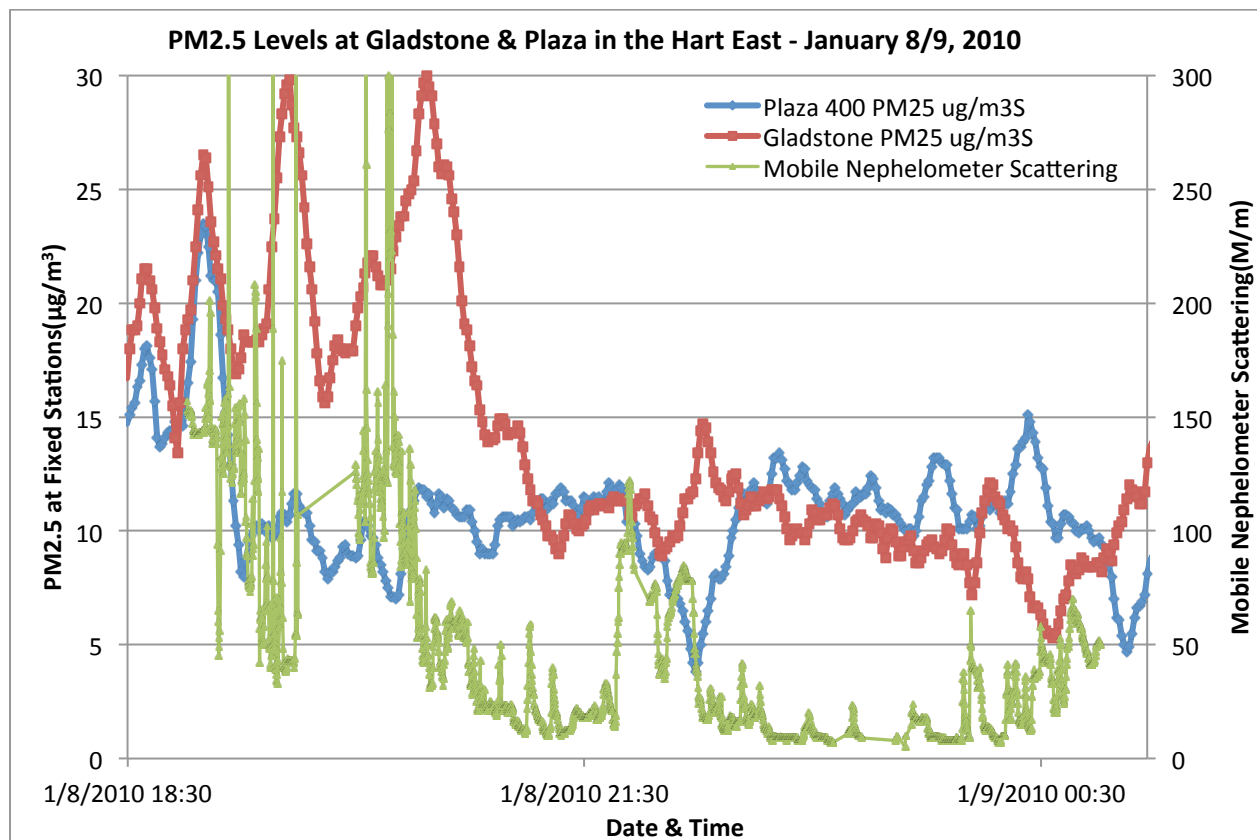


Figure H-5: PM2.5 at Gladstone & Plaza & On Route in Hart East Division of Prince George— January 8/9, 2010

January 22/23, 2010 - Central Fort George:

On this particular night the PM2.5 was not particularly high. Winds at Plaza were about 3-5m/s then descended somewhat around 10:30pm. Because of particulate levels not being very high monitoring was stopped around 10pm.

Particulate levels at both Plaza and Gladstone were between 4-8 $\mu\text{g}/\text{m}^3$ at all times during the monitoring period. This is a small enough difference that there is no need to use these differences to make an adjustment. As well, the pattern does not seem to show a clear increasing or decreasing trend.

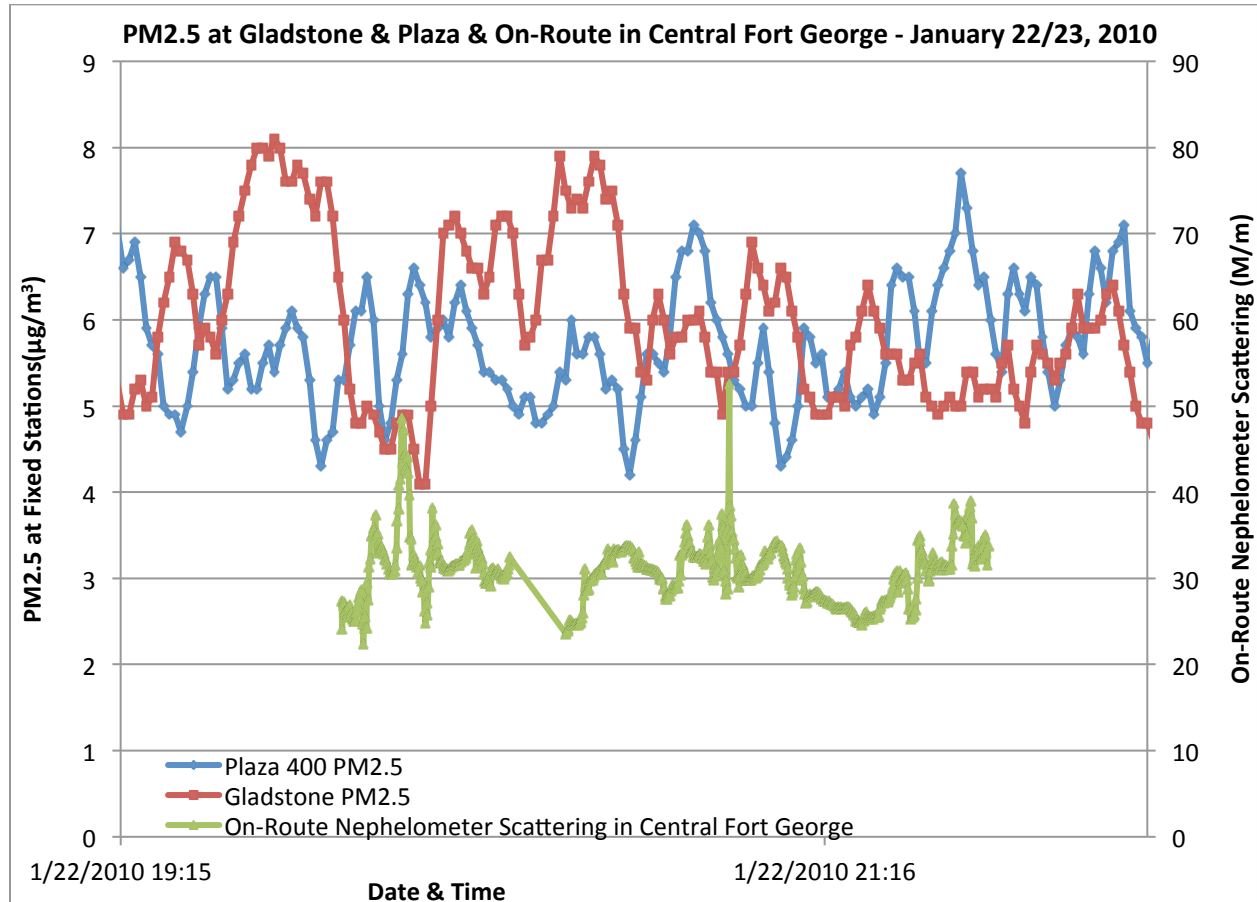


Figure H-6: PM2.5 at Gladstone & Plaza & On-Route in the Central Fort George Division – January 22/23, 2010 (Nephelometer B)

January 23/24, 2010 - Hart West:

This route started from the Plaza Building, than jumped to instruction number 25. There were very high levels on the road coming and going. From about 10:00-12:00 and again after midnight the more remote roads (Ferguson lake road..) explain the lower levels. Differences in elevation are not estimated to be a major component in explaining differences in woodsmoke in this division. The Plaza PM2.5 pattern clearly does not follow the same pattern as the On Route scattering. The Gladstone pattern doesn't really follow it either.

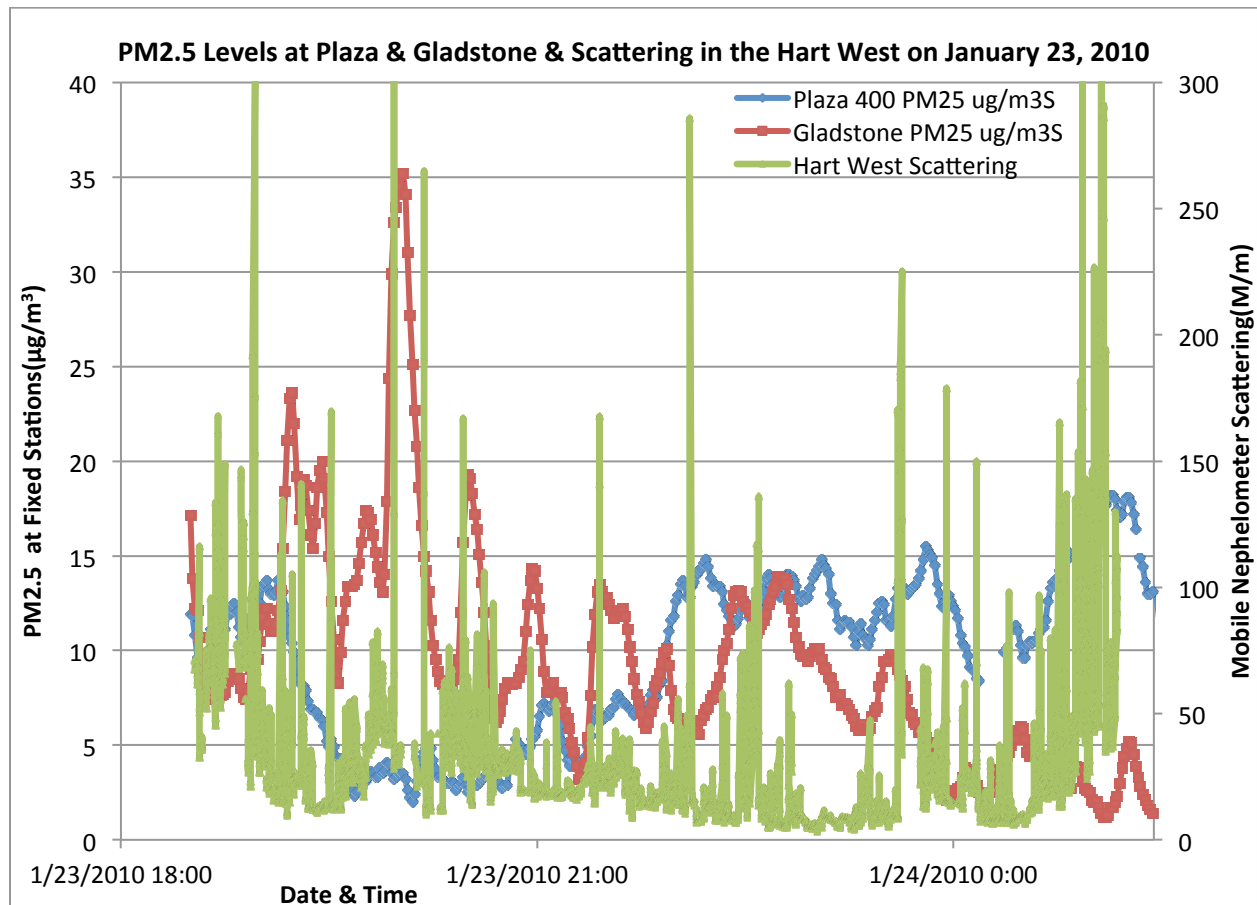


Figure H-7: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Hart West on January 23/24, 2010 (Nephelometer A)

January 23/24, 2010 - College Heights:

The route started at the beginning and went almost all the way until the end, while leaving out some of the streets that were out of city limits due to time constraints. The overlapping area seems to be lower at the end than at the beginning (approximately 20M/m vs. 40M/m).

