Annexure 12:

Responses to s92 requests prepared by Beca in respect of air quality matters

21 Pitt Street,
PO Box 6345, Auckland,
1141, New Zealand
T: +64 9 300 9000 // **F:** +64 9 300 9300
E: info@beca.com // www.beca.com

4 October 2024

Oceana Gold (New Zealand) Limited
P O Box 5442
Moray Place
Dunedin 9058

Attention: Dean Fergusson

Dear Dean

Air Quality Assessment - Further Information Response

Oceana Gold (New Zealand) Limited (OGL) has applied for resource consents from the Otago Regional Council (ORC) for a further expansion of Macraes Gold Mine (MP4). The ORC issued a request for further information dated 24 July 2024 in respect to issues raised by John Iseli (Specialist Environmental Services Ltd) who carried out a technical review of the Beca air discharges assessment.

Our response to the queries raised in Section 3 of the letter is set out below. We have grouped the queries according to the issues raised.

TSP monitoring results

Q3.1 *Figure 6-10 in the Beca AEE only includes total suspended particulate matter (TSP) monitoring data from site DG15 (Macraes township) to 2022. Please provide a summary of the TSP monitoring data (at least one year at each site) collected at sites DG07 (Horse Flat Road) and DG11 (Macraes Road) in relation to existing consents for Deepdell North Stage 3 (RM20.024.12) and Frasers WRS (RM10.351.52.V3). Please also update the DG15 TSP data to include the period from January 2022 to present.*

Response: Beca completes annual dust monitoring review reports on behalf of OGL in accordance with resource consent requirements. Dust monitoring results are submitted to ORC quarterly by OGL and summarized in an annual monitoring report submitted to the ORC in April each year. Monitoring reports for 2022 and 2023 are attached to this letter to provide results and analysis of the monitoring undertaken at the Macraes site and can be consulted to confirm recent air quality compliance trends.

The 2022 and 2023 TSP monitoring results for DG07, DG11 and DG15, along with relative humidity are shown in Figures 1 and 2 below. The locations of the monitoring sites are shown in Figures 3 and 4. The TSP limits for DG07, DG11 and DG15 are listed in Table 1 below.

Site DG11 (closer to the mine than DG15 in Macraes village) was decommissioned in 2023 as allowed for by Condition 6(a)(e) of consent RM10.351.52.V3. This request was made and approved on the basis that monitoring results at DG11 were very similar to those for DG15 (as can be seen in Figure 1).

Note: Since Aug 2023 the monitor at DG07 has had many data loss issues due to instrument faults and loss of power. Power provided by the solar panels is often insufficient during the winter months which has been difficult to resolve. The monitor is being repaired at Watercare. An option has been identified to move the DG07 TSP site to a previous TSP monitoring site located between the nearest receptor's woolshed and House which would provide mains power. OGL is negotiating with the owner for this change in location to be made.

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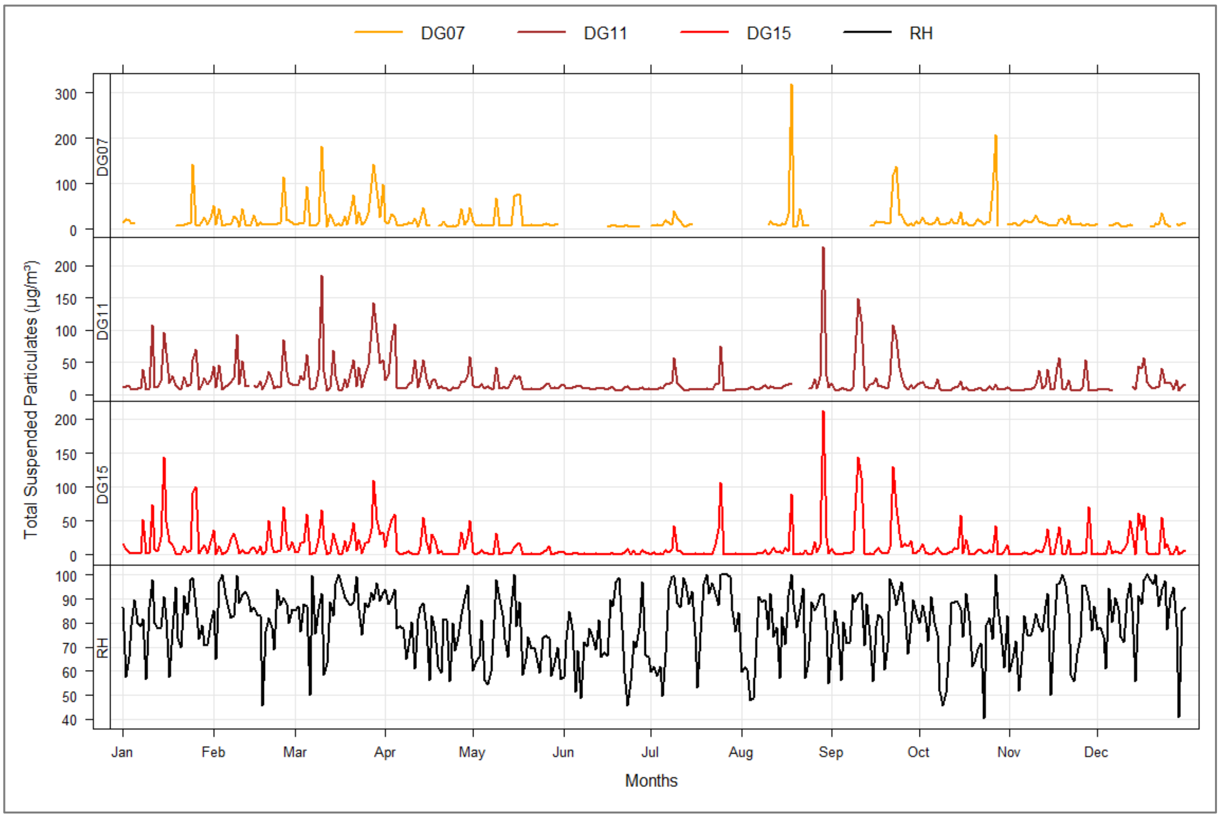

Figure 1 Graph showing 2022 TSP monitoring results for DG07, DG11 and DG15, along with relative humidity

