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4.4 Air Quality

4.4.1 Introduction

Air quality is defined as a measure of the condition of the atmosphere relative to the requirements of one or more biotic species or to any human need or purpose. Air quality parameters of interest to Project implementation include those which have the potential to affect human health or the environment, namely suspended particulate matter (PM_{10} and $PM_{2.5}$ and larger particle size nuisance dust), nitrogen oxides (NOx) and sulphur dioxide (SO_2).

Particulate Matter (PM_{10} and $PM_{2.5}$) and Dust

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. Particles up to 10µm that are inhalable into the upper respiratory tract are known as PM_{10} and particles up to 2.5µm, which are respirable deep into the lungs, are known as $PM_{2.5}$. These particles are of concern as they are small enough to enter the respiratory system and at certain elevated concentrations can affect human health. PM_{10} and $PM_{2.5}$ can travel in excess of 1km from the point of release and, unlike larger dust particles, their dispersal is not dependent upon wind direction. As such, monitored $PM_{10}/_{2.5}$ levels tend to be fairly consistent both up and downwind of a source[1]. The principal sources of $PM_{10}/_{2.5}$ are combustion activities, such as vehicle exhausts, woodstoves, power plants, etc. Because particles originate from a variety of mobile and stationary sources their chemical and physical compositions vary widely. $PM_{10}/_{2.5}$ can be directly emitted or can be formed in the atmosphere when gaseous pollutants such as SO_2 and NO_x react to form fine particles.

Larger mineral dust particles, between 10 and 75µm in size, do not pose the same health effects as smaller $PM_{10}/_{2.5}$ particles and are generally referred to as nuisance dust, as human concerns generally relate to the soiling of surfaces. Mineral particles between 30 and 75µm have a relatively high mass and settling velocity and tend to deposit naturally within 100m of the point of release, however 30µm particles can travel up to 300m from the point of release. Particles in the size range of 10-30µm tend to fall out of the atmosphere between 100m and 250m from the point of release, under normal meteorological conditions. Modelling studies have also shown that deposition rates decrease significantly (in an almost logarithmic manner) with increasing distance from the source. Deposition of these larger dusts may have

[1] "Do particulates from open cast mining impair children's respiratory health?" ('The Newcastle Report', HMSO, 1999)

detrimental effects on plant growth due to the obscuring of leaf surfaces leading to reduced photosynthesis and growth rates.

Nitrogen Oxides (NO_x)

Nitrogen oxides (NO_x) is a term used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). These are inorganic gases formed when oxygen and nitrogen (both readily available in the atmosphere) combine, and are also a by-product of combustion of fossil fuel by vehicles, industrial processes and power generation. There is some evidence that long-term exposure to NO_2 at concentrations above 40–100 µg/m^3 may decrease lung function and increase the risk of respiratory symptoms. Oxides of nitrogen are also a precursor for ozone formation, which at ground level can have potential effects on human health and damage to vegetation.

Sulphur Oxides (SO_x)

The term sulphur oxides (SO_x) refers to a range of sulphur and oxygen containing compounds, the most common of which is sulphur dioxide (SO_2). The largest anthropogenic source of SO_x is the combustion of sulphur containing fossil fuels (particularly coal and oil); however, SO_x are also produced during metal smelting and other industrial processes. Sulphur oxides also occur naturally through volcanoes, forest fires, the oceans and decaying plant matter. The oceans, wetlands and lakes act as natural sinks for SO_x.

Both chronic and acute exposure to SO_x can cause damage to the respiratory system; there is also a link between chronic high-level SO_x exposure and heart disease. SO_x can dissolve in moisture in the atmosphere forming sulphur acids (commonly known as “acid rain”). These attack the outer protective waxy coatings of leaves, effecting plant growth. Sulphur acids may also acidify soils and waterways, causing wider environmental effects.

Existing Emission Sources

There are no major urban or industrial centres in the region that will have a significant effect on the regional or local air quality. Jermuk is the closest potential source for emissions within the study area, with combustion emissions produced from vehicle exhausts, domestic heating and an operational domestic waste dump (Kechut). Jermuk is located over 10km north-north-west of the proposed open pit at Erato, with prevailing winds from the east. Jermuk has insufficient industrial activity to influence baseline monitoring at the Project.

From visual inspections the villages within 10km of the Project, and land within the Project, have very low levels of emissions. The limited emissions that do exist predominantly result from vehicle exhausts and, in winter, domestic fires for heating.

The most common fugitive emission in the Project and surroundings is dust or particulate matter which is released during various activities such as vehicle traffic on paved and unpaved roads, together with wind erosion from open storage of solid materials, exposed soil surfaces and unpaved roads.

4.4.2 Monitoring Methods and Locations

Gas Monitoring

Baseline monitoring for NO_2 and SO_2 at the site was undertaken by Geoteam, using Gradko diffusion tubes at five locations within residential settlements. The acrylic tubes are designed for passive sampling of airborne gases. The tube contains an adsorbent material which can then be analysed by UV/Visible Spectrophotometry with reference to a UKAS (United Kingdom Accreditation Service) calibration curve, appropriate to this methodology. The tubes have a recommended exposure length typically in the order of 4 weeks, after which time they are removed from their sampling location and returned to the manufacturer's accredited laboratory for analysis.

Two gas Gradko samplers for each parameter (SO_2 and NO_2) were established at five representative locations (see Figure 4.2.3). Each monitoring point had two diffusion tubes that ran concurrently over a period of 4-6 consecutive weeks during autumn and winter periods of 2011/2012 and consecutive monthly periods from December 2013. At the start of the 2013 monitoring, the Saralanj location was replaced by a new residential location in Jermuk. In 2015, the monitoring locations were revised and the equipment was changed to passive samplers supplied by IVL of Sweden, the Gradko samplers having become unavailable (see Section 4.4.3).

Dust monitoring - DustScan DS100

The DustScan DS100 is a directional dust gauge for assessing fugitive dust deposition (all dust 10-75 µm) and indicates from which directions emissions may originate (see Figure 4.4.1). Eight DustScan DS100s were used for monitoring at the site (see Figure 4.2.3 for locations).

Figure 4.4.1: DustScan DS100

The DS100 is a passive sampler, requiring no power, which collects fugitive dust from 360^{o} around the sampling point by trapping it on a sticky surface. The sampling cylinder slots into the monitoring post and is capped with a rain shield. North-facing notches in the sampling cylinder and the post ensure that the alignment of the sticky pad is consistent. The design of the sticky sample pad means that it is quite obvious if dust has been thrown at the pad, or been scratched at, in an attempt to alter results.

The manufacturer recommends that sticky pads are collected after 1 to 14 days exposure in the field. The average time that each sticky pad was left out during monitoring periods at the project is 7.5 days.

Usually the whole sampling cylinder is returned to the manufacturer in a customised transport flask. Geoteam chose to remove and seal the sticky pad on site before returning it to DustScan, due to difficulties associated with international shipping for analysis. The accuracy of this process can be maintained by laminating the sticky pad before submitting for analysis by DustScan.

Particulate monitoring

Osiris Turnkey

Two Osiris Turnkey monitors were used for short and long-term measurement of suspended particulate concentrations in air, in the PM_{10} and $PM_{2.5}$ ranges (see Figure 4.4.2).

Figure 4.4.2: Osiris Turnkey Monitor

The Osiris Turnkey Monitor uses a light scattering technique to determine the concentration and size fraction of airborne particles. The air sample is drawn into the instrument by a pump, beyond which it passes through a laser beam in a photometer and then through a filter. The light scattered by the individual particles is converted into an electrical pulse which is proportional to the size of the particle. The measurements of light scatter are taken at a narrow angle to remove the effects of material composition.

SKC EPAM 5000

A portable battery powered EPAM monitor has been purchased to supplement particulate monitoring capability, and can monitor $PM_{2.5}$ or PM_{10} continuously for up to 24hrs.

Figure 4.4.3: EPAM 5000 Monitor

The EPAM uses the principle of near-forward light scattering of an infrared radiation to immediately and continuously measure the concentration in mg/m^3 of airborne dust particles.

Monitoring Locations

Monitoring locations were selected for each type of measurement to establish an understanding of baseline conditions. The choice of monitoring points took into account local sensitive receptors and the development requirements for the Project, and has changed over time. Figure 4.2.3 shows current and future locations of the monitoring points.

4.4.3 Monitoring Results

Gas Monitoring

Results from SO_2 and NO_2 monitoring are shown in Table 4.4.1 to Table 4.4.3(see also Appendix 4.4.1).