The Gladstone station seems to show a similar pattern to the scattering data with few exceptions. Areas with differences occur at the very beginning and end. Plaza clearly has a very different pattern than the on-route scattering. Also, it is important to make a correction as the scattering values decrease pretty consistently throughout the night. It is best to use Gladstone to adjust.

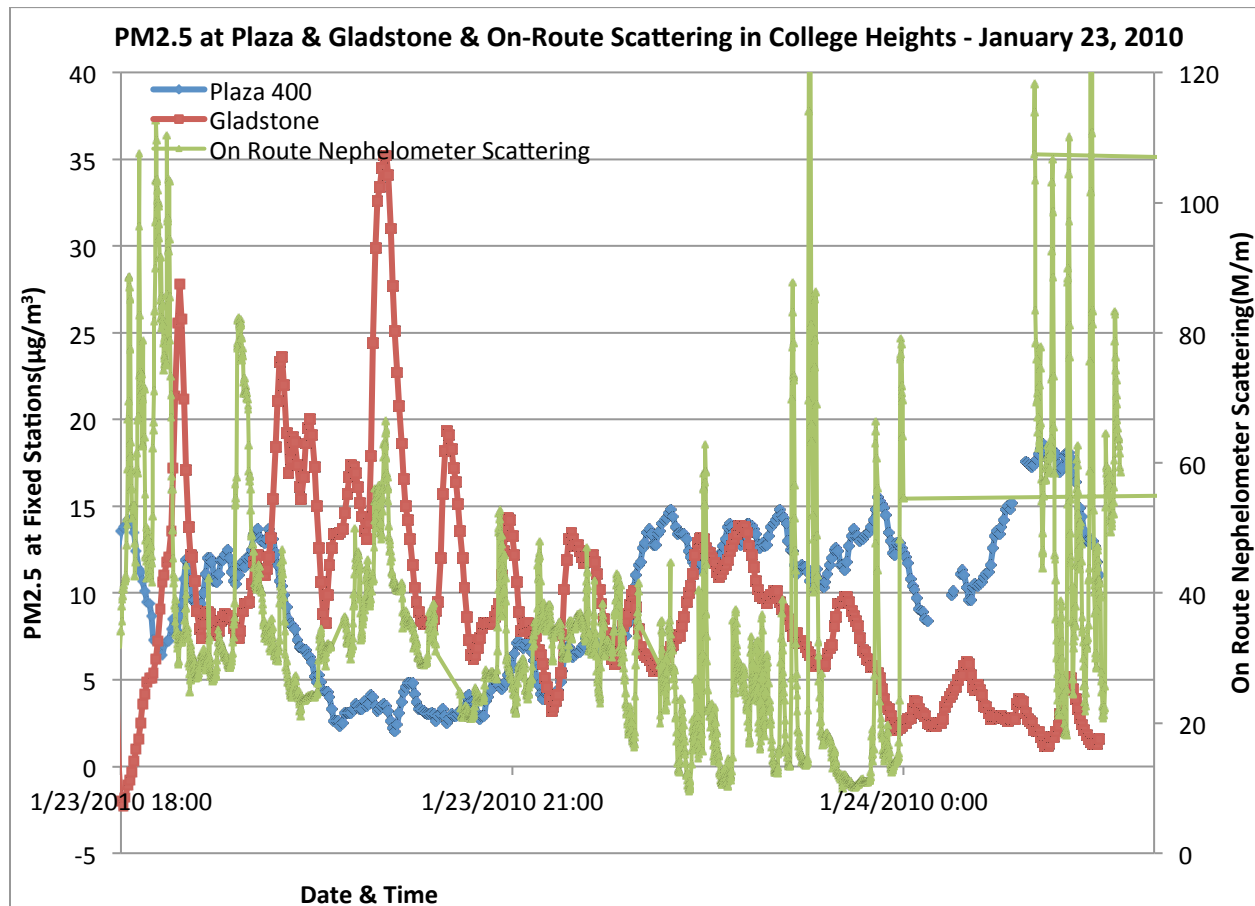


Figure H-8: PM2.5 at Plaza & Gladstone & On-Route Scattering in the College Heights Division of Prince George— January 23/24, 2010 (Nephelometer B)

January 26, 2010 - Central Fort George & Westwood:

Note that Central was the first division done on January 26, 2010. The Greater Central Division was finished by 9:30 at which time Westwood was begun. In this case the On-Route data does not seem to follow the same pattern as either fixed station. The scattering appears to be at lower levels in the Westwood Division. The Westwood Division is partly industrial. It is also further away from the pulp mills which may be causing higher background levels for Central.

Because they are so sudden, I have strong suspicions that the decrease in values happening at 8:28pm and 9:34pm are due to problems with the nephelometer. The meteorological and concentration data for the night of January 26/27 does not show anything that would cause these strong sudden changes.

It is better not to adjust either set of scattering values as TEOM values are at low enough levels throughout the night that their variation is not very meaningful.

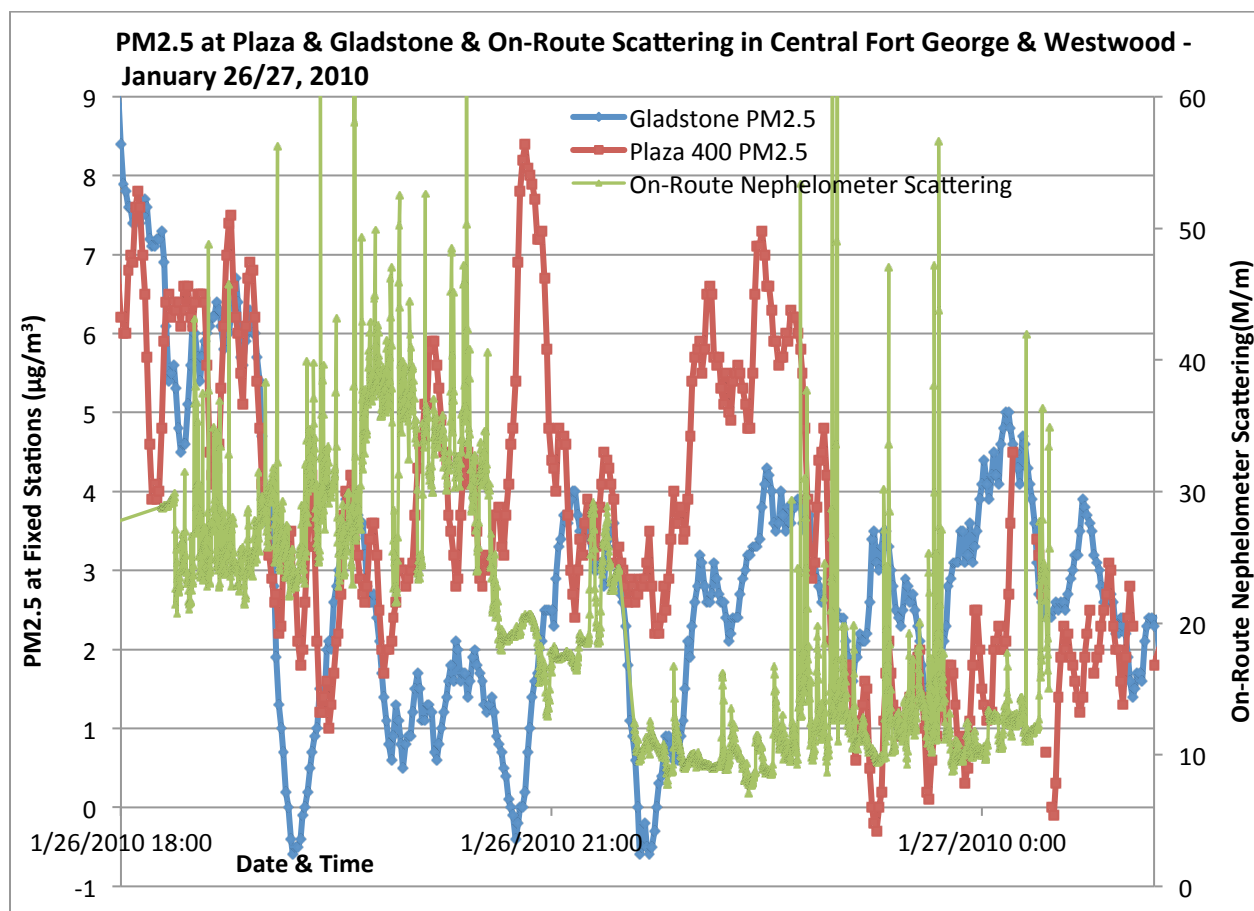


Figure H-9: PM2.5 at Gladstone & Plaza & On-Route in the Central Fort George & Westwood Divisions of Prince George—January 26/27, 2010 (Nephelometer B)

January 26, 2010 - Cranbrook Hill & Downtown:

The downtown area, which was done second starting at around 11:30, seems to be higher than Cranbrook Hill. Again, this higher background is most likely due to the pulp mills. The On-Route Nephelometer Scattering does not seem to follow the pattern of either TEOM. The TEOMs both record very low levels throughout the night, with the Plaza TEOM levels lowering slightly around 11pm. The recommendation is not to adjust the data.