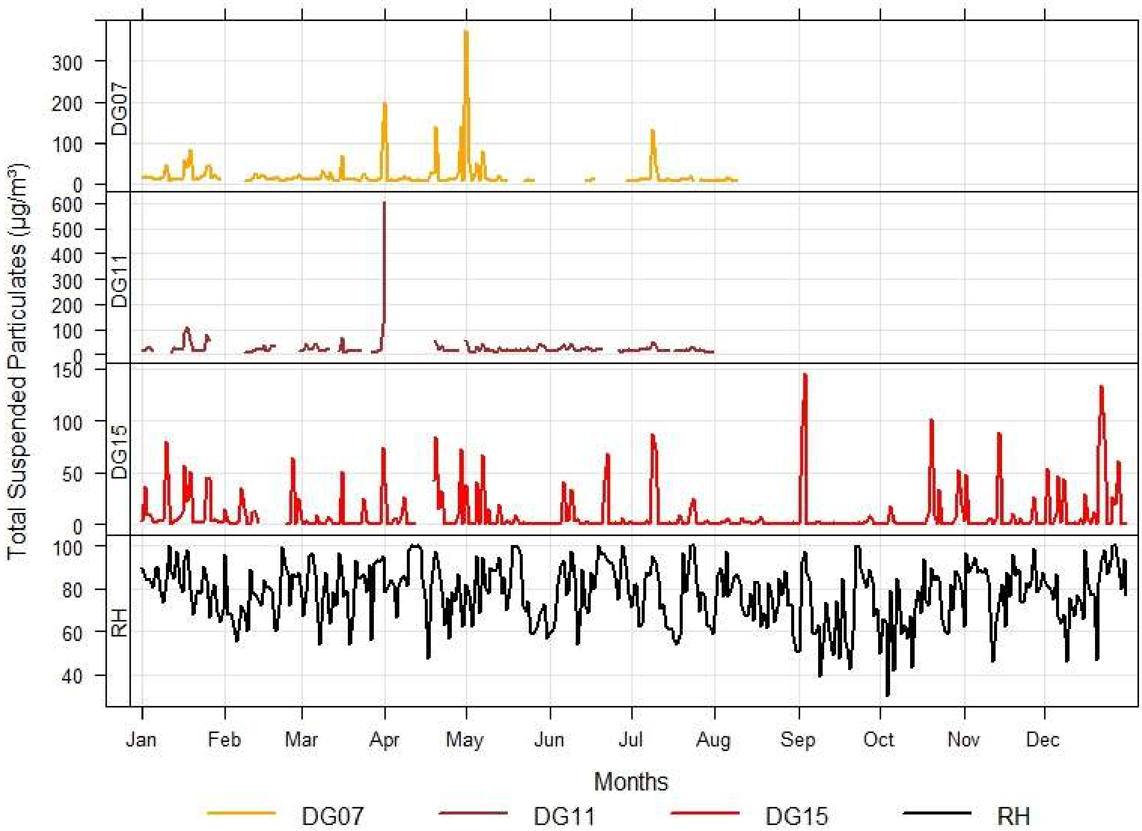

Figure 2 Graph showing 2023 TSP monitoring results for DG07, DG11 and DG15, along with relative humidity

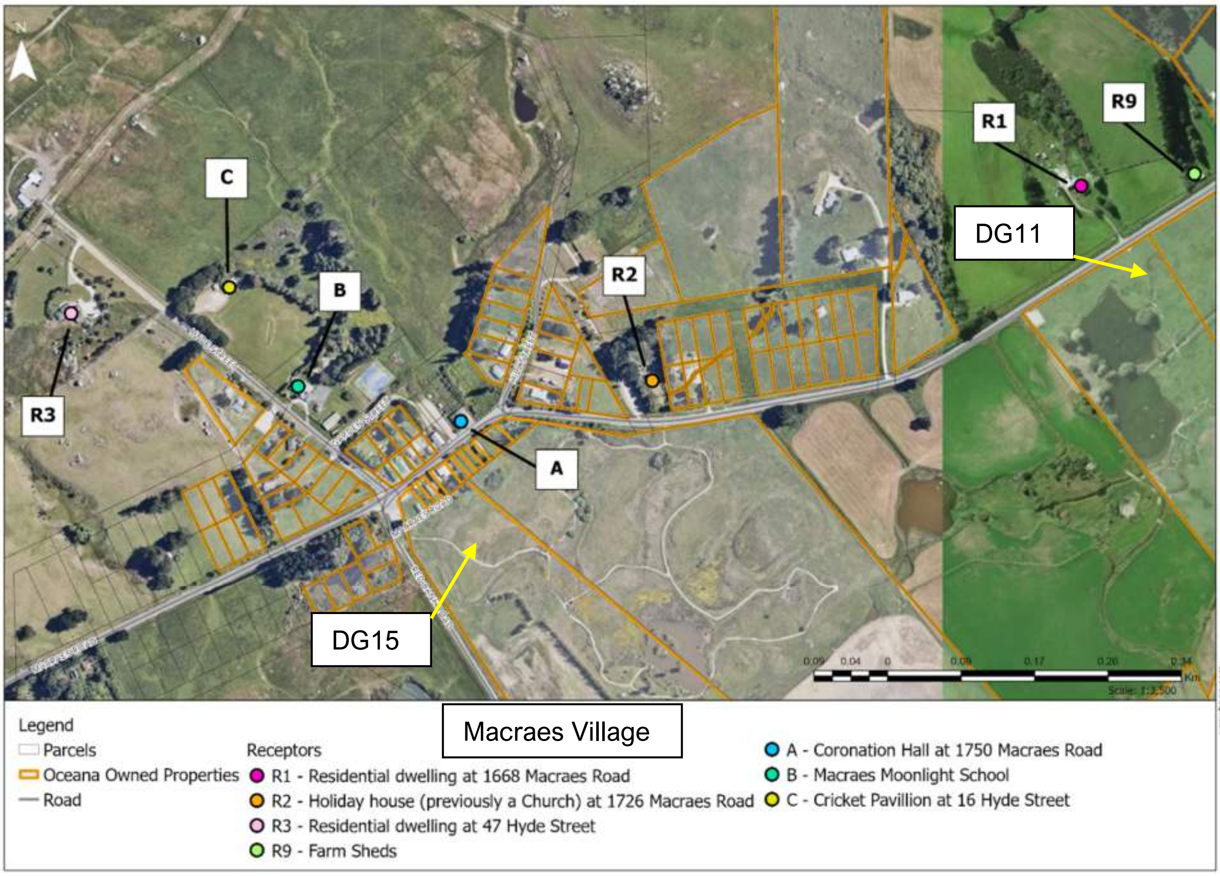

Figure 3 Map showing location of monitoring sites DG11 and DG 15 near FRWRS and nearby dwellings

Figure 4 Map show location of monitoring site DG07, near Deepdell North

DG15 TSP limit

Q3.2 *Is revision of the 120 µg/m³ (24-hour average) TSP limit for site DG15 proposed under this application? It is noted that the Good Practice Guide (GPG) for Dust Assessment suggests 24-hour average trigger limits of 60 µg/m³ (high sensitivity) and 80 µg/m³ (moderate sensitivity).*

Response: Revision of the 120 µg/m³ (24-hour average) TSP compliance limit for site DG15 is not proposed under this application as this limit is consistent with other site consents. The current dust controls on site, as documented in the Dust Management Plan, are effective and will continue to be implemented under the MP4 project. As can be seen in the tables, none of the exceedance in the 2022-23 data period were caused by mining activities.

The Dust GPG states that

"Where there is potential for significant adverse effects beyond the site boundary, trigger levels for total suspended particulate (TSP) or PM_{10} can be set to prompt action to control dust,…"

The conclusion of the assessment of environmental effects was that off-site effects are expected to be less than minor and therefore there are not expected to be significant adverse effects beyond the site boundary. However, adding the trigger level 80 µg/m³ to DG15 is sensible and is in the interests of aligning to good practice.

All current air discharge permits that require monitoring at DG15 have a TSP limit of 120 µg/m³. These consents are listed in Table 1 and most of them are valid until 2032.