Table 4.4.1: Results from Air Quality Monitoring, Using Gradko Diffusion Tubes over the Autumn/Winter Period 2011/12				
SO_2 Monthly (Time Weighted Average µg/m³)				
	Sept/Oct	**Nov**	**Dec**	**Jan**
Gorayk	2.19	1.57	2.37	1.29
Saralanj	1.66	1.25	3.23	2.05
Saravan	1.67	1.69	4.77	2.85
Gndevaz	1.44	-	2.36	1.15
Kechut	1.12	1.39	2.70	-
NO_2 Monthly (Time Weighted Average µg/m³)				
	Sept/Oct	**Nov**	**Jan**	
Gorayk	4.12	12.34	3.35	
Saralanj	5.42	5.83	4.59	
Saravan	4.12	3.42	8.97	
Gndevaz	6.21	3.86	2.74	
Kechut	1.92	9.89	-	

Table 4.4.2: 2014 NO_2 Results from Air Quality Monitoring, Using Gradko Diffusion Tubes												
Location	**2014 Monthly NO_2 Concentration (µg/m³)**											**Average Concentration (µg/m³)**
	Jan	**Feb/Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	
Gorayk	2.11	1.84	2.62	2.94	*1.69*	3.50	2.14	4.79	3.22	3.58	2.58	**2.82**
Saravan	9.71	7.83	5.83	6.13	5.07	4.60	3.79	7.78	9.47	9.59	9.41	**7.20**
Jermuk	4.76	3.08	2.58	3.11	2.34	3.17	2.61	4.79	4.40	4.81	5.61	**3.75**
Kechut	6.99	6.64	4.56	2.98	3.20	3.86	3.20	3.86	5.14	7.31	8.98	**5.15**
Gndevaz	3.82	2.45	1.94	2.50	2.59	3.03	2.19	4.11	3.44	3.97	3.87	**3.08**
Underlined results were below the reporting threshold - therefore the results presented are a worst case concentration												

Table 4.4.3: SO_2 Results from Air Quality Monitoring, Using Gradko Diffusion tubes												
Location	**2014 Monthly SO_2 Concentration (µg/m³)**											**Average Concentration (µg/m³)**
	Jan	**Feb/Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	
Gorayk	1.35	*0.73*	*1.22*	*1.15*	*1.02*	*0.20*	*0.79*	*0.97*	*1.44*	1.22	1.69	**1.07**
Saravan	1.23	*0.98*	*1.22*	*1.22*	*0.95*	*0.20*	*1.38*	*0.97*	*1.08*	1.29	*1.94*	**1.13**
Jermuk	*1.18*	*0.73*	*1.21*	*1.15*	*0.95*	*0.20*	*0.95*	*2.82*	*1.08*	*1.06*	*1.02*	**1.12**
Kechut	2.51	1.51	1.22	*1.15*	*0.95*	*0.20*	1.42	*0.97*	1.53	1.83	3.37	**1.51**
Gndevaz	*1.26*	*1.04*	*1.21*	*1.15*	*0.95*	*0.20*	1.50	*0.97*	*1.07*	*1.06*	*1.11*	**1.05**
Underlined results were below the reporting threshold - therefore the results presented are a worst case concentration												

In 2015, it was no longer possible to use Gradko Diffusion Tubes in non-EU countries and an alternative passive sampler was identified as a replacement. In August 2015, IVL Diffusion

Samplers which operate in a similar way to Gradko Tubes were deployed to the same five residential settlements and an additional six locations, shown on Figure 4.2.3 to continue monthly baseline data collection.

The first results of monthly NO_2 and SO_2 monitoring in 2015 are presented in Table 4.4.4.

Table 4.4.4: Results from Air Quality Monitoring, Using IVL Diffusion samplers for 2015

Location	Monthly Concentration (µg/m³)					
	August		September		October	
	NO_2	SO_2	NO_2	SO_2	NO_2	SO_2
Gorayk	3.0	0.8	3.0	0.7	2.8	0.5
Saravan	3.2	0.8	4.5	1.1	7.7	0.9
Jermuk	3.0	0.6	3.0	0.7	2.7	0.4
Kechut	1.8	0.7	2.2	0.8	3.0	0.6
Gndevaz	1.9	0.7	1.9	0.9	2.5	0.5
AQ1	1.1	0.7	0.8	0.8	0.9	0.4
AQ2	1.2	0.7	1.1	0.8	1.1	0.4
AQ3	1	0.7	0.8	0.9	1.1	0.5
AQ4	1.3	0.8	1.3	0.9	2.0	0.5
AQ5	0.7	0.7	0.5	1.1	0.8	0.5
AQ6	1.2	0.8	1.2	0.8	1.1	0.6

Background concentrations for NO_2, as shown in the preceding tables, are all significantly below WHO guideline levels (Table 4.4.5) for NO_2. As the WHO standard for SO_2 is based on a 24 hour mean, rather than long term averages, it is difficult to make a direct comparison. However, many of the analysis results for SO_2 yielded concentration below the laboratory equipment detection levels, making it highly unlikely that SO_2 levels at the monitoring locations ever came near the WHO 24 hour mean limit of 20 µg/m³. This finding is consistent with what is expected in a rural location with no significant pollution sources within the locality.

Table 4.4.5: World Health Organisation NO_2 and SO_2 guidelines[2].	
	WHO Guideline Value µg/m³
NO_2	40 (annual mean)
SO_2	20 (24 hr mean)
Notes: SO_2 It is not possible to convert the time weighted average concentrations to a 24hr mean; therefore direct comparison is not valid.	

Dust Monitoring

DustScan DS100 data has been collected from eight monitoring locations, as shown in Figure 4.2.3. Monitoring is undertaken only during snow-free period due to the difficulty of accessing monitoring locations in the winter months. It is unknown why monitoring has not been carried out year round at residential receptor sites in Gndevaz and Jermuk, but there is a low likelihood of dust generation during the months when snow cover is present.

The most comprehensive data is for the monitoring points ADE2, ADS3, and ADW4, with data available for consecutive weeks from June 2011 to August 2011, July 2012 to September 2012, and July 2013 to September 2013. ADN1 has the same data coverage as the previously mentioned sampling points, with the exception of data collected during 2011.

Data has been collected from sample points ADJ5, ADG7 and ADHLP8 during April 2013, and consecutive weeks in July, August, and September 2013. Data for ADHLP9 has only been collected during September 2013.

The number of DS100 samples collected each month for each sampling location is tabulated in Table 4.4.6. Since the sampling frequency was typically 6 or 7 days, the maximum number of samples that could be collected from a certain sampling location in any month would be either 4 or 5, depending on when the first sample for the month was collected.

[2] WHO Air quality guidelines for nitrogen dioxide and sulphur dioxide – Global update 2005 (Summary Risk Assessment)

Table 4.4.6: DustScan DS100 Sampling Week Frequency table														
	2011			2011 Total	2012			2012 Total	2013				2013 Total	Grand Total
Sample Points	June	July	August		July	August	September		April	July	August	September		
ADE2	1	3	2	6	2	2	1	5	1	5	4	4	14	25
ADHLP8										5	4	1	10	10
ADJ5									1	5	4	4	14	14
ADN1	1		1	2			1	1	1	5	4	4	14	17
ADS3	1	3	2	6	2	2	1	5	1	5	4	4	14	25
ADW4	1	3	2	6	2	2	1	5	1	5	4	3	13	24
ADG07									1	5	3	2	11	11
ADHLP09												3	3	3

DustScan DS100 samples provide two measurements of dust deposition: Absolute Area Coverage (AAC%) and Effective Area Coverage (EAC%).

According to DustScan's Guidance Note 3[3], AAC% indicates the magnitude and significance of dust sources. This is determined based on the presence of dust on the sticky pad, irrespective of dust colour. EAC% rates the nuisance potential that may be caused by dust, with regard to the darkness or potential soiling of the dust.

The DustScan DS100 is divided into directional segments, which allows one to determine the direction from which the dust deposited on the sticky pads was travelling.

Ranking criteria for dust source significance in terms of AAC% are shown in Table 4.4.7. Ranking criteria for dust nuisance potential in terms of EAC% are shown in Table 4.4.8.

[3] DustScan Guidance Note 3: Directional Dust Data Assessment, http://www.dustscan.co.uk/Portals/0/PDFs/Guidance%20Note3.pdf, Accessed 17/07/2014

Table 4.4.7: AAC% Source Significance		
Source Significance		**AAC% Value per Sampling Interval**
Very Low	0	<80%
Low	1	80% to <95%
Medium	2	95% to <99%
High	3	99% to 100%
Very High	4	100% for 45°

Table 4.4.8: EAC% Nuisance Potential		
Nuisance Potential		**EAC% Value per Day**
Very Low	0	<0.5%
Low	1	0.5% to <0.7%
Medium	2	0.7% to < 2.0%
High	3	2.0 to <5.0%
Very High	4	>=5.0%

Table 4.4.7 and Table 4.4.8 are compiled taking account of the assessment guidance in DustScan's Guidance Note 3, and the sampling result interpretation in each of DustScan's DS100 Directional Dust Flux Reports provided to Geoteam (see Appendix 4.4.1 for examples).