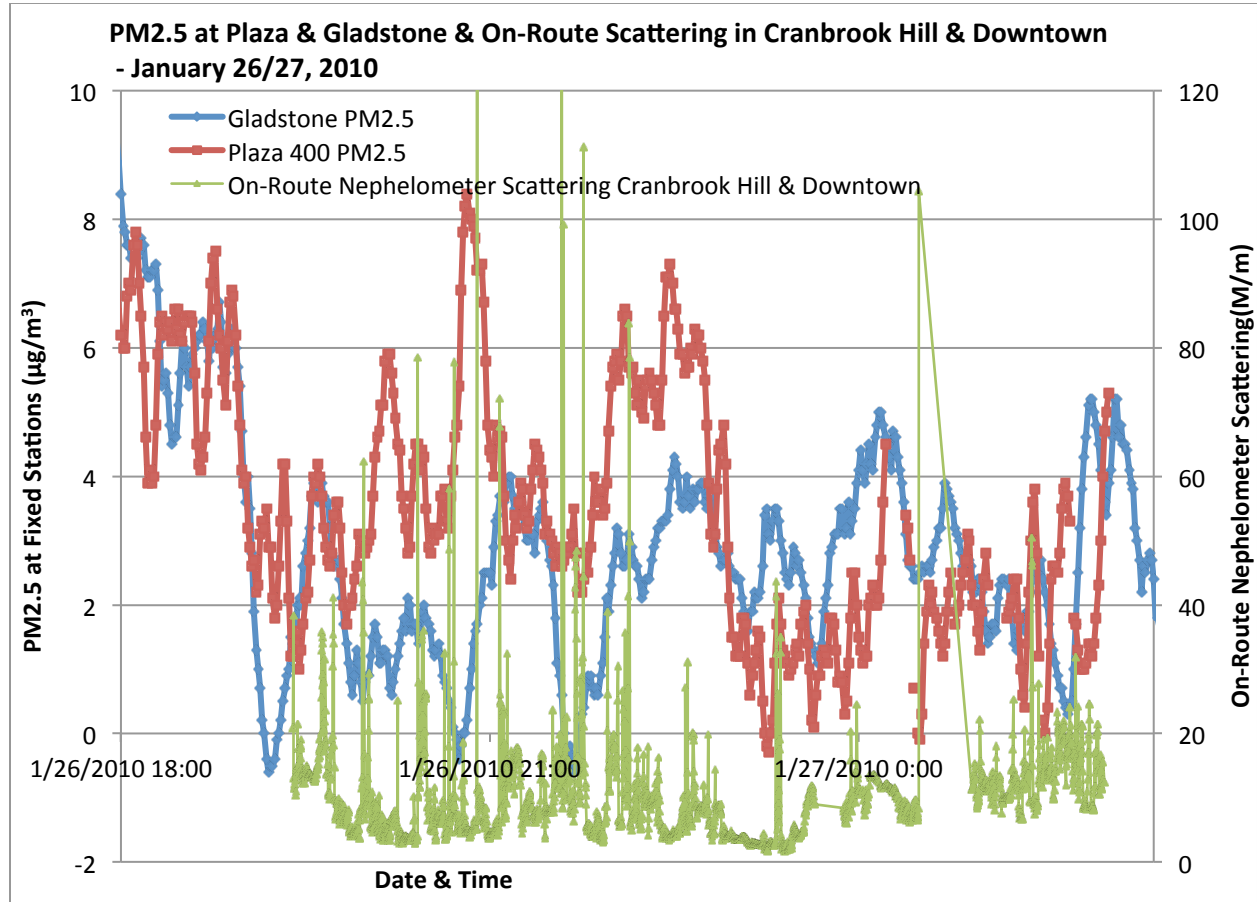


Figure H-10: PM2.5 at Gladstone & Plaza & On-Route in the Cranbrook Hill & Downtown Divisions of Prince George— January 26/27, 2010 (Nephelometer A)

January 27, 2010 - Prince George East:

The nephelometer scattering near the end appears to be somewhat higher than near the very beginning. Unfortunately on this night the Gladstone TEOM was down the entire night. As the scattering pattern does not seem to follow the same pattern as the Plaza TEOM, it is best not to adjust the data.

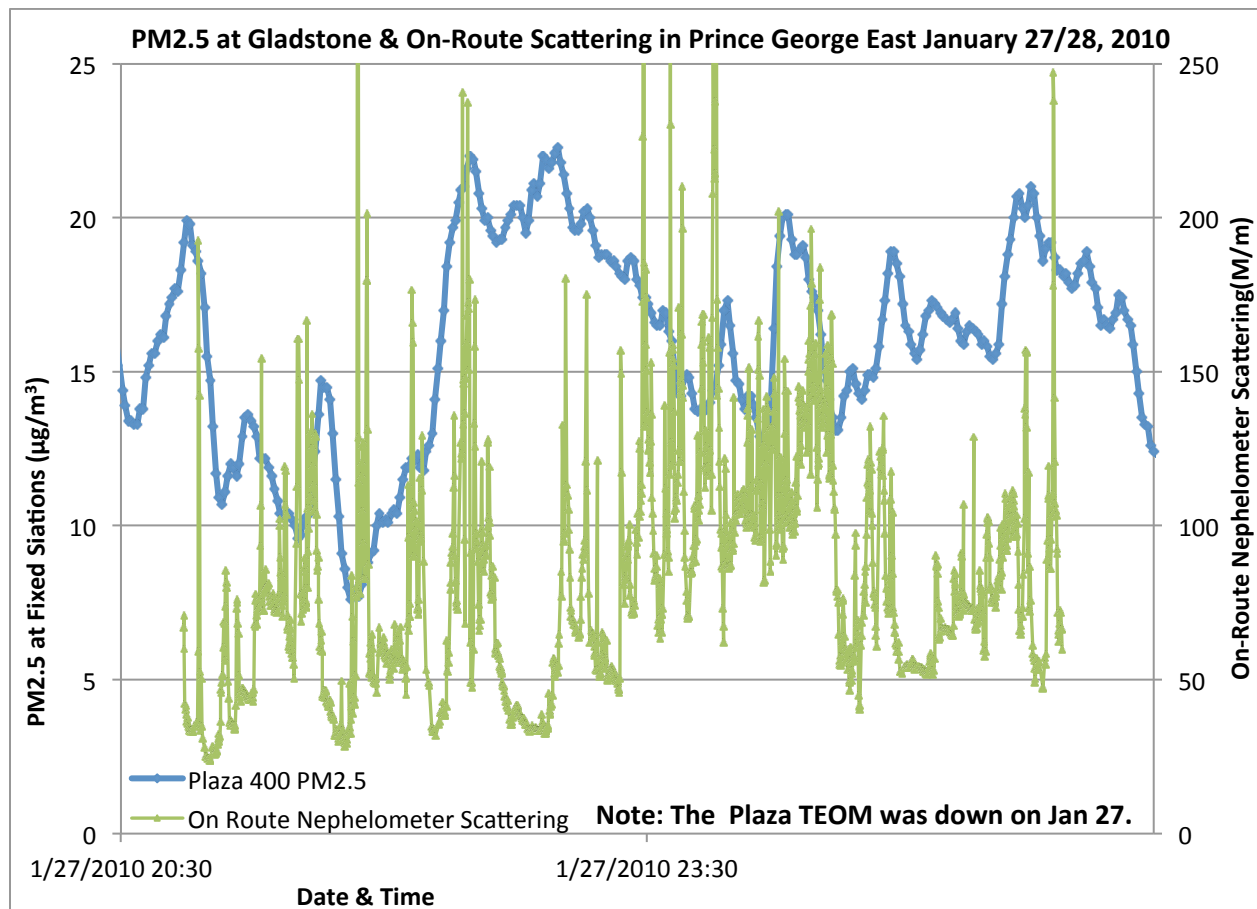


Figure H-11: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Prince George East Division of Prince George– January 27/28, 2010 (Nephelometer B)

January 27, 2010 - College Heights:

In this case, the scattering does not appear to follow the pattern of the Plaza TEOM. The base value seems to change somewhat throughout the night. At the beginning of the night the scattering values are about 30M/m where as at the end of the night they are close to 50M/m. It seems best not to adjust the data.

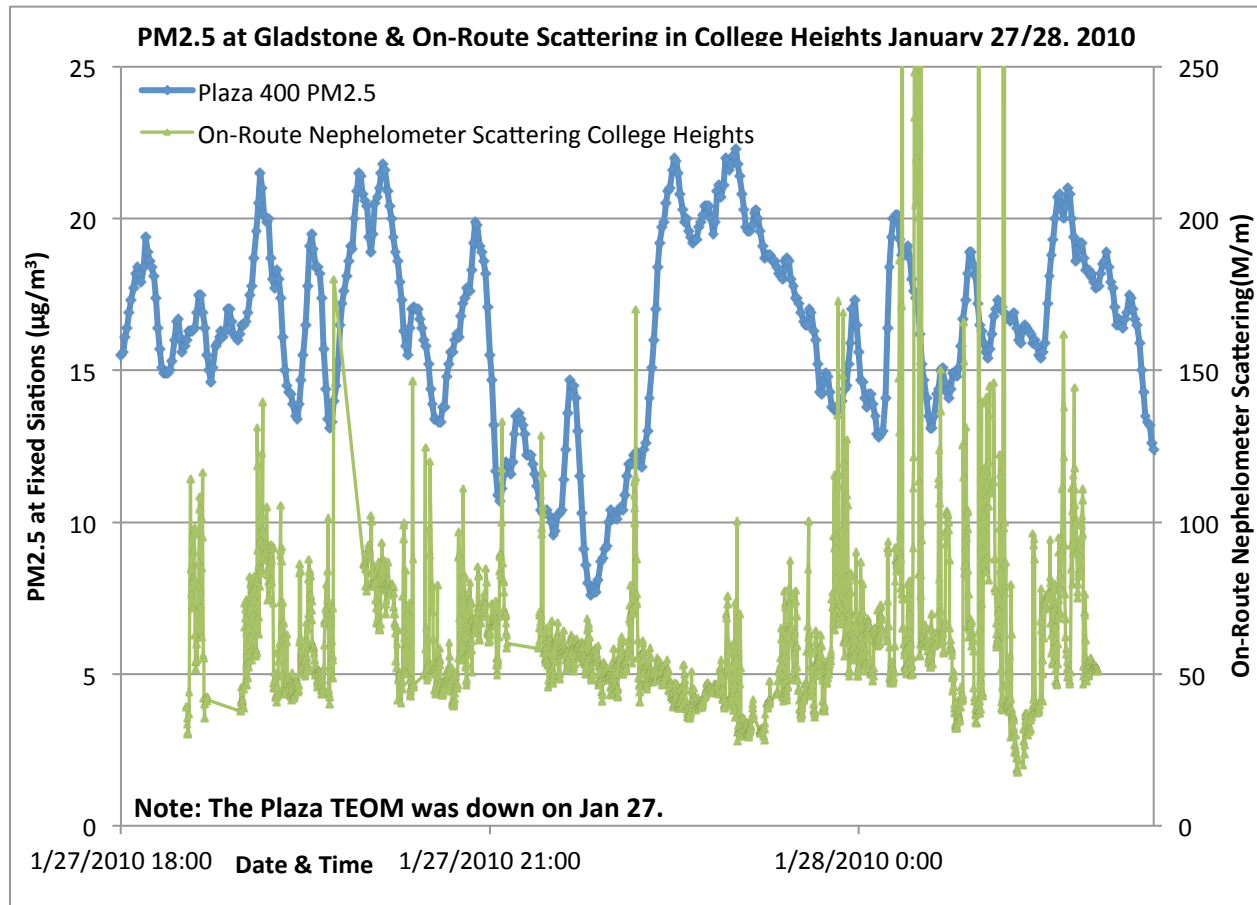


Figure H-12: PM2.5 at Gladstone & Plaza & On-Route Scattering in the College Heights Division of Prince George – Night of January 27/28, 2010 (Nephelometer A)

February 2/3, 2010 - South Fort George & Downtown:

South Fort George was the first route done over the night. The starting was direction #104 which was one third of the way through the route. The Downtown route started at 11:19pm with direction #50 also one third of the way through the route.