Table 1. Site TSP Monitoring Requirements

Consent Number	Cond. No	TSP sites	Dust Limit and Averaging Period
96785_V5 all of the site except Macraes Phase III and Coronation (expires 31/8/2032)	9 and 12c	DG15	Consent Limit: 120 µg/m³ 24hr average
RM10.351.52.V3 Macraes Phase III expansion and Frasers West (expires 31/8/2032)	~~6(a)(e)~~	~~DG11~~	~~Trigger Level 80 µg/m³ 24hr average, 250 µg/m³ 1 hourly~~[1]
	9 and 12c	DG15	Consent Limit: 120 µg/m³ 24hr average, no limit 1 hourly
RM12.378.15 (Coronation Waste Rock Stack, Coronation Pit and associated haul roads, utility areas and stockpiles). (expires 31/8/2032)	7 and 10c	DG15	Consent Limit:120 µg/m³ 24hr average, no limit 1 hourly
RM16.138.19.V1 (Coronation North). (expires 31/8/2032)	7 and 10c	DG15	Consent Limit: 120 µg/m³ 24hr average, no limit 1 hourly
RM20.024.12 Deep Dell (Deepdell North Stage III) (expires 23/9/2026)	5c	DG07[2]	Trigger Level: 80 µg/m³ 24hr average, 250 µg/m³ 1 hourly
	10 and 13b	DG15	Consent Limit:120 µg/m³ 24hr average, no limit 1 hourly

[1] This monitoring requirement is no longer required as Otago Regional Council agreed for this monitoring site to be removed under condition 6(a)(e) as the results at DG11 were very similar to DG15.

[2] 406 Horse Flat Road

TSP Exceedances occur during the summer period

Q3.3 *The TSP monitoring data for DG15 to 2022 indicates several exceedances of an 80 μg/m³ (24-hour average) TSP trigger/limit. While some exceedances may be attributed to fog affecting the nephelometer during winter, other exceedances occur during the summer period. Please provide further analysis or explanation?. Is the mitigation proposed expected to be sufficient to enable compliance with a limit in the order of 60 – 80 μg/m³ (24-hour) in future?*

Response: There is no trigger limit at DG15, and as explained in our response to Q3.2, a trigger limit is not considered necessary but OGL is prepared to accept a trigger limit in line with the GPG dust. There is no proposal to reduce the TSP monitoring compliance limit of 120 μg/m³. Periods where TSP monitoring concentrations at DG15 were above the consent limit have been presented in the attached monitoring reports alongside the humidity data and the results of investigations into those exceedances. There were several times where the monitor indicated the limit was exceeded when the humidity was 100% which means that the optical monitoring method was actually measuring water aerosols. These events are highlighted green in Table 2.

Oceana advises that at times during summer, dry windy conditions can pick-up dust from exposed surfaces that cannot be treated with water or there are other dusty rural activities occurring out of the control of Oceana. These events are highlighted blue in Table 2.

If the TSP limit was reduced from 120 μg/m³ to 80 μg/m³ the monitoring data in 2022 and 2023 would have showed some more exceedance of the limit, as can be seen in Table 3 (events highlighted in yellow). Review of days where the TSP concentration measured at DG15 was over 120 μg/m³ has shown that none of the exceedances related to mining activities. Excluding these events, there would be an increase of 12 exceedance events, of which some are likely to relate to non-mining activities in the area or humidity effects as has been found with the consent limit exceedances.

The TSP concentrations presented in the Dust GPG are trigger values and are not intended to be compliance limits. The GPG states *"These triggers are intended to be used for the proactive management of dust on site. They are not intended to be used for enforcement because exceedance of trigger levels does not necessarily infer an adverse effect offsite."* As discussed above, the current dust management practices are complying well with consent limits and also maintain low occurrences of exceedances of the TSP trigger level of80 μg/m³. Therefore, whilst it is not necessary to suggest a compliance limit related to the Dust GPG trigger values, having this trigger limit will mean the site will operate in keeping with good practice in so far as managing potential mining related exceedances.

Table 2. DG15 TSP monitoring, triggers above 120 μg/m³ 2022-2023

Date	DG15 TSP (μg/m³) 24 hour average	Humidity (%RH)	Reason for exceedance
15/01/2022	142.4	92.9	Non mining activity source.
29/08/2022	214.9	100.0	Non mining activity source.
10/09/2022	146.6	100.0	Meteorological conditions and mining operations at the time of the exceedance were reviewed and it was determined that mine activities were not the cause of the exceedance.
22/09/2022	132.5	100.0	Meteorological conditions and mining operations at the time of the exceedance were reviewed and it was determined that mine activities were not the cause of the exceedance.
3/09/2023	145.5	97.33	The exceedance was deemed to be not mine related, as the wind was blowing towards the mine during that day.
22/12/2023	133.4	93.26	A review was undertaken, and the exceedance was deemed to be not mine related, as the wind was blowing towards the mine during that day. Extremely dry summer conditions have resulted in large quantities of dust from local farmland becoming suspended.

Table 3. DG15 TSP monitoring, triggers above 80 µg/m^3

Full date	DG15 TSP (µg/m³) 24 hour average	Humidity(%RH)
15/01/2022	142.4	92.9
25/01/2022	92.2	92.8
26/01/2022	100.0	86.8
28/03/2022	108.7	72.8
25/07/2022	106.4	45.5
18/08/2022	88.9	71.1
29/08/2022	214.9	100.0
10/09/2022	146.6	100.0
11/09/2022	113.4	100.0
22/09/2022	132.5	100.0
20/04/2023	84.7	97.37
9/07/2023	86.7	94.86
2/09/2023	94.8	92.39
3/09/2023	145.5	97.33
20/10/2023	101.8	89.62
14/11/2023	88.4	73.44
22/12/2023	133.4	93.26
23/12/2023	82.9	98.24

Monitoring at DG07 and DG11

Q3.4 *Is ongoing real-time TSP or PM_{10} monitoring proposed at sites DG07 and DG11 (or other locations nearby sensitive receptors), with trigger levels set to assist proactive dust management?*

Response: As noted above in Table 1, TSP monitoring at DG07 is required as part of consent RM20.024.12 and this will continue for the MP4 Project application currently under consideration. The site changes subject to this application are not expected to increase activity in the vicinity of the DG07 monitor besides some more truck traffic along the current haul route that will service the Coronation Pit.

As discussed above, the DG11 monitoring site has been decommissioned as provided for by consent RM10.351.52.V3. No additional monitoring sites are proposed as the TSP sites at DC15 and DG07 provide adequate coverage for the proposed MP4 mine areas and are suitably located in the vicinity of the nearby occupied residences in Macraes Village (DG15) and at the private residence at Horse Flat Road (DG07).

Haul road dust effects

Q3.5 *Receptors R1/R9 and R5 are potentially affected by dust emissions from haul roads at times. The past complaints originating from R5 suggest that such effects can extend over 1 km from the source. The haul road beside Innes Mills is described as 2 km long with approximately 192 truck movements per day at up to 60 km/h speed.*

(a) *Are any specific mitigation measures proposed to control dust emissions from this source and also from the haul road east of R5?*

Response: The application for the additional areas to be mined, on either side of the Innes Mills Pit in the central mining area to the east of Macraes village and other areas, will not change the mining operation and dust controls employed on the haul roads in the vicinity of R1 and R5 (Horse Flat Road), as authorised under the consents above.