The following pollution roses in Table 4.4.9 provide the percentage frequency counts of source significance levels and nuisance potential of dust coming from 12 directions, for each of the sampling locations. When readings are below the detection limit, the reading is not included in the count. Table 4.4.6 shows the AAC% pollution roses in Table 4.4.9 overlain on the Air Quality Baseline Monitoring map to help provide a spatial representation of baseline dust deposition.

Consideration is first given to AAC%. ADN1 and ADS3 show the greatest frequency of dust deposition with a high source significance, with high significance dust at ADN1 coming predominantly from the south-east (11.3% of the time monitored), and high significance dust at ADS3 coming from the east and east-north-east (5.6% of the time monitored).

The high source significance readings at ADN1 and ADW4 are likely a result of exploration and geotechnical studies being undertaken at Amulsar during the sampling periods. The high readings coming from the east of ADS3 correlate with the prevailing wind direction, and may

be as a result of road traffic along the Vorotan Pass. High frequencies of medium significant sources of dust deposition have been detected at the Jermuk monitoring point (ADJ5), with dust fluxes coming from the south-east. This is likely due to road traffic near the sampling location. Dust deposition at the Gndevaz sampling point shows deposition of low or greater significance coming from the north about 3.4% of the time monitored. This indicates that a minor dust source exists within Gndevaz – possibly as a result of small fires for rubbish disposal.

Considering EAC%, most sampling points show low frequencies (2% or less) of high to very high nuisance potential over the sampling periods, from all wind directions combined. The exception is ADN1 that shows that deposition has a high to a very high nuisance potential for approximately 9% of the sampling period from the south to the east-south-east of ADN1 (9.8% from all directions combined).

Table 4.4.9: Pollution Roses showing frequencies of dust deposition by wind direction, grouped by source significance (AAC%) and nuisance potential (EAC%)

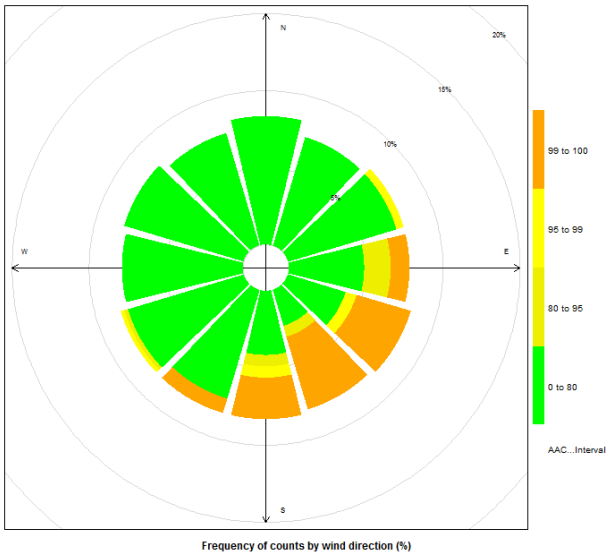
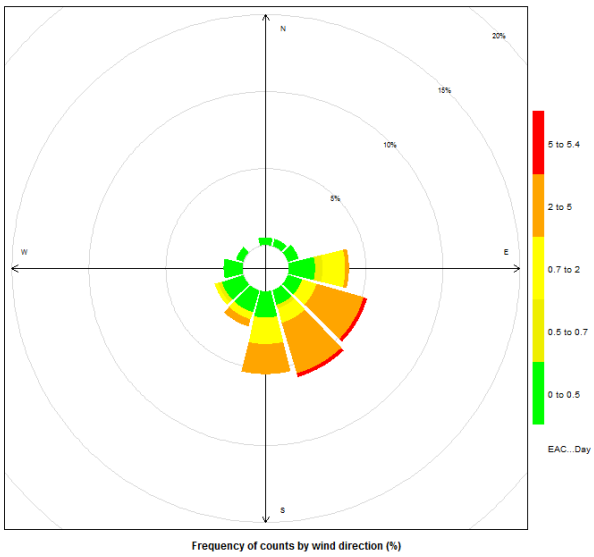
Sample point	AAC% per Interval	EAC% per Day
ADN1		

Table 4.4.9: Pollution Roses showing frequencies of dust deposition by wind direction, grouped by source significance (AAC%) and nuisance potential (EAC%)

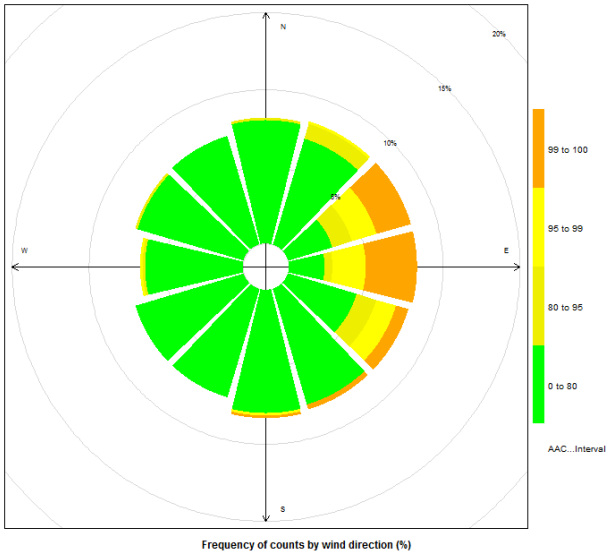
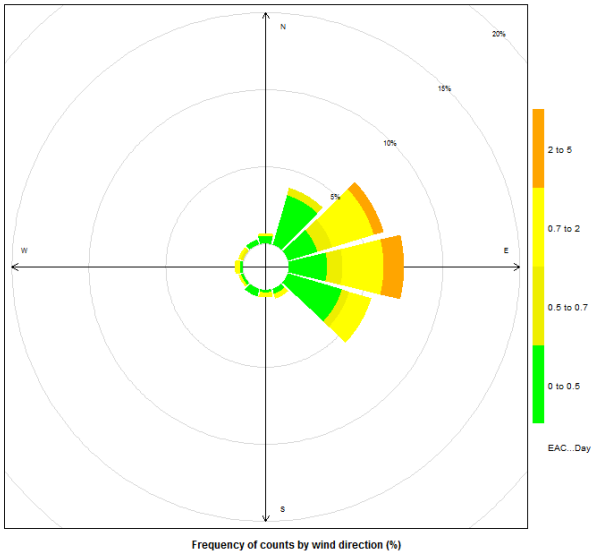
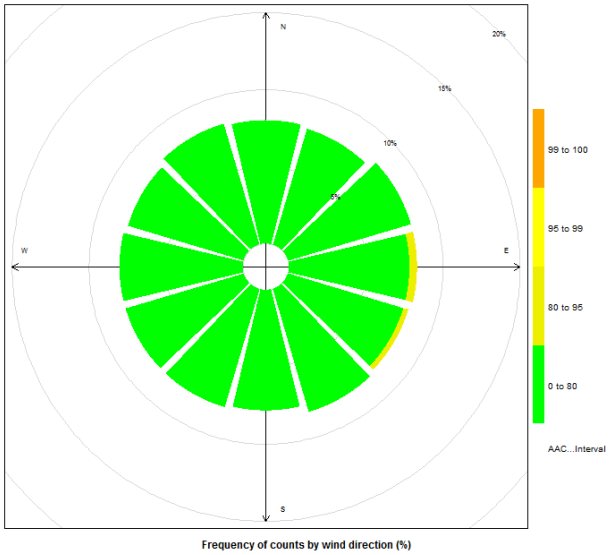
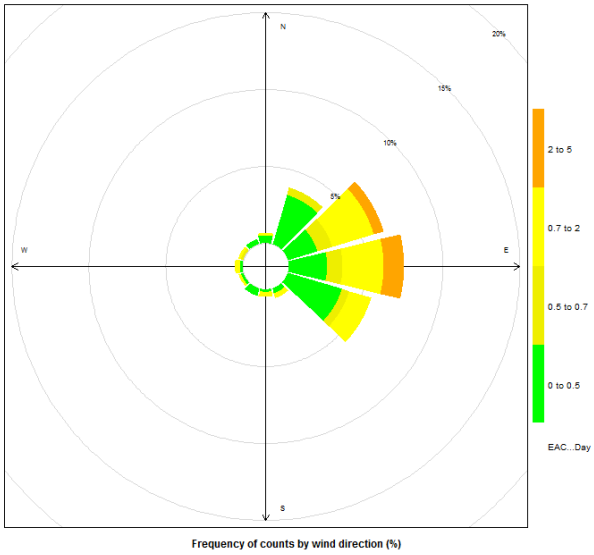
Sample point	AAC% per Interval	EAC% per Day
ADS3		
ADE2		