Around 10:17pm there were problems with the power inverter overheating and it needed to be shut off to cool down for a little while.

It is questionable whether the decrease occurring at 10:15pm and 11:24pm were due to problems in the nephelometer as this type of decrease was known to be a problem in the collocation results (see Appendix on Collocation Results).

For South Fort George it is best not to adjust the data, however, best to adjust the Downtown data using the Plaza TEOM. The Downtown pattern seems to match with Plaza TEOM's very well.

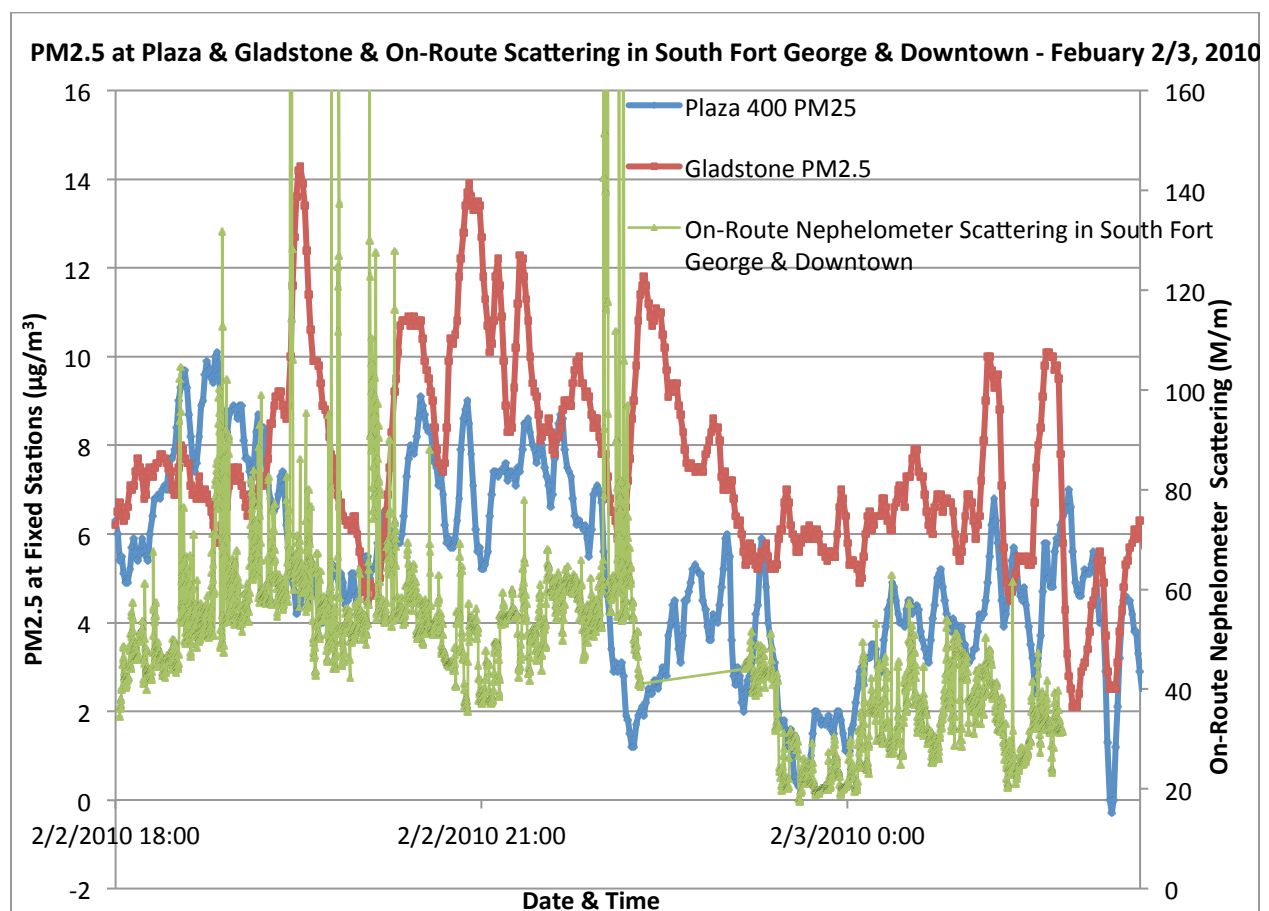


Figure H-13: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Greater South Fort George & Downtown Divisions of Prince George— February 2/3, 2010 (Nephelometer B)

February 6/7, 2010 - Foothills:

It looks like this is another night where the scattering patterns do not follow either TEOM. Values for overlap appear to be pretty close (90M/m at the beginning compared to 105M/m at the end).

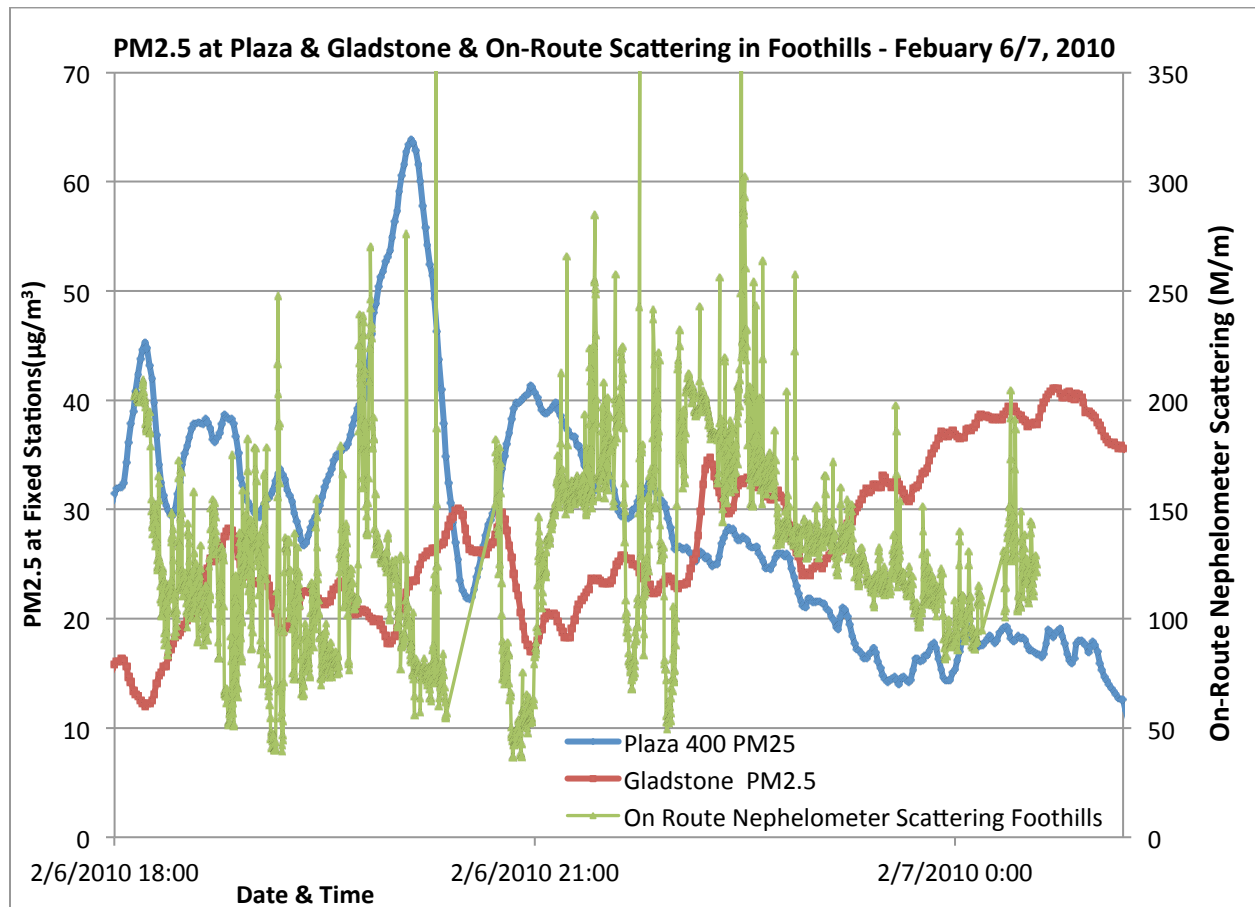


Figure H-14: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Foothills Division of Prince George– February 6/7, 2010 (Nephelometer A)

February 6/7, 2010 - South Fort George:

The starting point was #104 which was half way through the set of directions. The PM2.5 values were quite high at both TEOMs. However, the patterns between the TEOMs and the mobile monitor seem to be fairly different, therefore it is best not to adjust the data. As there are no individual spiking - the scattering pattern shows that the nephelometer pump is broken.