Three complaints (listed in Table 7-7 of Beca's AEE) related to Coronation haul road (R5) between 2018 - 2019. Weather conditions played a part in two of the complaints. None of these complaints have related to the haul road near receptors R1 and R9 near Frasers Pit. The corrective actions undertaken for Coronation haul road indicate that provided water trucks are routinely watering the road as per the Dust Management Plan, dust is effectively controlled.

The dust controls currently applied in line with the site Dust Management Plan will continue to be utilised. These controls focus on appropriate watering and maintaining the road surface, and keeping road speeds below 60 km/hr.

(b) *Are short-term PM_{10}/TSP triggers proposed (e.g. 150 μg/m^3 (1 hr) PM_{10} or 250 μg/m^3 (5 min) TSP as noted in the GPG Dust) with monitoring to determine that such mitigation is effective?*

Response: There are already monitoring triggers in place at DG07 under RM20.024.12 as shown in Table 1. These monitoring triggers are considered appropriate and will continue to be employed for the MP4 Project. It is accepted that applying a short-term trigger limit at DG15 will mean that the site will operate in keeping with good practice as per the GPG Dust. Accordingly, OGL would accept a short-term trigger limit at DG15 which reflects what is in place at DG07, subject to the trigger level being practicable to manage, and the triggered response being appropriate. OGL intends to submit amended conditions that volunteer a short-term trigger limit at DG15 and prescribe an appropriate management response.

Sensitive receptors

Q3.6 *Have tenanted dwellings on OGL owned land been included in the analysis of sensitive receptors? If they have not been included, please update the analysis to include these residential dwellings as sensitive receptors or provide justification for why they have not been included. Please also clarify whether receptor R9 (1668 Macraes Road) is owned by OGL?*

- Note: Occupiers of residential dwellings are also considered to be sensitive receptors.

Response: As the effects of an activity are assessed at the boundary of the site, the receptors within the boundary of the site are not considered sensitive receptors.

Outside the site boundary, sites which are not owned by OGL are interspersed with those that are owned by OGL and therefore the assessment covers all the properties within the Macraes Village i.e. a dwelling-by-dwelling assessment is not warranted. The residential tenancy agreements with properties owned by OGNZL provide that tenants have accepted noise, vibration and other effects that OGNZL's mining activities may have on the tenant and the rented property.

The property shown as receptor R9 is on land owned by OGL and is a shed not a house and therefore R1 is the closest actual dwelling (which is actually 1668 Macraes Road rather than the previously reported 1700 Macraes Road). The property details in this area have been reviewed in detail with Waitaki District Council.

Equipment use

Q3.7 *The Beca AEE states that not more than 19 trucks will be used from 2024, but Table 2-2 shows greater truck numbers. Please clarify? Question 3.8 queries the limited use of the electrical excavator.*

Response: The reason for equipment numbers changing over time is the numbers presented in the table are actually a schedule of trucks per hour i.e. the trucking rate, not individual truck numbers. The trucking rate was the basis for assessing air quality effects.

To clarify further, the trucking rates are presented in annual steps. In general terms, to meet the production schedule over the course of a year, mobile mining equipment will be moved between locations. As a result, there appears to be an excess of trucks at times. Typically, the dust assessment considers the maximum trucking numbers at vulnerable locations along the haulage routes between the pit and waste destination.

For the MP4 production schedule, the electric shovel is planned to be used till 2027, but this may change. Deployment of this shovel was delayed due to commissioning problems associated with electricity supply. Shovels and excavators are essentially static machines and the dust generated from operating them is minimal.

IAQM Assessment

Q3.9 *The IAQM assessment describes the Dust Pathway Effectiveness in relation to R1/R9 as "ineffective". Have cumulative effects with emissions from other OGL sources been taken into account, including from areas that would affect the receptors under different wind directions (such as the Innes Mills haul road, Frasers pit/WRS)?*

Response: All the sites are considered to have an "ineffective" dust pathway for the reasons provided in Section 7.8 of the Beca's AEE. All the dust sources are greater than 400 m from the receptors and winds above 5 m/s are infrequent. The part of the proposed activity that is near Macraes village relates to the extension of Innes Mills Pit toward the village (IM Stage 9) and this has a separation distance of approximately 1 km from the closest receptor (R1).

Road Names

"*Note: addresses for some sensitive receptors seem to be incorrect. For example, receptors R1, R9, A, and R6 are described as being on Macraes-Dunback Road. This road does not exist. These receptors are located on Macraes Road."*

Response: The information provided by OGL to Beca, as part of the potential road realignment, referred to the road as "Macraes-Dunback Road". This is now an anachronism – it is agreed its formal name is 'Macraes Road'.

Dust Management Plan

Q 3.10 *It appears that the Dust Management Plan (DMP) attached to the Beca AEE has not been updated for some time. For example, the required TSP monitoring at the DG07 and DG11 sites is not included. Will a current, updated DMP be provided for consideration as part of this application? If not, please provide justification for this.*

Response: The updated Dust Management Plan is attached.

Yours sincerely

Rhys Kevern

Rhys Kevern

Associate - Air Quality Engineer

on behalf of

Beca Limited

Phone Number: +64 93080878
Email: Rhys.Kevern@beca.com

Sensitivity: General

Oceana Macraes - Ambient Air Monitoring Report for 2022

Consent Compliance

Prepared for OceanaGold New Zealand Limited
Prepared by Beca Limited

7 June 2023

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Contents

Appendices

Revision History

Revision Nº	Prepared By	Description	Date
1	Rhys Kevern and Suzanne Cawood	Draft for Client review	16 May 2023
2	Rhys Kevern	Final	7 June 2023

Document Acceptance

Action	Name	Signed	Date
Prepared by	Rhys Kevern	Rhys Kevern	7 June 2023
Reviewed by	Mathew Noonan	M Noonan	7 June 2023
Approved by			7 June 2023
on behalf of	Beca Limited		

Executive summary

Background

OGNZL currently holds air discharge permits associated with different aspects of the Macraes Gold Project site. Some of these conditions require ambient monitoring to be undertaken, as well as an external review of the monitoring results.

The following monitoring is currently undertaken around the mine sites as required by OGNZL air discharge consent numbers 96785_V5, RM10.351.52.V1, RM12.378.15, RM16.138.19 and RM20.24.12:

- Dust deposition rates at monthly intervals at 16 sites,
- Real time total suspended particulate (**TSP**) concentrations at Sites DG07 Horse Flat Road and DG11 Macraes Road (short term programme) and DG15 Macraes Township (ongoing),
- Continuous meteorological monitoring at two representative locations (i.e. Sites DG03 mixed tailings dam/offices and DG15),
- Daily record kept of water used for dust suppression.

Results

Data Capture

Meteorological monitoring at DG03 for 2022 captured data for 100% of the time except for 6 m temperature in winter which achieved 77%. At DG15 the data capture rate ranged between 99.8 and 100%.

The TSP monitoring for 2022 data capture was quite low at DG07, ranging from 36 – 100% capture with an annual average of 71.25%. The TSP monitoring data capture at DG11 ranged from 76% to 100%. At DG15 the data capture rate ranged between 84 and 100%.