Table 4.4.9: Pollution Roses showing frequencies of dust deposition by wind direction, grouped by source significance (AAC%) and nuisance potential (EAC%)

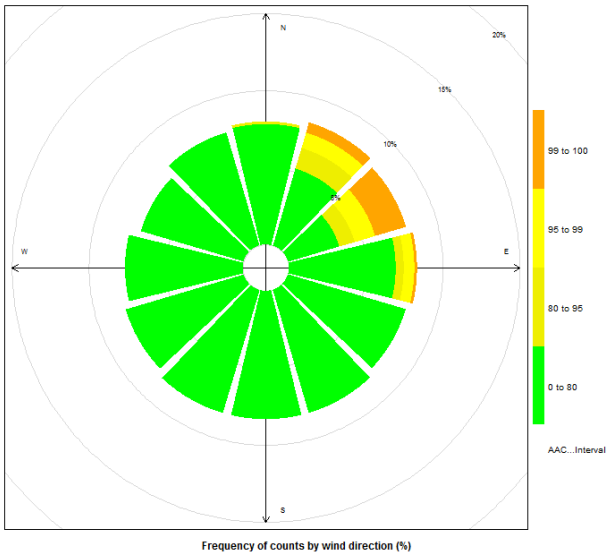
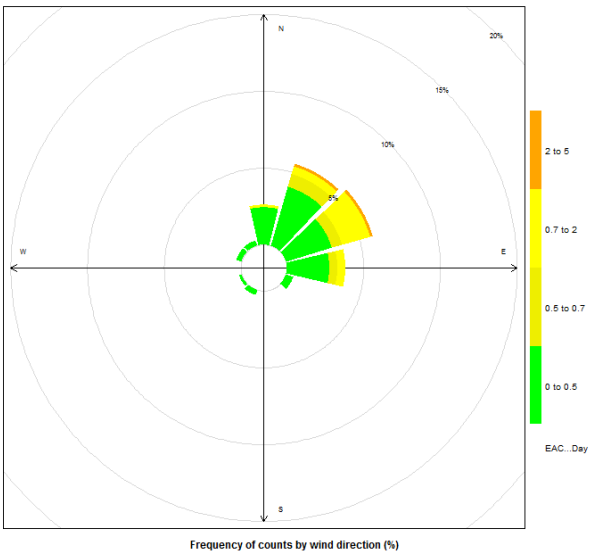
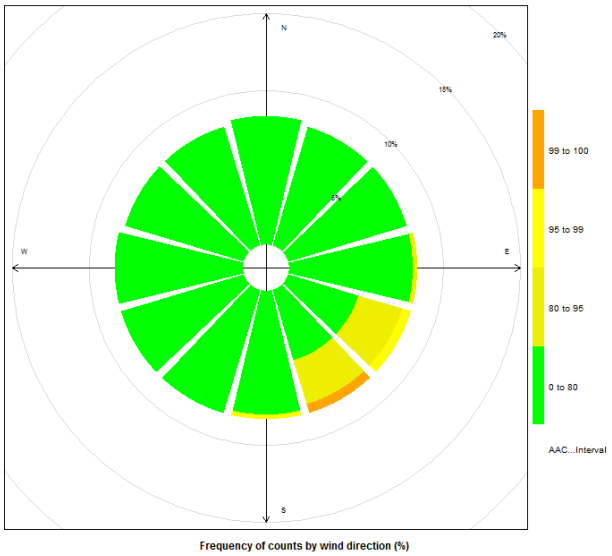
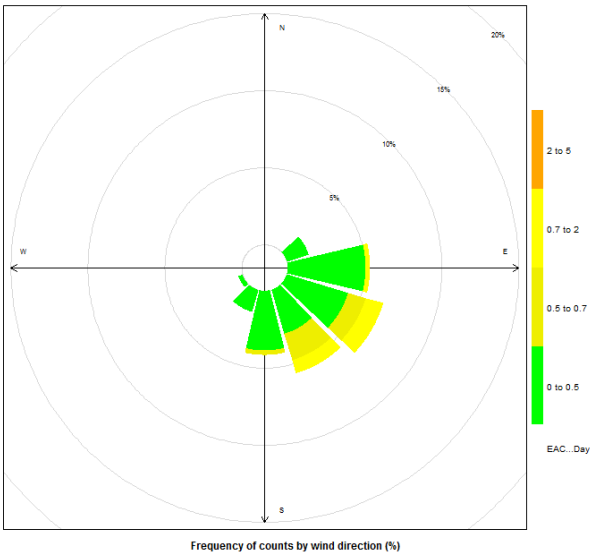
Sample point	AAC% per Interval	EAC% per Day
ADW4		
ADJ5		

Table 4.4.9: Pollution Roses showing frequencies of dust deposition by wind direction, grouped by source significance (AAC%) and nuisance potential (EAC%)

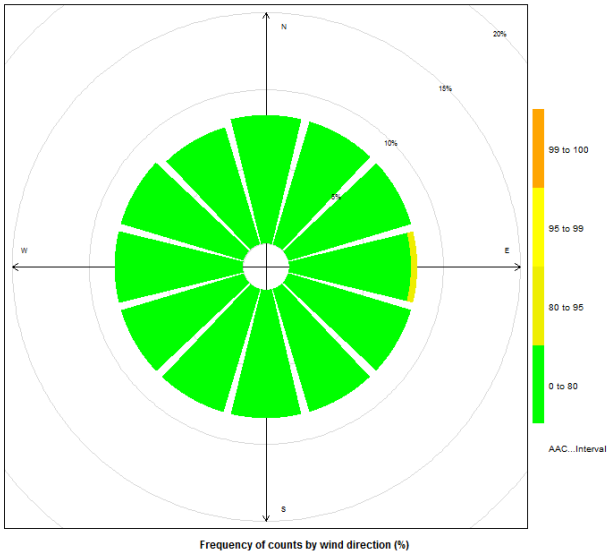
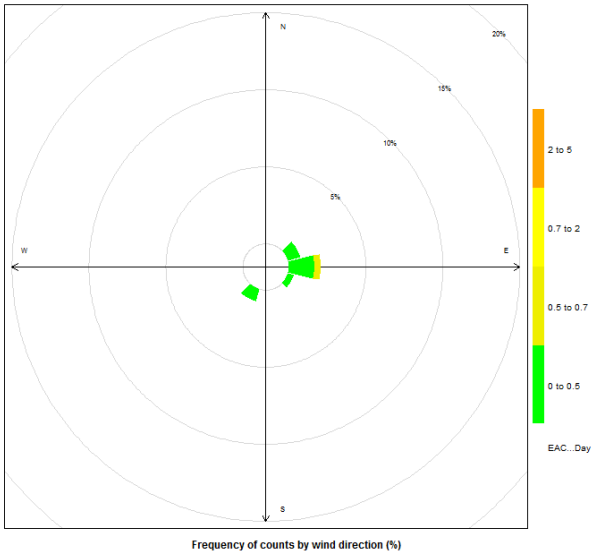
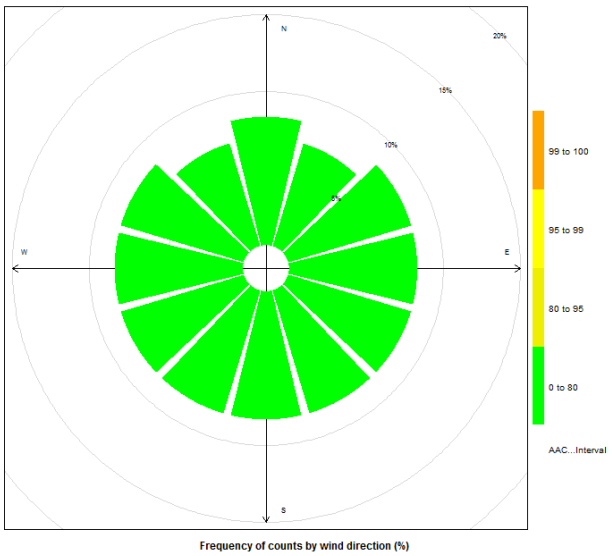
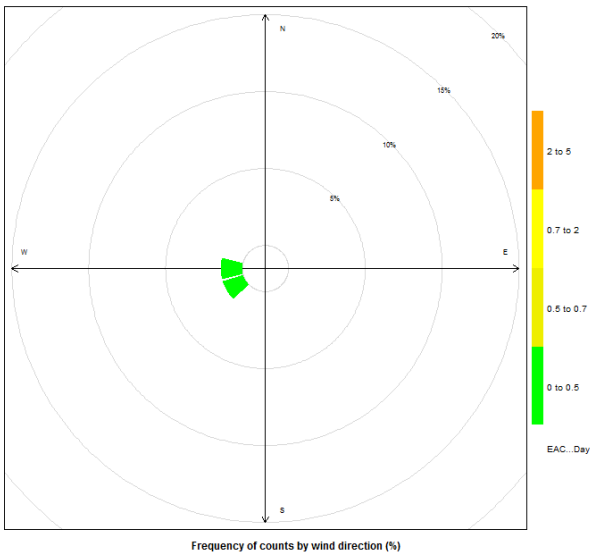
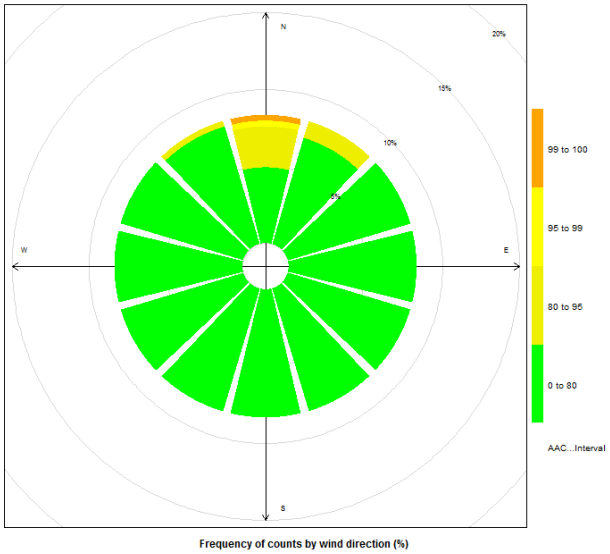
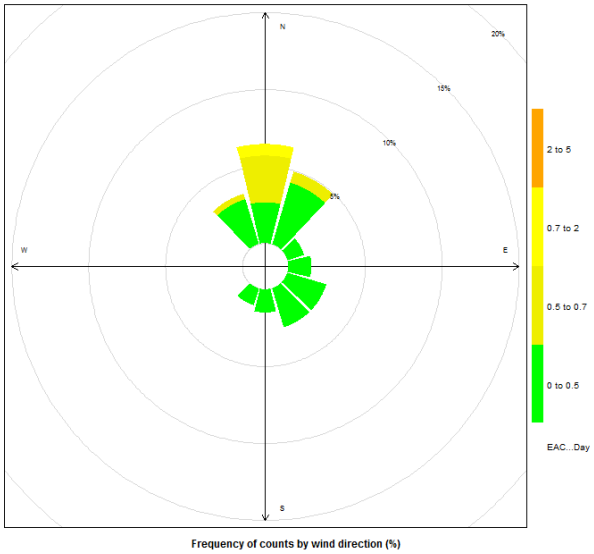
Sample point	AAC% per Interval	EAC% per Day
ADHLP 8		
ADHLP 9		