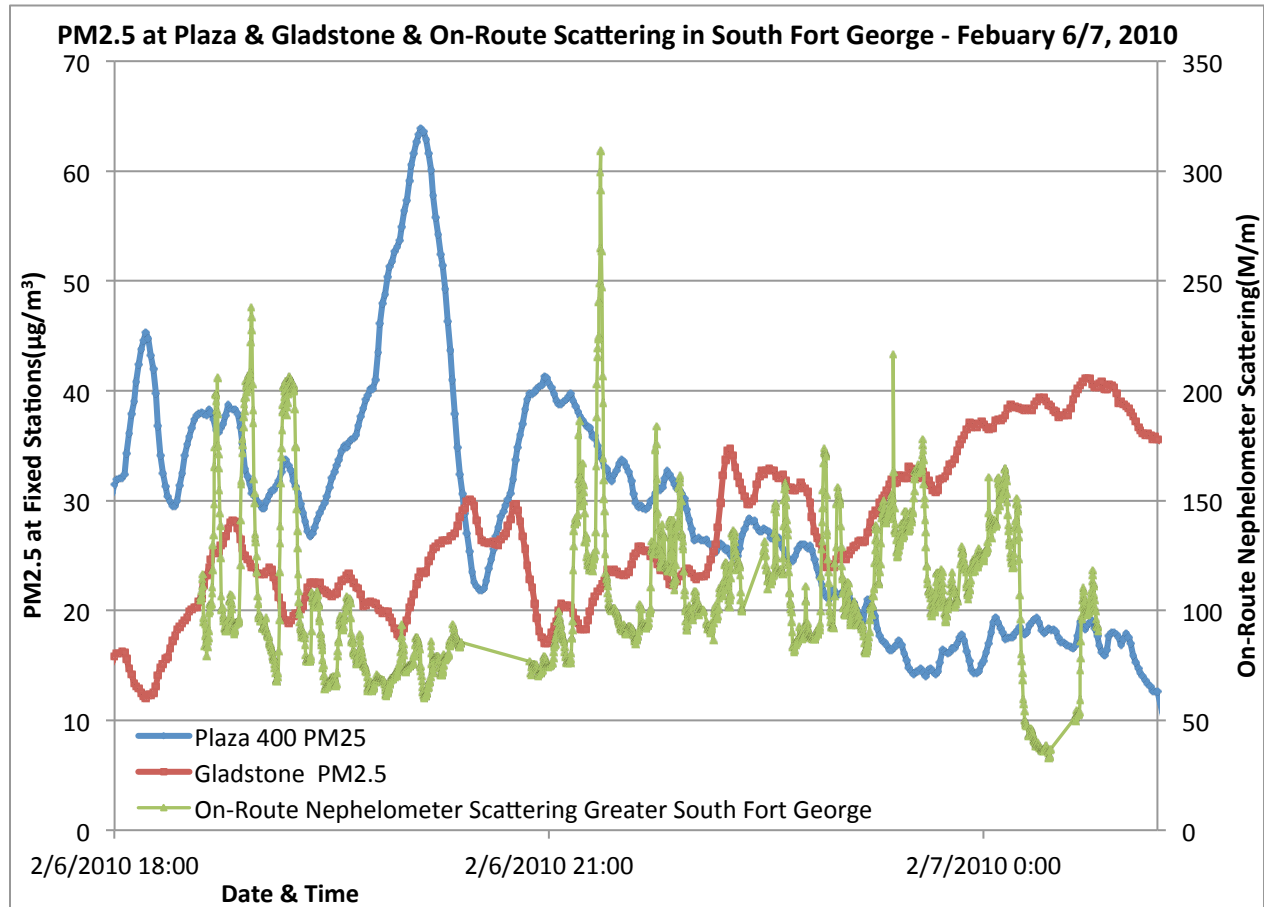


Figure H-15: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Greater South Fort George Division of Prince George – February 6/7, 2010 (Nephelometer B)

February 7/8, 2010 - College Heights:

The scattering values appear to follow Gladstone's pattern fairly well. Values at the beginning tend to be fairly different during the overlapping period (25M/m vs. 55M/m).

Because there tends to be a fairly different set of base values along the route, it seems best to adjust using Gladstone.

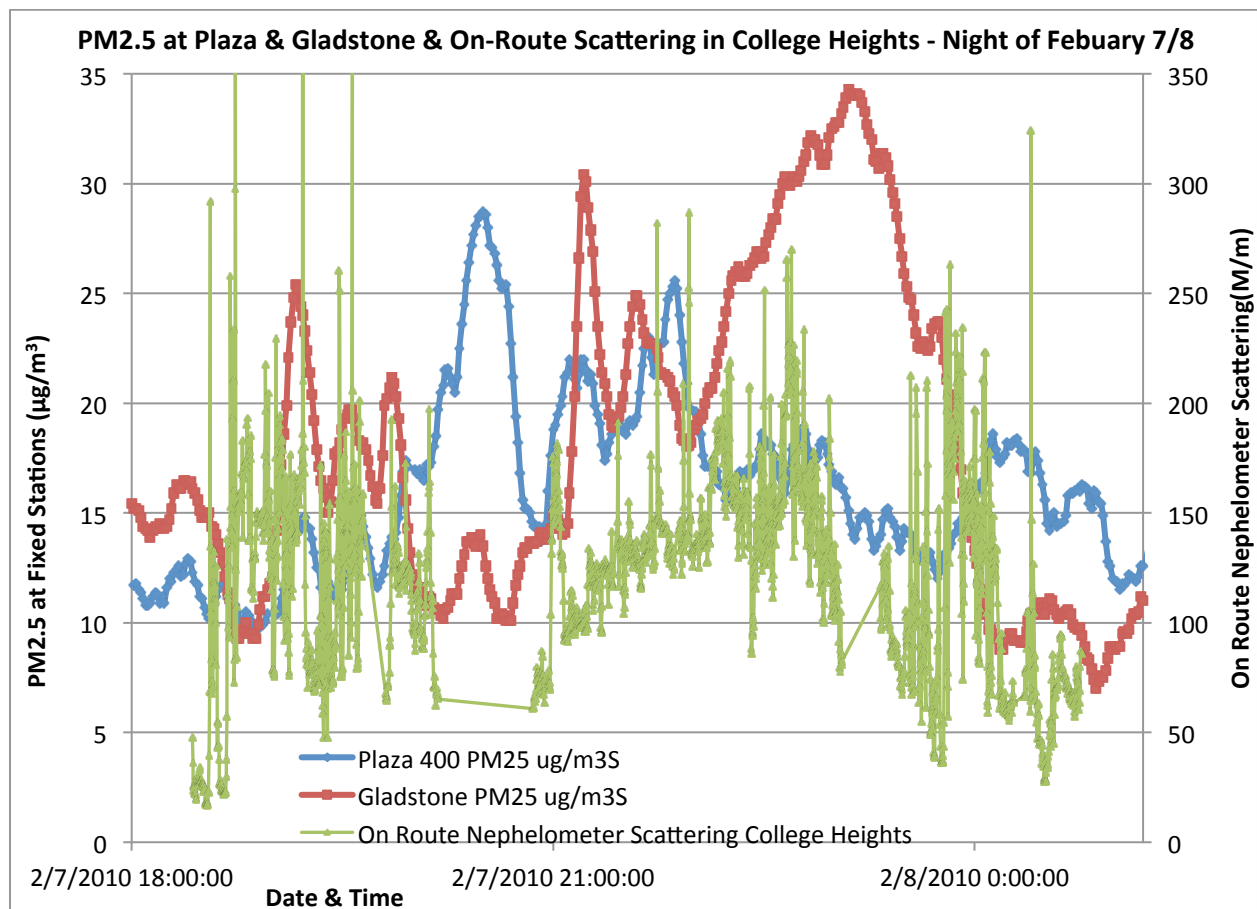


Figure H-16: PM2.5 at Gladstone & Plaza & On-Route Scattering in the College Heights Division of Prince George— February 7/8, 2010 (Nephelometer A)

February 7/8, 2010 - Hart East:

The starting direction was number 230. The Gladstone TEOM looks like it may be fairly representative. However, because the base values seem to be fairly constant at between 40-60M/m I think it is best not to adjust the mobile monitoring data.

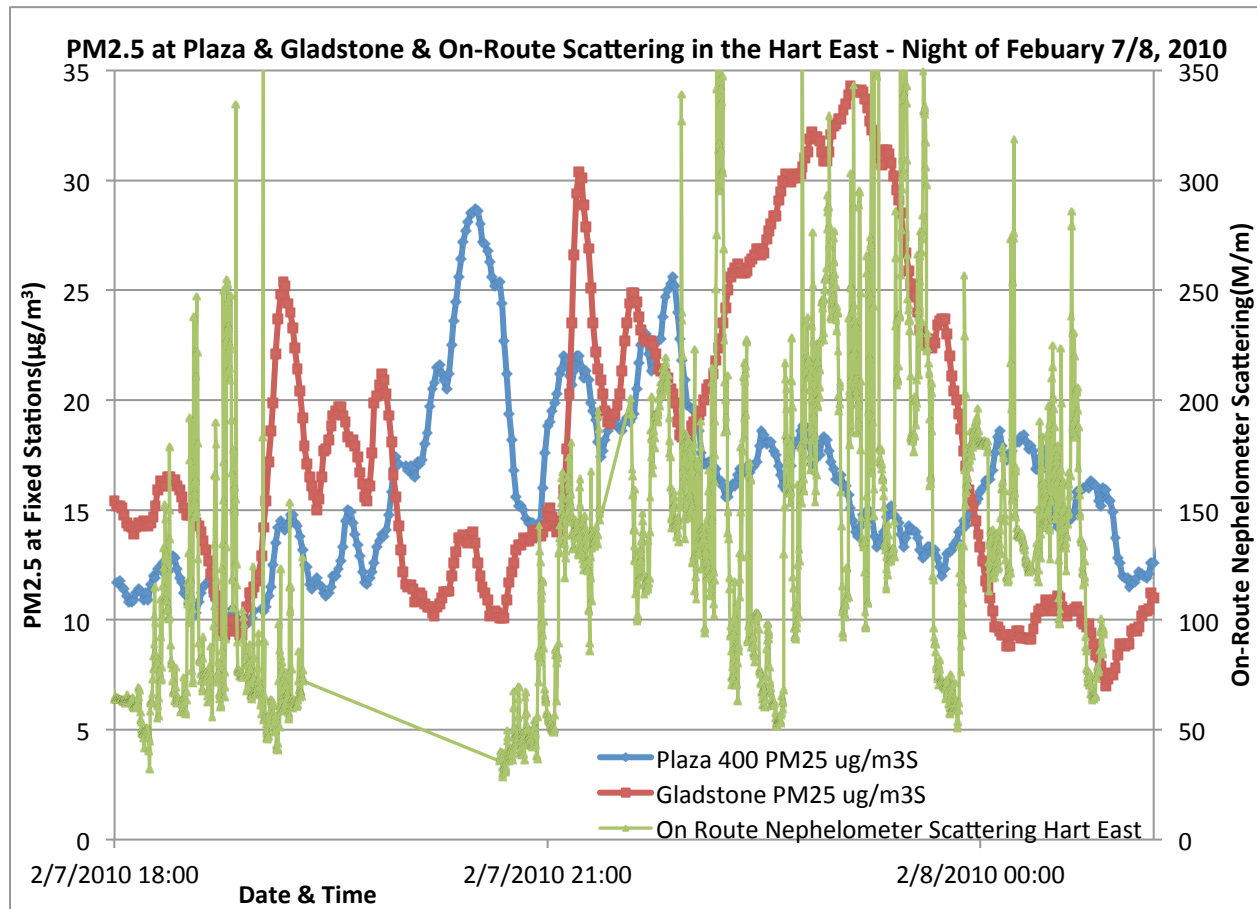


Figure H-17: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Hart East Division of Prince George– February 7/8, 2010 (Nephelometer B)

February 8/9, 2010 - Hart West:

The starting point was direction #142, estimated to be a third of the way through the route. The nephelometer clearly does not follow the pattern of either TEOM. The values at the beginning and the end of the route are similar at roughly 60M/m. Very close to the beginning of the route scattering goes down to about 30M/m, values close to the end of the route are in this range as well. The best option would be not to adjust scattering values by either TEOM.