Windspeed and Direction

The DG03 windrose shows that winds experienced are predominantly from the east-northeast and west-southwest directions. The strongest winds come from the west-southwest direction. However, the DG15 windrose shows that the winds experienced at DG15 are predominantly east, northwest and southwest direction. The strongest winds come from the southwest direction.

Temperature and Solar Radiation

Temperature and solar radiation were on average lowest in winter months (June – August) and highest during the summer months (December, January, and February). The temperatures measured at DG03 (at a mast height of 1.5 m) and DG15 are similar, however the air temperatures at DG15 (-6.9ºC – 28.5ºC) throughout 2022 are on average 3.5ºC cooler than the temperatures measured at DG03 (-3.9ºC – 28.8ºC) at 1.5 m.

Humidity

Humidity at DG03 ranged from 18% to 100% with an annual average of 79.4% for 2022.

Rainfall

Approximately 30% of the annual rainfall recorded at DG03 fell in July, with a total rainfall of 184.6 mm for the month. A similar trend was observed at the neighbouring monitoring station DG15, with 144.6 mm measured over the month (28% of the total annual rainfall). The driest month measured at DG03 for 2022 was in June, with only 6.2 mm rain measured for the month. While at DG15, May was the driest month with 16.4 mm of rain measured.

Deposited Dust

There was one dust deposition exceedance at DG15 in January 2022 for background A and B related to bird droppings, and one exceedance at DG21 in December 2022 for background B related to the presence of lots of flies. High deposition rates were measured at DG03 as the site is beside the OGNZL gravel road entrance to their offices and the unsealed Golden Point Road.

TSP

The maximum TSP 1-hour average concentration at DG07 for 2022 was 1528.4 μg/m^3. There were a total of 102 exceedances of the 250 μg/m^3 1-hour average consent limit throughout the year. The maximum 24-hour average concentration at DG07 for 2022 was 317.7 μg/m^3, while the annual average 24-hour concentration for 2022 was 20.7 μg/m^3. There were 14 exceedances of the 24-hour consent limit, the majority recorded in March.

The maximum TSP 1-hour average concentration measured at DG11 for 2022 was 1318.0 μg/m^3. There were a total of 103 exceedances of the 250 μg/m^3 consent limit through the year, with most of these exceedances occurring in the first three months of the year. The maximum 24-hour average concentration at DG11 was 235.2 μg/m^3. There were a total of 14 exceedances of the 24-hour consent limit (of 80 μg/m^3).

Table F-1 and F-2 in **Appendix F** present the exceedances of the hourly consent limit recorded for DG07 and DG11 alongside the hourly relative humidity measurements at DG03. For all but two of the exceedances, the relative humidity measured at the monitoring station was 99% or above. The correlation between a TSP exceedance and the relative humidity would suggest that during these periods the instrument was reporting water aerosol (fog) concentrations, rather than dust from mining activities.

There is no 1-hour TSP consent limit in any of the resource consents regarding DG15. The results show the annual 1-hour average TSP concentration for 2022 was 13 μg/m^3, however the maximum 1-hour average TSP concentration was 720.3 μg/m^3. The results indicate that, in the winter months (June – August), the TSP measurements decreased, which would coincide with higher rainfall during this period.

Ongoing TSP Monitoring at DG07 and DG11

Condition 5(e) of consent RM20.24.12 allows for review of the need for ongoing monitoring at DG07. Similarly, condition 6(a)(e) of consent RM10.351.52.V1 allows for review of the need for ongoing monitoring at DG11. In both cases, the total suspended particulate monitoring may be amended or suspended if such agreement is provided in writing by the Consent Authority.

The TSP monitor at DG07 had a reasonably low data collection rate and therefore, did not provide a full set of monitoring data over the year. Generally, the dust emissions are low as shown by the monthly average 24-hour average results. This site is in a separate valley to DG11 and DG15 and therefore provides monitoring data representative of that separate location. It is recommended this site continues to assist in the monitoring and management of mine dust in that area. In addition, a local meteorological station should be installed at DG07 to allow for determination of windy conditions (>5 m/s) to aid in dust management in that valley.

The TSP monitor at DG11 is located close to DG15 (843 m away WSW - see Figure 7-1), and therefore the monitoring results are similar as shown in Figure 6-1. It is recommended that DG11 is decommissioned as DG15 is representative of the TSP concentrations in the Macraes area.

Observations

- The standard anemometer height is 10 m above ground level rather than the 6 m masts installed at the OGNZL site

- The temperature monitors at two heights at DG03 have the same accuracy but are not the same model, the 1.75 m temperature probe is a combined humidity and temperature probe.
- The anemometer at DG03 is currently aligned to magnetic north rather than true north. Any new meteorological installations should be aligned to true north. To maintain the integrity of the wind direction data at site DG03 with historic data the current monitoring configuration should be maintained however the data that is reported should include the recorded results and the wind direction corrected to true north.
- Watercare's averaging of site recorded 10-minute data to produce hourly averages has used linear averaging rather than vector averaging, which is incorrect. Section 2.8.4.4 of AS/NZS 3580.14:2014 states that vector averaging is the preferred method of averaging data. Section 2.8.2 of the USEPA Quality Assurance Handbook recommends a unit-vector algorithm should be used for calculating scalar wind speed and wind direction.
- Several of the results sheets (6 sites) note that the gauges have bird droppings in them. Bird repellent paste should be used or add spikes to the ring to reduce this effect. In addition, there were several occasions (twice on DG07 and DG17) where the dust gauge on Horse Flat Road DG07 was not accessible for changeover. Arrangements need to be made to ensure OGNZL has ongoing access to the monitoring site.
- Condition 5d of consent RM20.24.12 requires meteorological monitoring to be undertaken at Horse Flat Road (DG07) but this monitoring has not occurred.

Conclusion

Dust is being managed effectively as:

- All but three of the dust deposition results were lower than the consent limit of 3 g/m^2/30 days. The deposition rate for January (background A) was 3.7 g/m^2/30 days, January (background B) was 3.4 g/m^2/30 days and December (background B) was 3.2 g/m^2/30 days.
- Although several TSP exceedances were recorded at each of the monitoring sites DG07, DG11 and DG15, nearly all of them can be attributed to the monitoring instrument being affected by fog during high relative humidity conditions.
- The monthly average of 24-hourly average TSP ranges from 6.8 - 40.9 µg/m^3 for DG07, 10 – 41.1 µg/m^3 for DG11 and 2.1 – 23.1 µg/m^3 for DG15, indicating that for much of the time TSP concentrations are low compared to the consent limit.

1 Introduction

1.1 Overview

Oceana Gold (New Zealand) Limited (**OGNZL**) operates a large open cast and underground gold mine in Otago, northwest of Palmerston and northeast of Middlemarch. The predominant discharge to air from the mining activity is dust (or particulate matter), from the handling and transportation of waste rock and ore.

OGNZL currently holds air discharge permits associated with different aspects of the Macraes Gold Project site as listed in Table 1-1. Some of these conditions require ambient monitoring to be undertaken, as well as an external review of the monitoring results.

Table 1-1. Existing air discharge consents currently held by OGNZL.