Table 4.4.9: Pollution Roses showing frequencies of dust deposition by wind direction, grouped by source significance (AAC%) and nuisance potential (EAC%)

Sample point	AAC% per Interval	EAC% per Day
ADG7		

The analysis of AAC% and EAC%, illustrates that dust deposition was usually low during the sampling period and illustrates influence from the prevailing wind direction (prevailing wind was easterly during the monitoring period, see wind rose in Section 4.2, Figure 4.2.6).

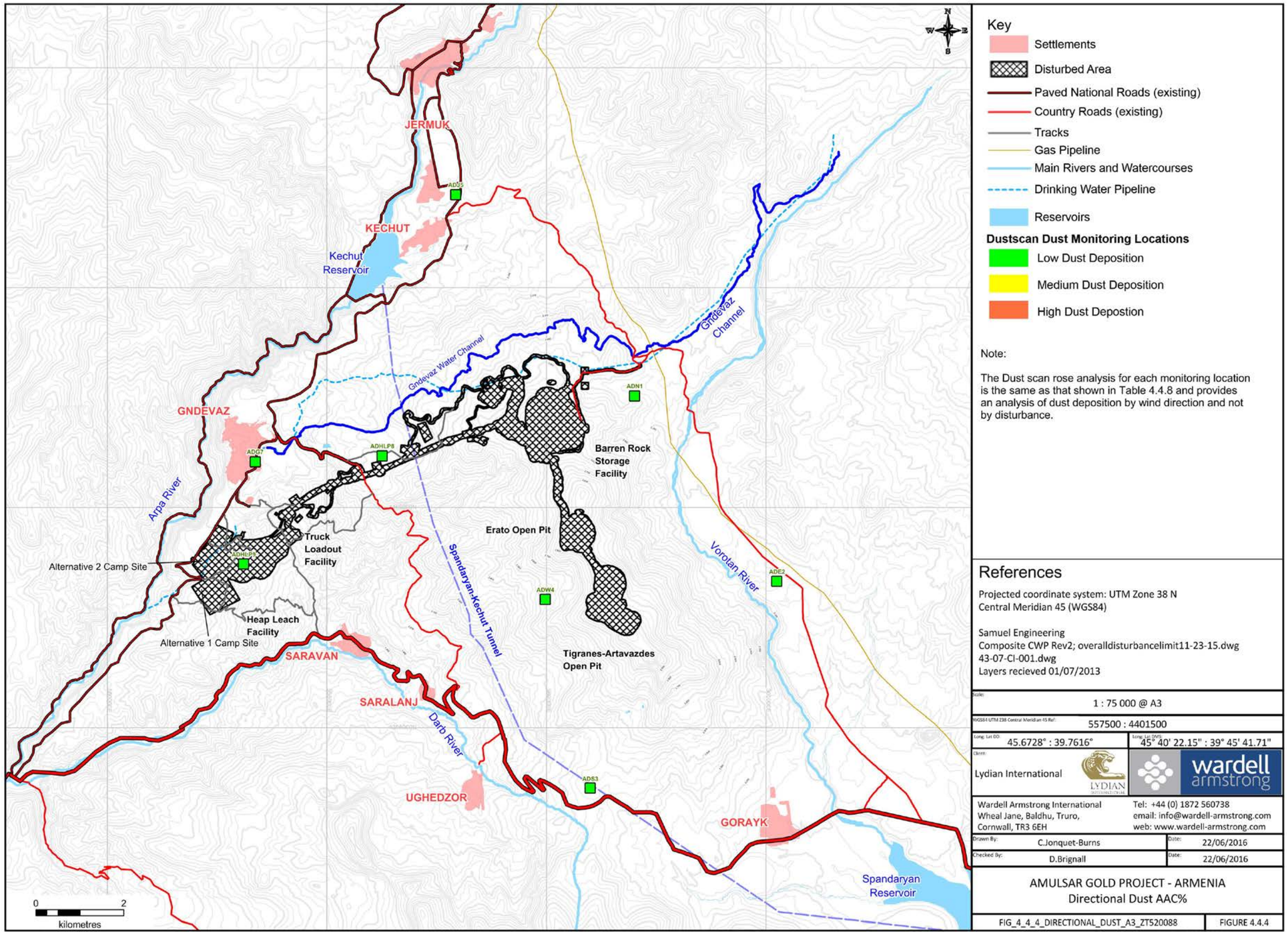


Figure 4.4.4: Directional Dust AAC%

Particulate Monitoring

In 2011, limited baseline particulate monitoring data was collected from locations within the five residential settlements. One-hourly measurements taken between 5 and 30 days from June to November 2011 showed wide variation in background particulate concentrations which were influenced by outlying data samples associated with such short monitoring periods.

In 2014, both Osiris monitors were returned to the manufacturer for calibration and upgrading. Research was carried out to identify a suitable portable monitor capable of accurate 24hr measurement in remote locations without a mains power source to supplement Osiris measurements. In accordance with the Air Quality, Noise and Vibration Management Plan (V2), The Osiris monitors were located in the nearest most sensitive receptor locations to the mine operations, at Gndevaz and Kechut to establish a reliable long-term baseline at these locations. An EPAM monitor was purchased and field tested alongside the Osiris instruments used in Gndevaz and Kechut from June 2015.

The instruments monitored PM_{10} concentrations at Gndevaz and Kechut from June to October and $PM_{2.5}$ concentrations at the same locations from June to mid-July 2015. The 24hr mean results are shown in Figure 4.4.5 to Figure 4.4.8.