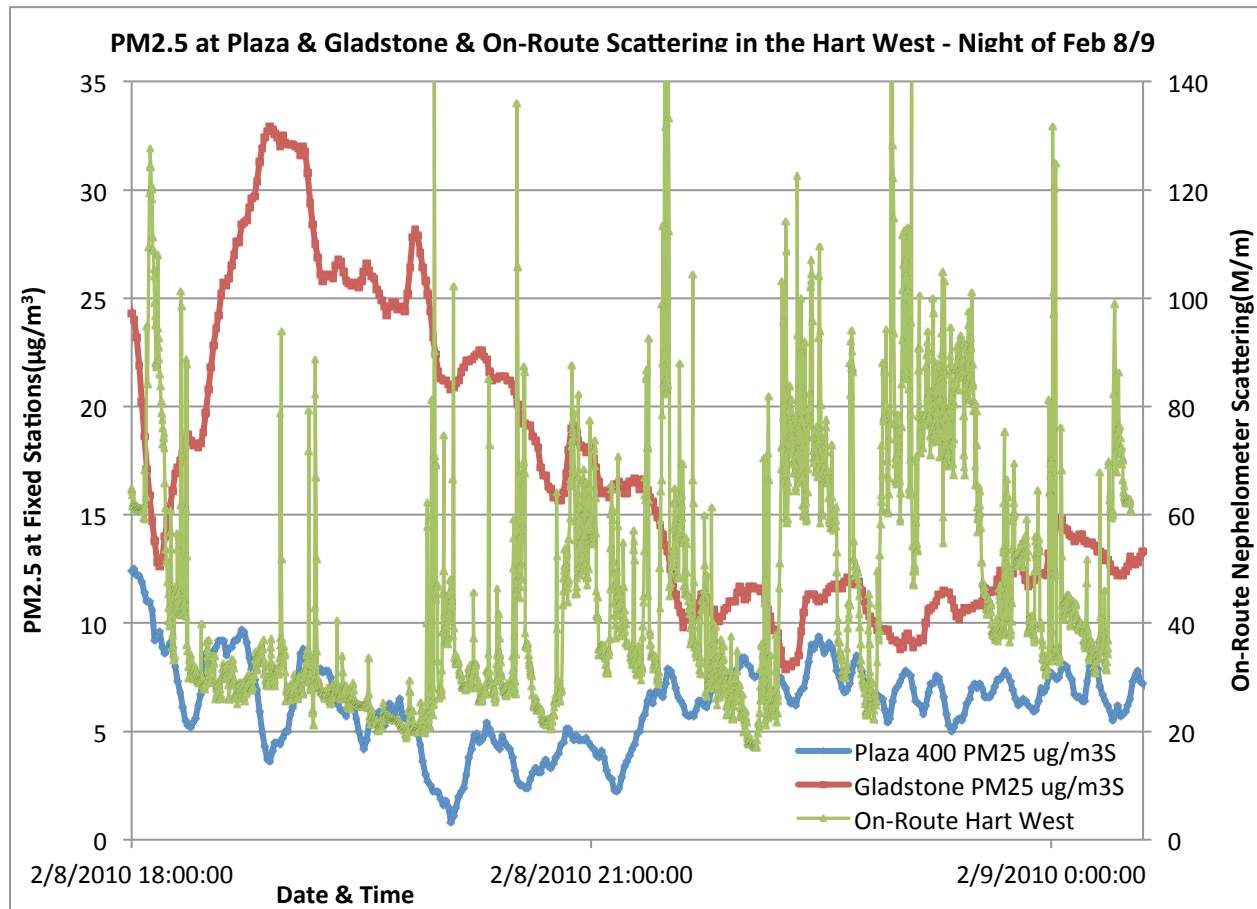


Figure H-18: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Hart West Division of Prince George— February 8/9, 2010 (Nephelometer B)

February 10, 2010 - North Nechako:

The first thing noticeable in these results is that there does not seem to be any singular highs. In fact, the scattering results do not seem to fluctuate freely from one point to the next in the same way they did on other nights. It was Nephelometer B that was used for this route. The pump on this nephelometer was found to be no longer working two weeks later; therefore it looks like this may have been having a strong influence already. This data should be taken with more of a grain of salt than usual.

The starting point for the route was #52 in the directions. This starting point is approximately one third the way through the route.

The best option is to use the data without doing an adjustment because the data tends to descend to its base value in the low twenties.

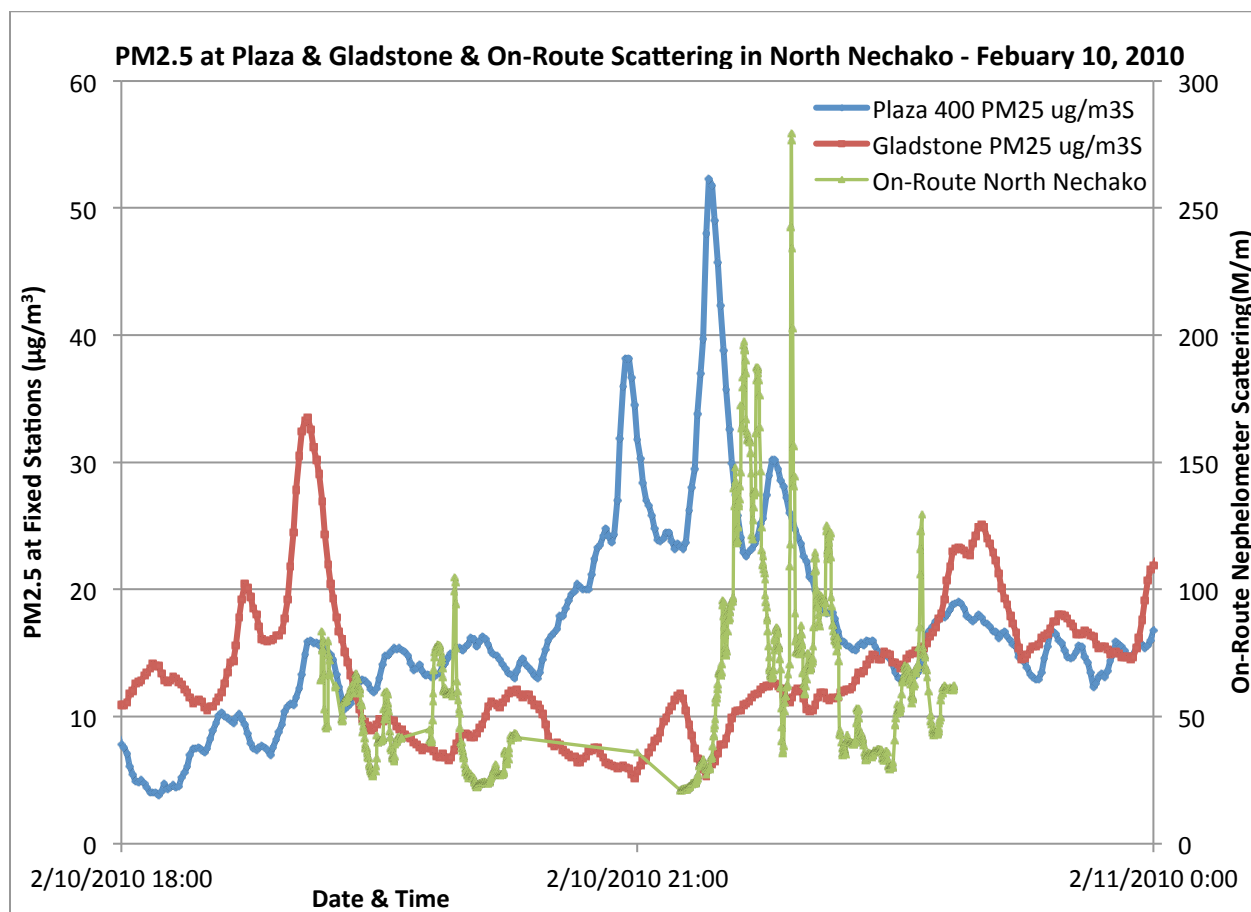


Figure H-19: PM2.5 at Gladstone & Plaza & On-Route Scattering in the North Nechako Division of Prince George– February 10/11, 2010 (Nephelometer B)

February 15, 2010 - Cranbrook Hill & Downtown:

Cranbrook Hill was the first division done finishing at 11:20pm. Because of its shape, it will clearly have to be adjusted for nightly variation. Gladstone seems to be the best fit for the adjustment. Downtown does not need to be adjusted.