Consent Number	Details
Discharge Permit 96785_V5	To discharge contaminants from mining operations and post-mining rehabilitation to air in the vicinity of Macraes Flat (all of the mine site except features associated with Macraes Phase III and Coronation).
Discharge Permit 2006.689	To discharge contaminants to air for the purpose of ventilating Frasers Underground Mine.
Discharge Permit 2007.511	To discharge contaminants to air for the purpose of carrying out mining activities and post mining rehabilitation (Golden Bar Pit, Rock Stack, Silt Ponds and Infrastructure).
Discharge Permit RM10.351.52.V1	To discharge contaminants from mining operations and post mining rehabilitation to air for the purpose of undertaking mining operations (Macraes Phase III expansion and Frasers West).
Discharge Permit RM12.378.15	To discharge contaminants from mining operations and post-mining rehabilitation to air for the purpose of undertaking mining operations (Coronation Waste Rock Stack, Coronation Pit and associated haul roads, utility areas and stockpiles).
Discharge Permit RM16.138.19.V1	To discharge contaminants from mining operations and post-mining rehabilitation to air for the purpose of undertaking mining operations (Coronation North).
Discharge Permit RM20.024.12	To discharge contaminants from mining operations and post-mining rehabilitation to air for the purpose of undertaking mining operations (Deepdell North Stage III).
Discharge Permit RM20.130.01	To discharge contaminants to air for the purpose of ventilating the Golden Point Underground Mine (Golden Point Underground Mine – Macraes).

1.2 Monitoring Overview

The following monitoring is currently undertaken around the mine sites as shown in Figure 1-1 as required by OGNZL air discharge consent numbers 96785_V5, RM10.351.52.V1, RM12.378.15, RM16.138.19.V1 and RM20.24.12:

- Dust deposition rates at monthly intervals at 16 sites,
- Real time total suspended particulate (**TSP**) concentrations at Sites DG07 Horse Flat Road and DG11 Macraes Road (short term programme) and DG15 Macraes Township (ongoing),
- Continuous meteorological monitoring at two representative locations (i.e. Sites DG03 mixed tailings dam/offices and DG15),

- Daily record kept of water used for dust suppression.

All of the consents mentioned above include essentially the same condition which requires an annual review of dust and meteorological monitoring results.

Figure 1-1. Site mining locations

1.3 Purpose of This Report

Beca has been commissioned to provide an assessment of the ambient air monitoring results against the conditions of all five consents based on information provided by OGNZL. A summary of the relevant conditions of each of these consents that require monitoring is provided in **Appendix A.** The general text of the consent conditions which relate to the preparation of the annual monitoring review report is provided in Section 1.4.

This report also considers whether the additional TSP monitoring could be suspended at Site 11 under RM10.351.52.V1 condition 6(e) and for the Deepdell air discharges at Site 7 under RM20.024.12 condition 5(e), following review of at least 12 months of monitoring data.

The review of specific monitoring results is as follows:

- Analysis of insoluble deposited dust monitoring results from OGNZL for all monitoring sites for 2022, calculation of background dust deposition rates and comparison of the results with consent limits.
- Analysis of continuous nephelometer TSP monitoring data collected by Watercare during 2022 and comparison of the results with consent limits.
- Analysis of continuous meteorological data (wind speed, wind direction temperature and humidity) collected by Watercare at two sites during 2022.
- Review of information from OGNZL on mining activities during 2022 as they related to the emissions to air and ambient air quality levels outside of the site boundary.
- Review the quality of the monitoring data and the adequacy of the ambient monitoring programme and describe any improvements that are recommended.
- Review the adequacy of the dust mitigation measures used by OGNZL and describe any changes that are recommended.
- Recommend any changes to the monitoring conditions that might be necessary.

1.4 Summary of Consent Conditions

A summary of the resource consent conditions[1] as they relate to the preparation of an annual air quality monitoring report are as follows:

An independent consultant, engaged by the Consent Holder in consultation with the Consent Authority, shall [must] undertake an annual review and assessment of all dust monitoring data. The reviewer's report shall [must] include:

(a) The name, qualifications, and experience of the reviewer;

(b) The methods used and the investigations undertaken for the review;

(c) Interpretation of the monitoring data reviewed;

(d) An assessment of the quality of the monitoring data;

(e) An assessment of the monitoring regime;

(f) A description and evaluation of each of the dust mitigation measures used by the consent holder;

(g) Recommendations on whether:

> *i) The monitoring of dust is adequate or should be changed, and if changed the changes that are recommended;*

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[1] Consent numbers 96785_V5 (Cnd 17), RM10.351.52.V1 (Cnd 18), RM12.378.15 (Cnd 16), RM16.138.19.V1 (Cnd 16) and RM20.24.12 (Cnd 18)

ii) The dust mitigation measures used by the consent holder are adequate, or should be changed, and the changes that are recommended; and

iii) Any changes should be made to the conditions of this consent; and

(h) Any other matters that the reviewer considers should be drawn to the attention of the consent holder or the Consent Authority.

The Annual report shall be provided to the consent authority by 30 April each year.

1.5 Reviewers Qualifications

A summary of the reviewer's qualifications is included in **Appendix B**.

1.6 Limitations

This report has been prepared by Beca for OGNZL. Beca has relied upon the information provided by OGNZL in completing this document. Unless otherwise stated, Beca has not sought to independently verify this information as provided. This report is therefore based upon the accuracy and completeness of the information provided and Beca cannot be held responsible for any misrepresentations, incompleteness, or inaccuracies provided within that information. Should any new or additional information become available, this report will need to be reviewed accordingly.

2 Review and Analysis of Methodology

Beca has undertaken a review of the monitoring data using the following methods:

- Auditing of the data supplied by OGNZL for gaps in the data and anomalous results,
- Statistically analysing the ambient air quality and meteorological data to produce monthly, quarterly and annual values including windroses, and
- Comparing deposited dust and total suspended particulate (**TSP**) concentration data against consent limits.

Unit vector averaging of wind direction and scalar averaging of wind speed has been used to produce summary data in comparison to the linear averaging undertaken in the data provided by Watercare. The wind directions of site DG03 near the mixed tailings dam, for the last five years of data, have been corrected from magnetic north to true north by subtraction of 25º.

In instances when the recorded monthly dust deposition at the background deposition gauge rate was higher than the deposition rate recorded at the monitoring site, the difference between deposition rate (i.e. the deposition rate above background levels) has been reported as a nominal value of 0 g/m^2/30 days.

3 Site Monitoring

3.1 Monitoring Operations

Watercare Laboratory Services Limited (Watercare) carries out the meteorological and continuous TSP monitoring (on behalf of OGNZL), and OGNZL carries out the deposited dust monitoring. Scott Technical Instruments calibrates and maintains both meteorological sites. A full description of the climate, dust deposition and TSP stations is included in the quarterly monitoring reports prepared by Watercare Laboratory Services (Watercare Reports). Copies of these reports are included in **Appendix C.** The details of the monitoring instruments and comparison with the Ministry for the Environment *Good Practice Guide for Monitoring and Data* 2009 (GPG monitoring) requirements is provided in **Appendix D**.

3.2 OGNZL Air Quality Monitoring Programme

OGNZL currently operates 2 meteorological monitoring stations, 16 dust deposition stations and 3 continuous TSP monitoring stations. Table 3-1 provides a summary of the monitoring sites, and the locations of the sites are shown in Figure 3-1.

Table 3-1. Summary of Macraes Mine monitoring programme.