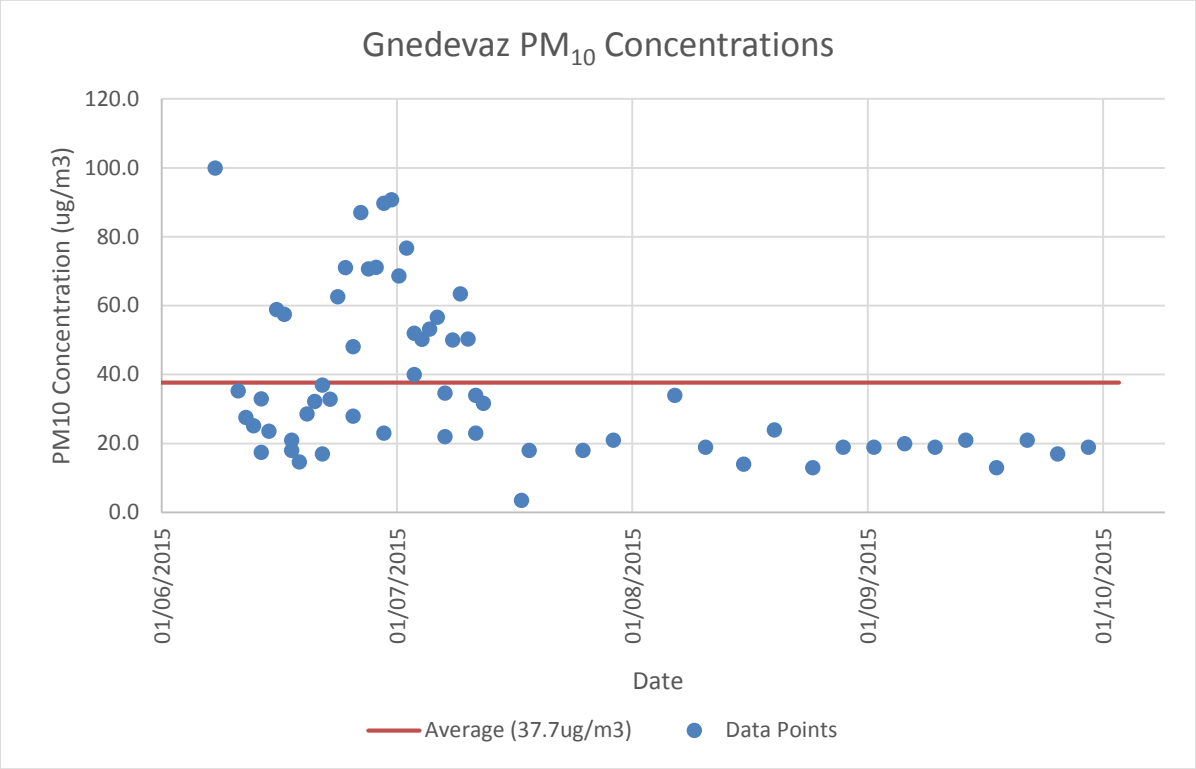


Figure 4.4.5: 24hr mean PM_{10} Concentrations – Gndevaz

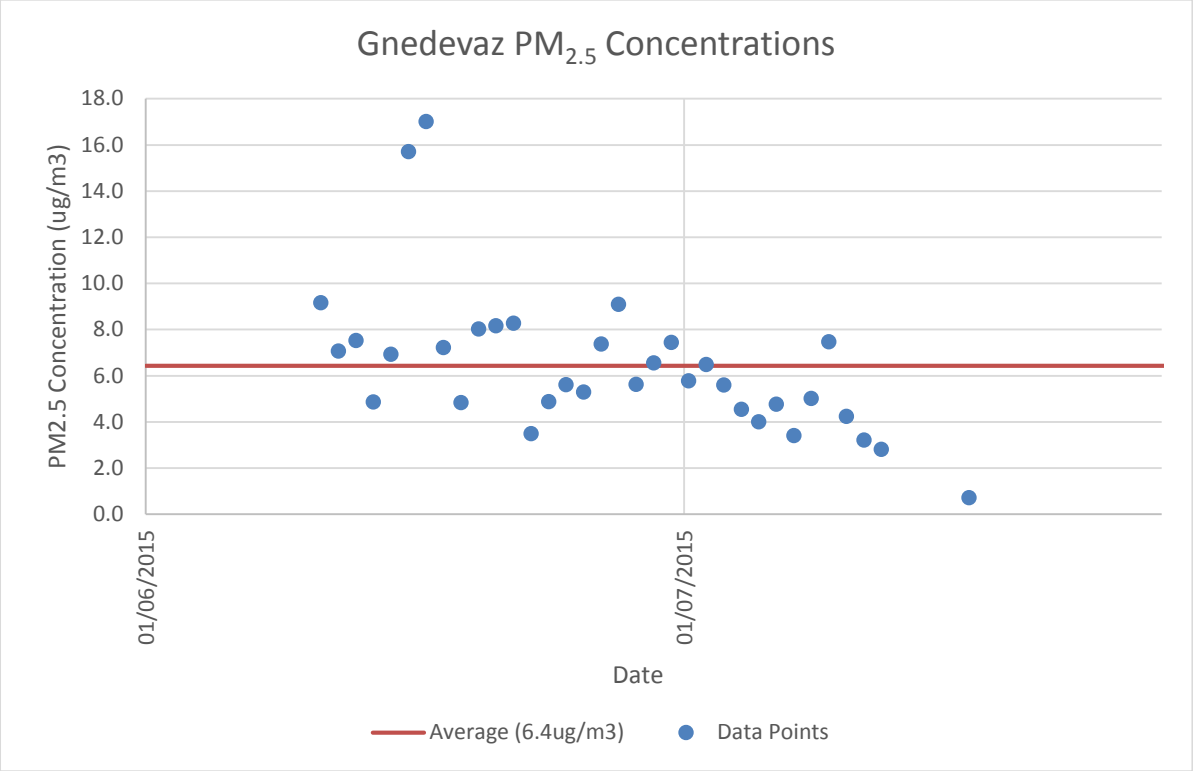


Figure 4.4.6: 24hr mean $PM_{2.5}$ Concentrations - Gndevaz

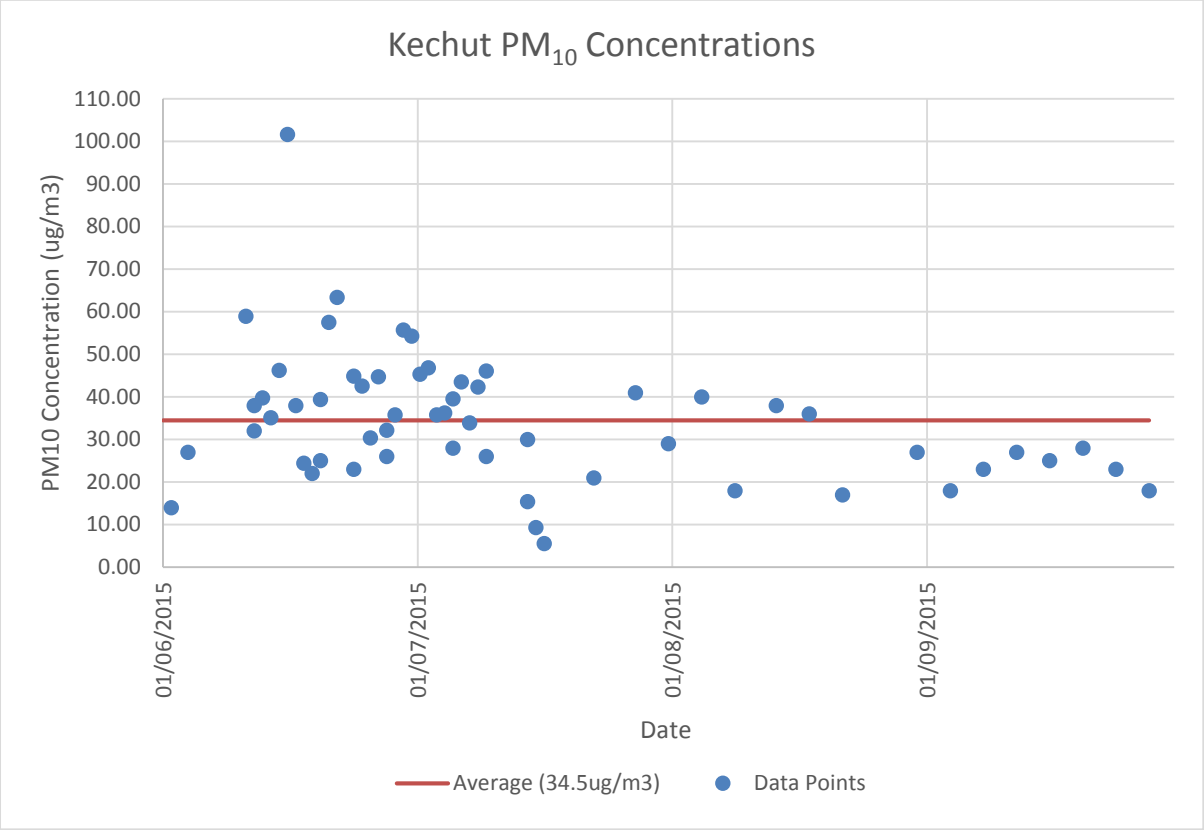


Figure 4.4.7: 24hr mean PM_{10} Concentrations - Kechut

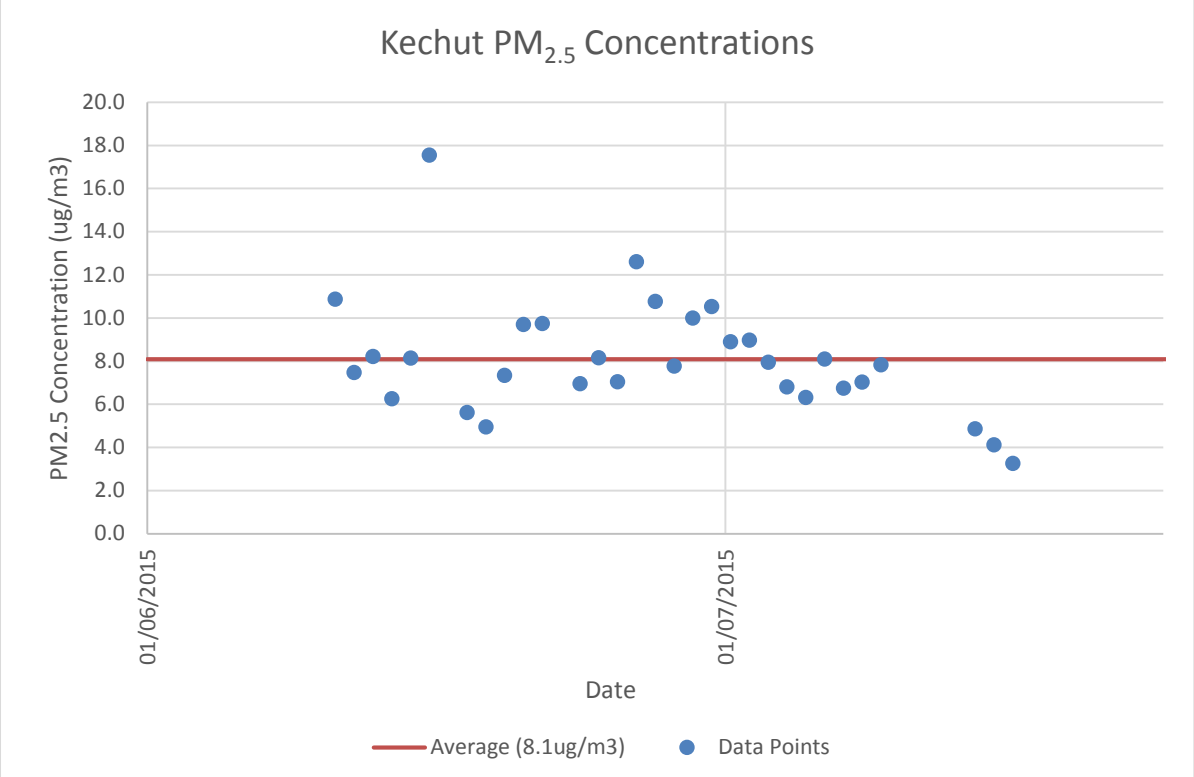


Figure 4.4.8:24hr mean $PM_{2.5}$ Concentrations - Kechut

In addition to establishing long-term monitoring locations in Gndevaz and Kechut, short term (24hr) periodic baseline particulate monitoring has commenced in rural locations within the project footprint. Air Quality monitoring points –AQ9 to the west of Tigranes/Artavazdes