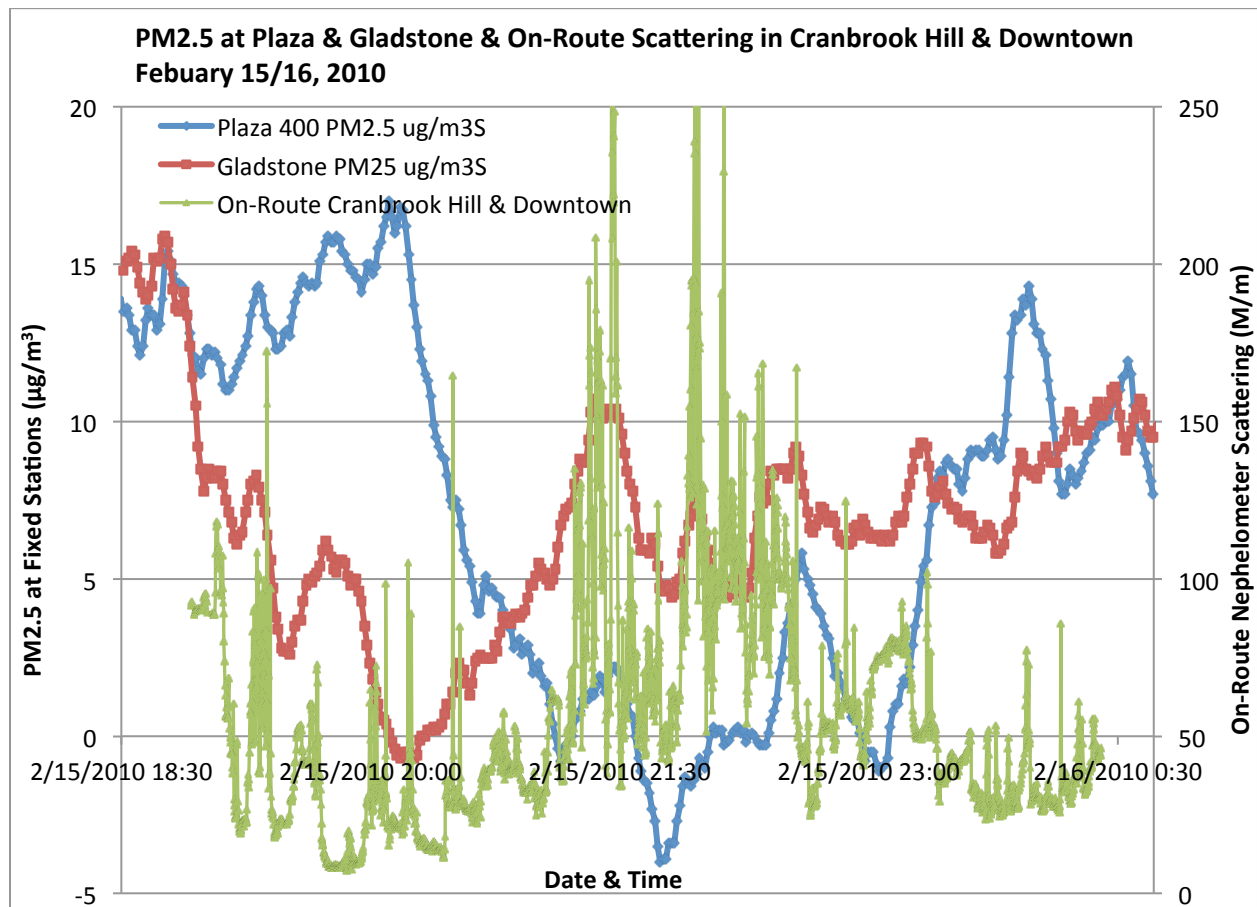


Figure H-20: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Cranbrook Hill & Downtown Divisions of Prince George— February 15/16, 2010 (Nephelometer A)

February 15, 2010 - Foothills:

Over this part of the evening PM2.5 levels are fairly constant at both fixed sites, therefore, no adjustments will be necessary.

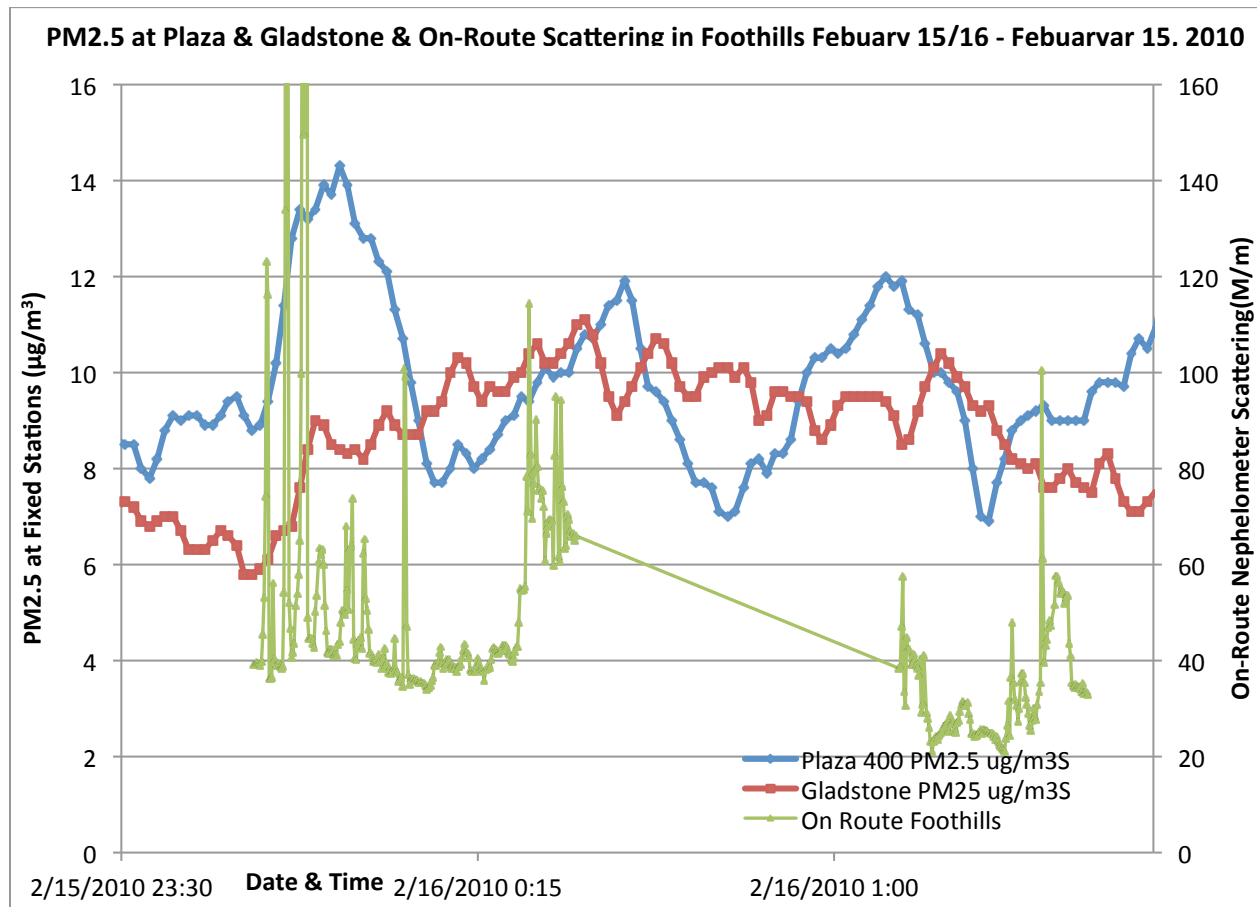


Figure H-21: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Foothills Division of Prince George– February 15/16, 2010 (Nephelometer B)

February 17/18, 2010 - Greater Foothills:

During this night, the PM2.5 at Plaza remains low. PM2.5 at Gladstone escalates around 10pm. It is better not to adjust the data. The starting point was one third of the way through the direction list.

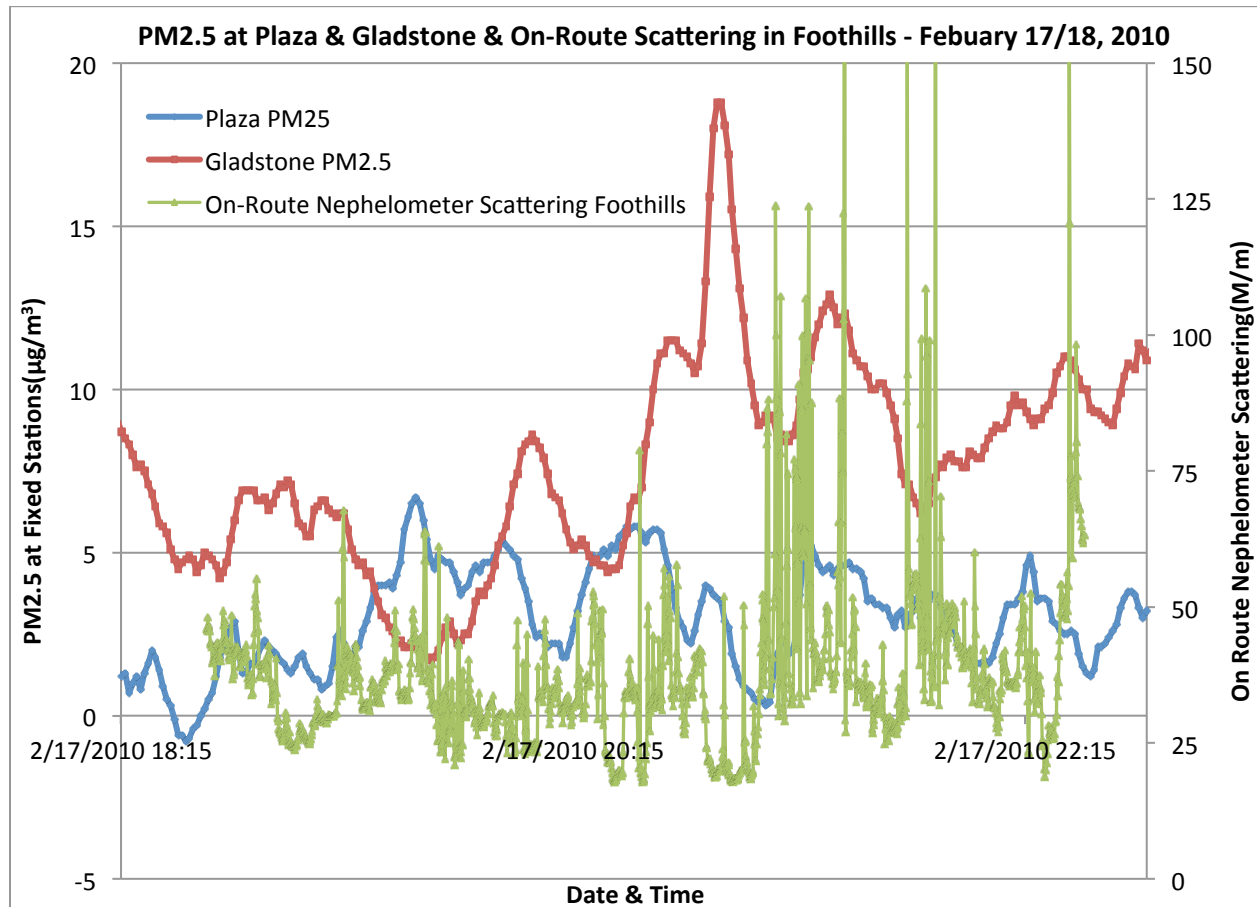


Figure H-22: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Foothills Division of Prince George— February 17/18, 2010 (Nephelometer A)

February 20/21, 2010 - Hart West:

Starting point is direction #1. On January 23, 2010 the starting point was also #1. It's interesting to see that on both nights the scattering values are quite high at the beginning of the night. This shows consistency between nights. Since neither TEOM seems to show the same pattern as the scattering the best option seems to be not to adjust the results.