Site Num	Location of Monitor	Monitor Purpose	Parameters Recorded	Limit
DG02	Back of Macraes	Consent compliance 96785_V5, RM16.138.19.V1 and RM12.378.15. RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17	≤3 g/m²/30 days above background
DG03	South of Mixed Tailings Dam beside a gravel section of Golden Point Road	Meteorological Monitoring	The consent requires monitoring of wind speed, wind direction, air temperature at 2 heights, rainfall and solar radiation. Relative humidity is also monitored. Dust deposition is monitored in addition to consent requirements	-
DG07	Howard's farm	Consent compliance 96785_V5, RM20.24.12, RM16.138.19.V1 and RM12.378.15 RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17 TSP	≤3 g/m²/30 days above background except for twice per year. 80 µg/m³ 24hr average, 250 µg/m³ 1hr average
DG09	Control 7 km ex H/W 85	Background levels – control site for DG02, DG07, DG15, DG20, DG21	Dust deposition	-

Site Num	Location of Monitor	Monitor Purpose	Parameters Recorded	Limit
DG10	Control 3.25 km ex Macraes	Background levels – control site for DG02, DG07, DG15, DG20, DG21	Dust deposition	-
DG11	Expansion drilling site, across from 1,700 Macraes Rd	Consent compliance for consent RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG17. TSP	≤3 g/m^2/30 days above background except for twice per year. 80 µg/m^3 24hr average, 250 µg/m^3 1hr average
DG13	Red Bank Rd	Non Consent Monitoring	Dust deposition	-
DG15	Behind 1757 Macraes - Dunback Road, Macraes across from Stanley's Hotel	Consent compliance 96785_V5, RM16.138.19.V1 and RM12.378.15 RM10.351.52.V1	Wind speed, wind direction, temperature and rainfall. Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17. TSP	≤3 g/m^2/30 days above background 120 µg/m^3 24hr average, no limit 1 hourly
DG17	Horse Flat Rd	Consent compliance RM20.24.12 Background levels – control site for DG02, DG07, DG11, DG15, DG20 and DG21	Dust deposition above average of DG09, DG10 and DG24.	≤3 g/m^2/30 days above background except for twice per year
DG18	North of Top Tipperary Tailings Storage Facility	Non Consent Monitoring	Dust deposition	-
DG19	East of Top Tipperary Tailings Storage Facility	Non Consent Monitoring	Dust deposition	-
DG20	East of Frasers East Rock Stack	Consent compliance 96785_V5, RM16.138.19.V1 and RM12.378.15 RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17.	≤3 g/m^2/30 days above background except for twice per year

Site Num	Location of Monitor	Monitor Purpose	Parameters Recorded	Limit
DG21	East of Frasers South Rock Stack	Consent compliance, 96785_V5, RM16.138.19.V1, RM12.378.15 except for RM20.24.12 RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17.	≤3 $g/m^2/30$ days above background except for twice per year
DG22	North of Coronation	Consent compliance RM12.378.15 and RM16.138.19.V1	Dust deposition above average of DG09, DG10 and DG24.	≤3 $g/m^2/30$ days above background except for twice per year
DG24	East of Coronation	Background levels-control site for DG02, DG07, DG15, DG17 DG20, DG21, DG22, DG25	Dust deposition.	-
DG25	North of Coronation North Pit	Consent compliance RM16.138.19 (installed in April 2017 to replace DG23 - RM12.378.15)	Dust deposition above average of DG09, DG10 and DG24.	≤3 $g/m^2/30$ days above background except for twice per year

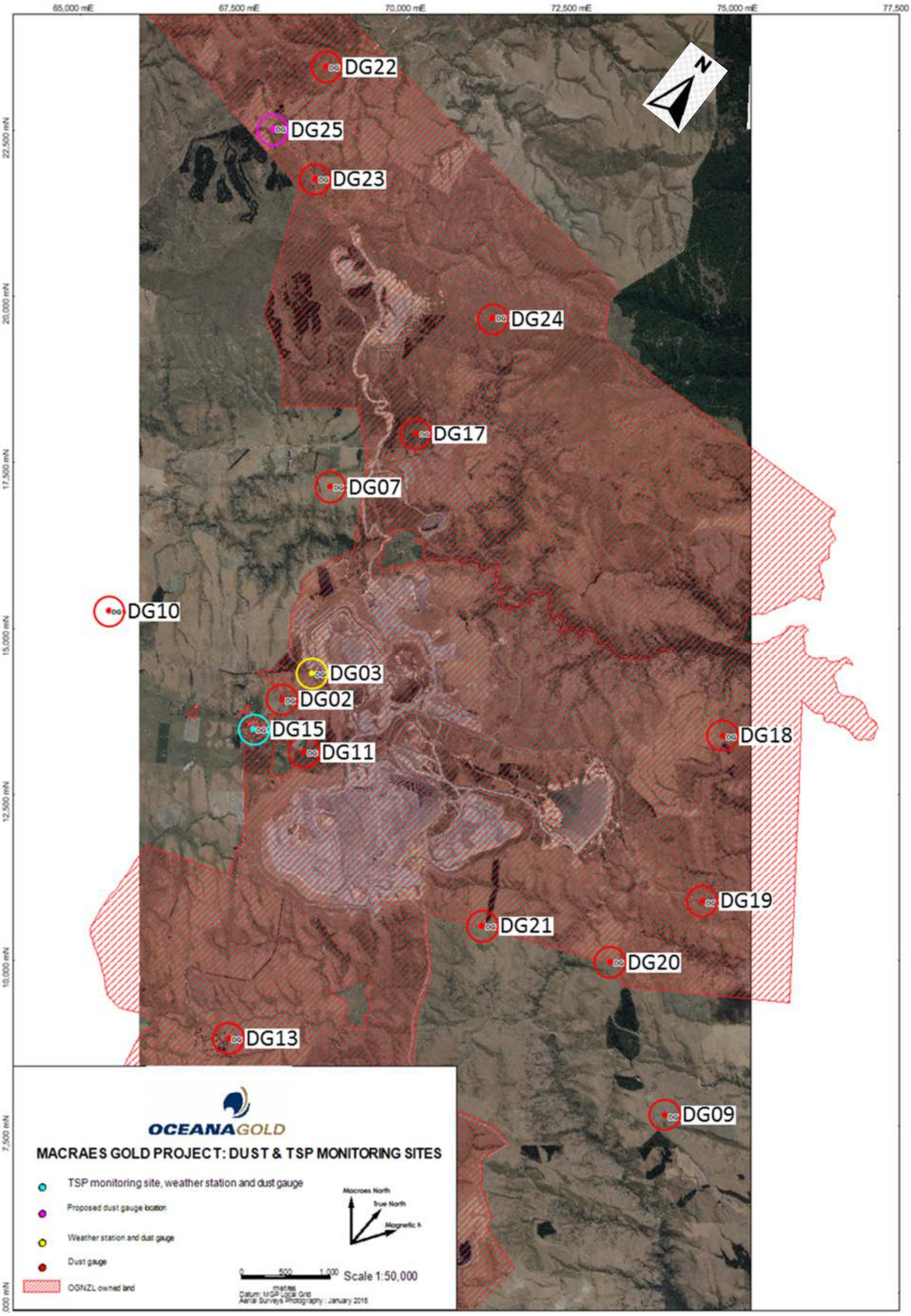

Figure 3-1. Locations of OGNZL meteorological stations, deposited dust and TSP monitoring.