and AQ10 to the north of the BRSF were chosen to establish baseline conditions near to operational areas of the project but away from the possible influence of human activities in the settlements (such as domestic fuel burning for heat/cooking purposes). Air quality monitoring locations are shown on Figure 4.2.3. The 24hr mean results for the additional monitoring locations are shown in Figure 4.4.9 to Figure 4.4.12.

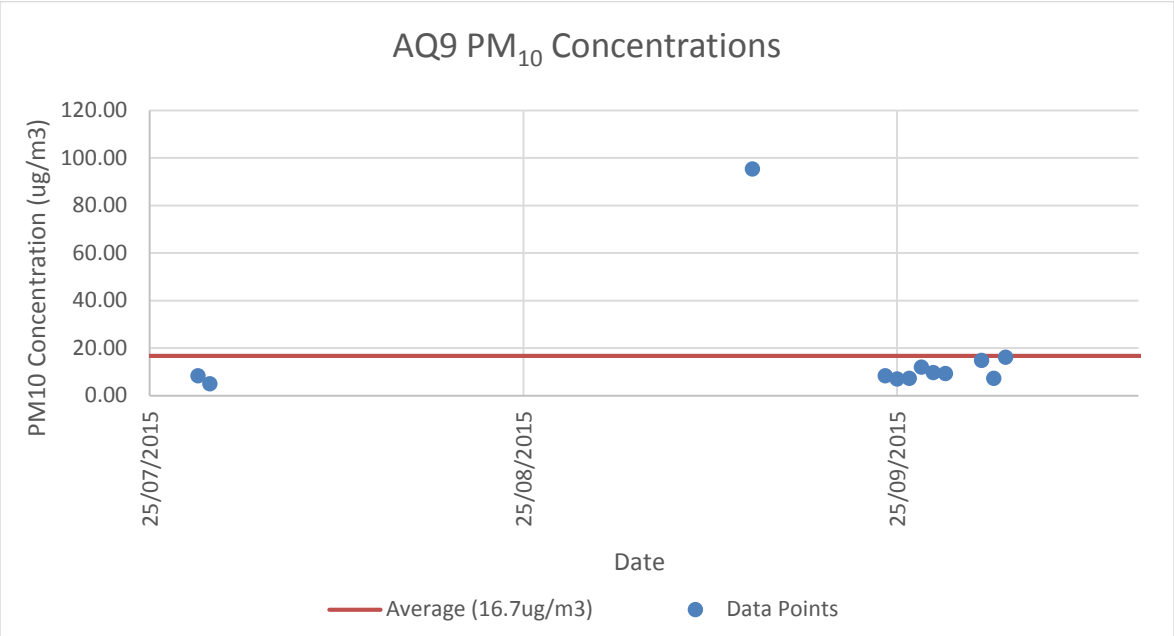


Figure 4.4.9: 24hr mean PM_{10} Concentrations – AQ9 West of Tigranes/Artavazdes

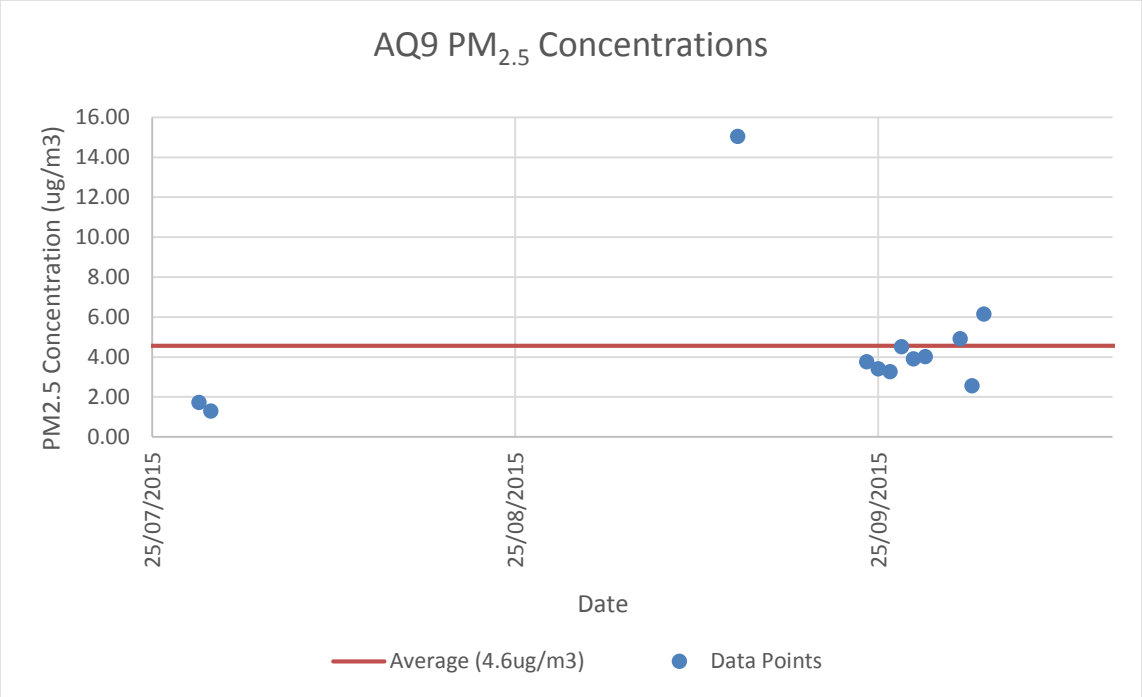


Figure 4.4.10: 24hr mean $PM_{2.5}$ Concentrations - AQ9 West of Tigranes/Artavazdes