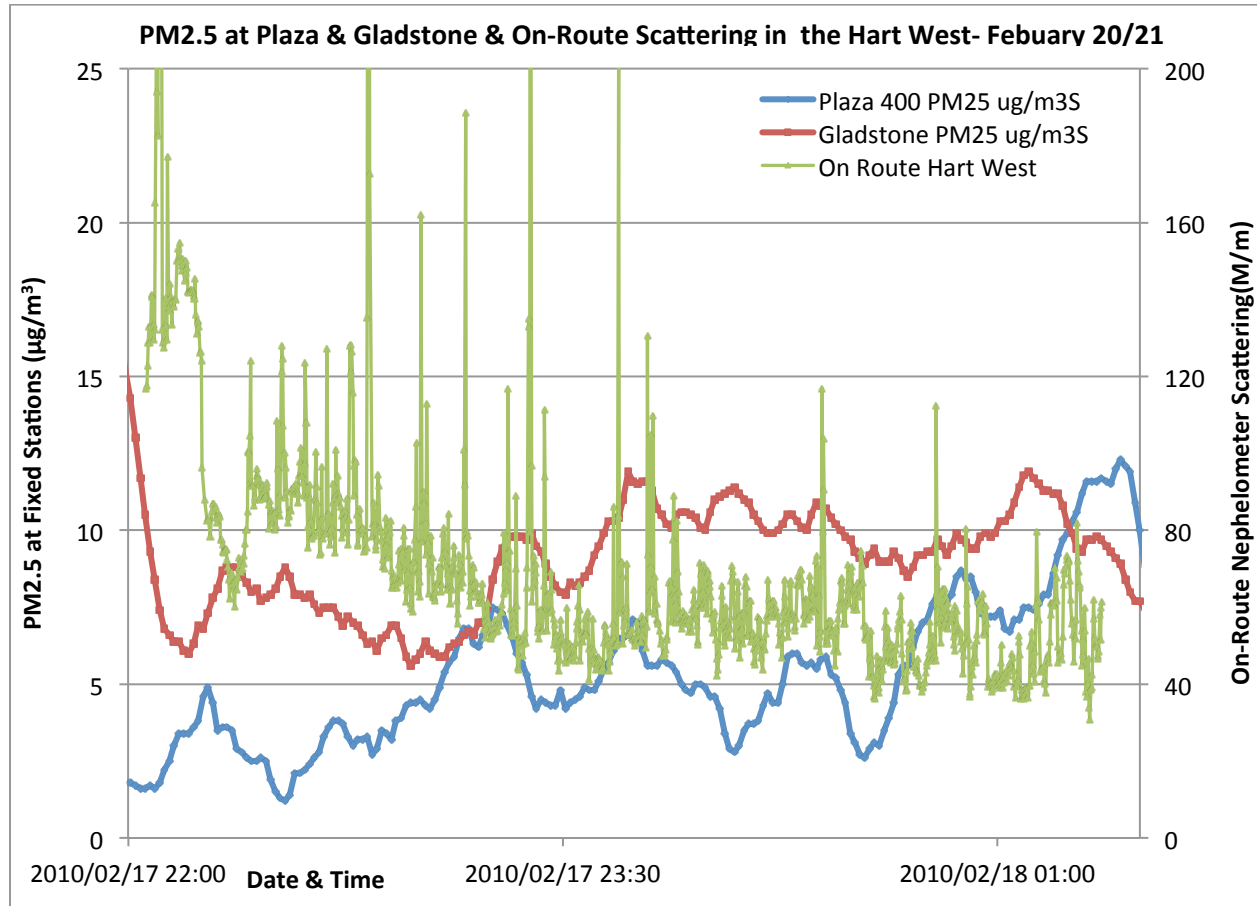


Figure H-23: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Hart West Division of Prince George— February 20/21, 2010 (Nephelometer A)

February 21/22, 2010 - Hart East:

The night started from direction number 1 and appears to be a high woodsmoke night with scattering values rarely below 60M/m. These values of about 60M/m occur both at the beginning and the end of the night – therefore, it is most likely not necessary to adjust by the TEOMs. However, this is somewhat of a difficult call seeing as scattering values between 7:30pm and 10:30pm remain particularly high and both TEOMs are particularly high at the beginning of the evening as well.

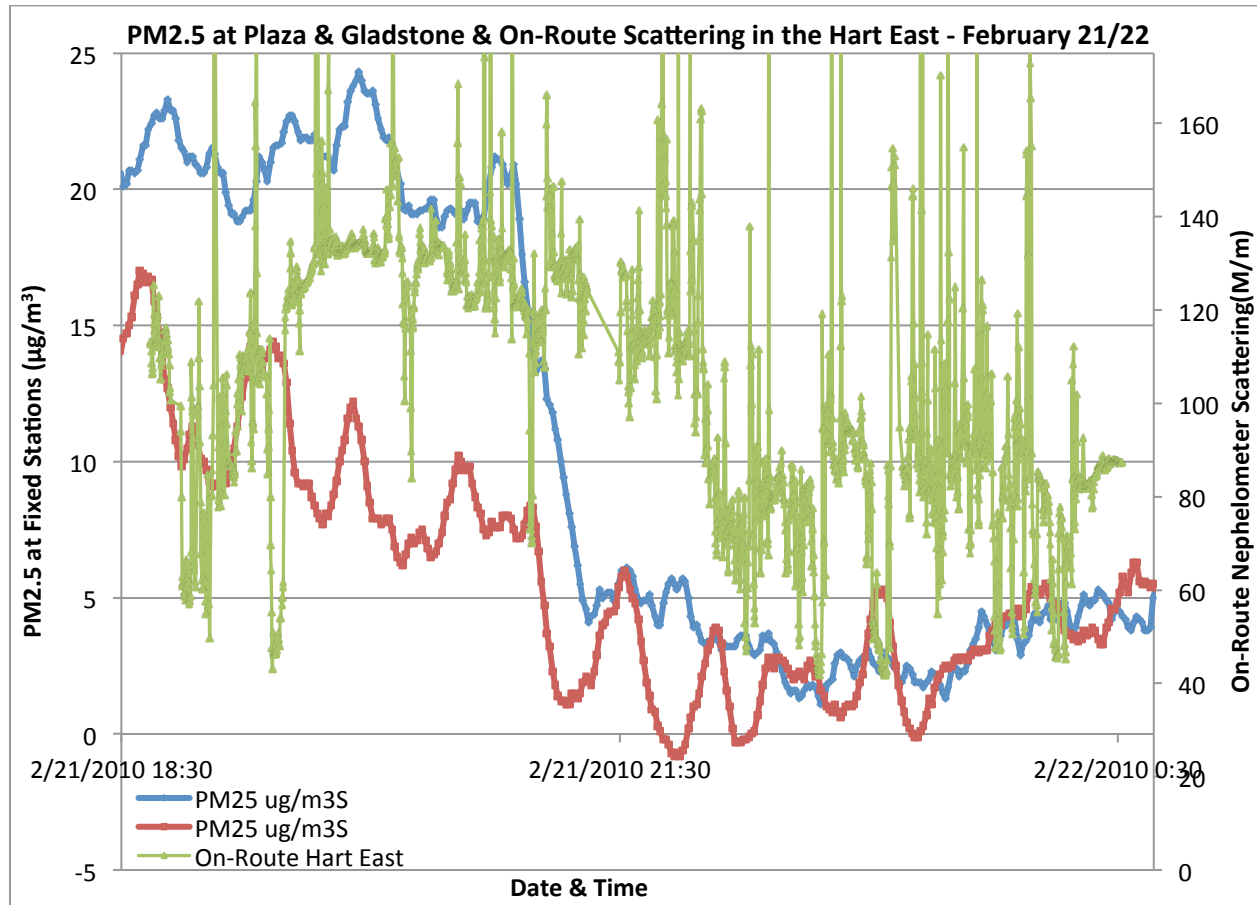


Figure H-24: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Hart East Division of Prince George– February 21/22, 2010 (Nephelometer A)

February 27/28, 2010 - Hart West:

The nephelometer values have a pretty consistent base value throughout the night. This is one indication that scattering values do not need to be adjusted. Scattering values also do not follow either TEOM.

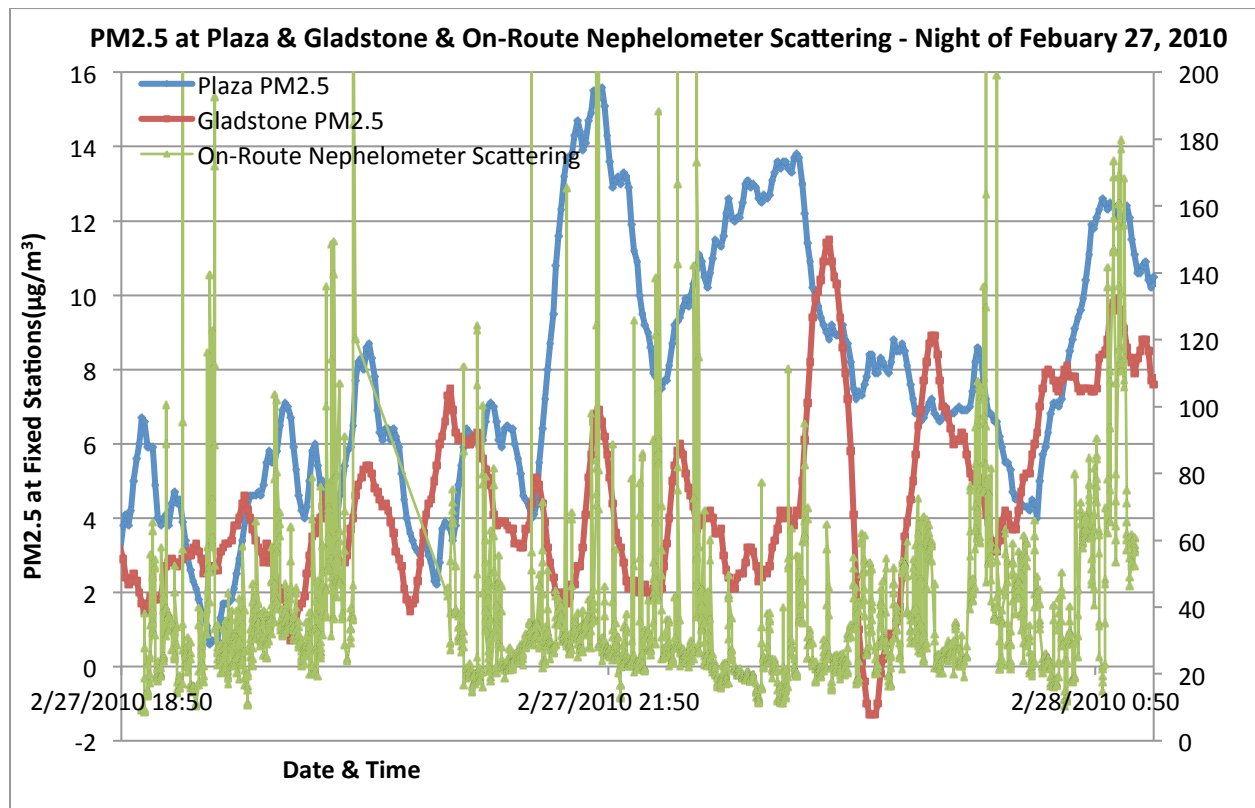


Figure H-25: PM2.5 at Gladstone & Plaza & On-Route Scattering in the Hart West Division of Prince George— February 27/28, 2010 (Nephelometer A)