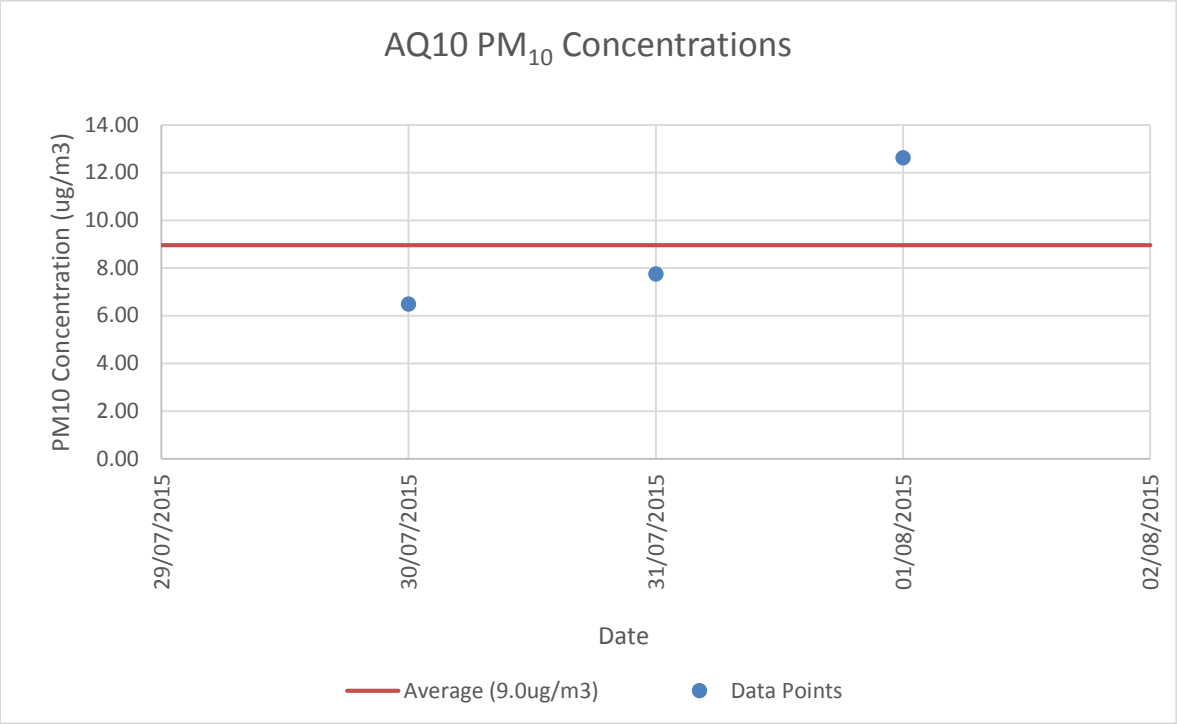


Figure 4.4.11: 24hr mean PM_{10} Concentrations - AQ10 North of BRSF

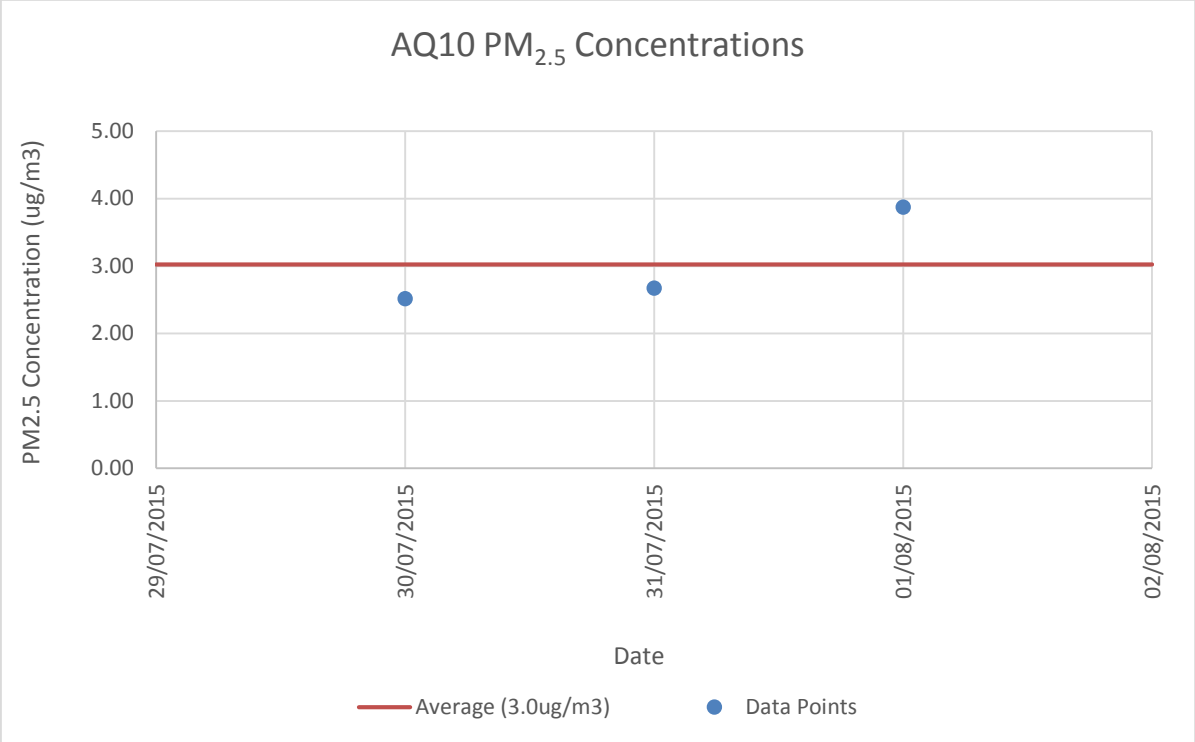


Figure 4.4.12 24hr mean $PM_{2.5}$ Concentrations - AQ10 North of BRSF

The WHO guideline values for particulates are shown in Table 4.4.10:

Table 4.4.10: World Health Organisation PM_{10} and $PM_{2.5}$ guidelines.

	WHO Guideline Value µg/m³	
	24 hour mean	annual mean
PM_{10}	50	20
$PM_{2.5}$	25	10

From the data obtained it can be seen that baseline PM_{10} concentrations exceed the WHO 24hr mean guideline in Gndevaz on 19 days out of 59 days (32%). In Kechut, the PM_{10} guideline value was exceeded on 6 days out of 56 days (11%). There was only 1 day of exceedance at AQ9 and no exceedances at AQ10 during the short period of monitoring to date. There were no exceedances of the WHO $PM_{2.5}$ 24hr mean value at any monitoring location.

The pattern of measured particulate concentrations, over the period monitored to date, indicates that WHO annual mean guidelines will follow a similar pattern in that the PM_{10} guideline is expected to be exceeded in the vicinity of the Project prior to operations commencing. Monitoring suggests that the $PM_{2.5}$ annual guideline value will not be exceeded.

4.4.4 Summary

Air quality monitoring has been carried out in and around the Project area since 2011 to establish the existing baseline conditions.

Monitoring for gaseous NO_2 and SO_2 has been completed in five local communities near to existing houses. Very low results were recorded (with SO_2 levels often below the limits of detection), consistent with what is expected in a rural location with no significant pollution sources within the locality. The monitoring programme is ongoing at these gauges.

Dust deposition was monitored at locations near to the main Project infrastructure locations. Results demonstrate low levels of natural and potentially man-made sources of dust, distributed according to local wind patterns. Fine particulate monitoring (PM_{10} and $PM_{2.5}$) has shown a pattern of elevated PM_{10}, but low $PM_{2.5}$ concentrations. Further monitoring of PM_{10} and $PM_{2.5}$ will ensure that reliable baseline conditions are further established, prior to commencement of construction (see Appendix 8.14).