3.3 Meteorology

3.3.1 Site DG03 Mixed Tailings Dam

Meteorological parameters recorded over the annual period from 1 January 2022 to 31 December 2022 at Site DG03 are:

- wind direction at 6 m above ground level,
- wind speed at 6 m above ground level,
- rainfall at ground level,
- temperature at 1.75 m and 6.0 m above ground level,
- solar radiation at 1.75 m, and
- relative humidity at 6.0 m.

3.3.2 Site DG15 Macraes Village

Meteorological parameters recorded over the annual period from 1 January 2022 to 31 December 2022 at Site DG15 are:

- wind direction at 6 m above ground level,
- wind speed at 6 m above ground level,
- rainfall at ground level,
- temperature at 6.0 m above ground level, and
- Total Suspended Particulate Matter.

The locations of the monitoring sites are shown in **Figure 3-1**.

3.4 Deposited Dust

Deposited dust is comprised of soluble and insoluble dust fractions. Soluble dust is only of interest downwind of sources that produce water-soluble emissions, such as milk powder from a dairy factory. For OGNZL, the only emissions of any significance are crustal dust particles, which are insoluble in rainwater, therefore only insoluble deposited particulate is discussed in this report.

Dust deposition rates are measured at the sites using dust gauges, as shown in Figure 3-2, in accordance with draft ISO Standard ISO/DIS 4222.2, *("Air Quality Measurement of Atmospheric Dustfall* – Horizontal *Deposit Gauge Method"* 1980). The monitoring is required by air discharge consent conditions in Consent 96785_V5, Consent RM10.351.52, Consent RM12.378.15, Consent RM16.138.19 and Consent RM20.024.12. The locations, purposes, relative background level and deposition limits of the monitoring sites are described in Table 3-2.

Figure 3-2. View of Frasers Pit West Waste Rock Store from Monitoring site DG11 (black dust deposition gauge) looking SE

3.5 TSP Monitoring

At the end of January 2013, OGNZL commissioned a new continuous TSP monitor at Site 15 (across from Stanleys Hotel in Macraes township) in accordance with Condition 12(a) of Consent RM10.351.52 and Condition 10(a) of Consent RM12.368.15. The monitor is a Met One E-Sampler-9800, which is a type of nephelometer. Nephelometers measure particulate matter using forward laser light scattering. The instrument is able to record, and output, real-time measurements of particulate data which allows measurements to be reported over a variety of averaging periods including 10-minute, 1-hour, and 24-hour. The accuracy of the instrument is +/-5% based on a traceable PSL 0.6 micron reference standard. The instrument has a particle size sensitivity of 0.1 to 100 microns with an optimal sensitivity of 0.5 to 10 micron particles.

Nephelometers of the type used at OceanaGold, are either calibrated by passing dust with known optical properties through the instrument and adjusting the response of the instrument or, by using an internal filter that allows for a gravimetric correction to be applied to the results.

Every instrument has an uncertainty associated with each measurement. Inadequate or faulty heating of the inlet air on some particulate monitors (most commonly seen on Beta Attenuation TSP Monitors (BAMs)) can allow moisture to affect the sample, giving rise to large positive spikes, normally followed by large negative spikes.

The monitors have heated inlets to reduce the effects of fog on measurements as fog also produces scattering of the laser light. Descriptions of the instrument and the monitoring method are included in the quarterly monitoring reports prepared by Watercare **(Appendix C)**.

In February 2021, in accordance with resource consent conditions for Frasers West (Consent RM10.351.52.V1) and Deepdell North Stage III (RM20.024.12), continuous total suspended particulate (TSP) monitoring commenced using nephelometers at two air quality monitoring stations: Horse Flat Road (at DG07) near the C and E Howard property and Macraes Road (at DG11). Thermo ADR-1500 Area Dust Monitors were installed by WaterCare Services Limited to monitor TSP at both locations.

Total suspended particulate concentrations at the Horse Flat (DG07) and Macraes Road sites (DG11) are continuously measured on a 10-minute average basis and reported as 1-hour and 24-hour averages. Results are compared against the consent limit of 250 ug/m^3 (1-hour average) and 80 ug/m^3 (24-hour average). If these levels are exceeded an alert message is sent to OGNZL staff, and a review of dust sources and dust control measures onsite must be undertaken. If the onsite activities are likely to have contributed to or caused an exceedance of the consent limits, then dust control management needs to be revised or additional measures implemented. If the consent limits are exceeded again within a 7-day period, and the exceedance is likely to have been caused by or contributed to by onsite activities, the dust control measures need to be continued and potentially be added to the dust management plan.

3.6 Comments on the Programme

3.6.1 Anemometer height

The standard anemometer height is 10 m above ground level rather than the 6 m masts installed at the OGNZL site. Section 2.6.1 of AS/NZS 3580.14:2014 states that it is generally considered that the appropriate wind speed and direction monitoring height should be 10 m above ground. Table 0.12 of USEPA Quality Assurance Handbook[2] states that 10 m above open terrain level is the standard monitoring height. Section 5.9.1 of the World Meteorological Organisation[3] states "*Wind speed increases considerably with height, particularly over rough terrain. For this reason, a standard height of 10 m above open terrain is specified for the exposure of wind instruments*.". The Ministry for the Environment Monitoring Good Practice Guide (Monitoring GPG[4]) states that the anemometer height should be between 6 and 10 m above ground level.

3.6.2 Temperature measurement

The Monitoring GPG recommends if a temperature vs height measurement is undertaken, it should be at 1.5 and 10 m, the upper height is only 6 m at the site DG03. The monitoring GPG also recommends both temperature sensors have an accuracy of 0.1ºC and are the same model. The temperature monitors have the same accuracy but are not the same model, the 1.75 m temperature probe is a combined humidity and temperature probe.

3.6.3 Wind direction

Sections 2.8.1 and 2.9.1 of AS/NZS 3580.14:2014 state wind direction should be referenced to true north, DG03 is currently aligned to magnetic north. Any new meteorological installations should be aligned to true north. To maintain the integrity of the wind direction data at site DG03 with historic data the current monitoring configuration should be maintained however the data that is reported should include the recorded results and the wind direction corrected to true north.

3.6.4 Wind averaging

Watercare's averaging of site recorded 10-minute data to produce hourly averages has used linear averaging rather than vector averaging, which is incorrect.

[2] EPA-454/B-08-002 **Quality Assurance Handbook for Air Pollution Measurement Systems** Volume IV: Meteorological Measurements Version 2.0 (Final) 2008

[3] Guide to Instruments and Methods of Observation Volume I –Measurement of Meteorological Variables, World Meteorological Organization, 2021

[4] Good Practice Guide for Air Quality Monitoring and Data Management 2009

Section 2.8.4.4 of AS/NZS 3580.14:2014 states that vector averaging is the preferred method of averaging data. Section 2.8.2 of the USEPA Quality Assurance Handbook recommends a unit-vector algorithm should be used for calculating scalar wind speed and wind direction.

Section 6.1 of Meteorological Monitoring Guidance[5] (which is referred to in AS/NZS3580.14) states that hourly averages can be calculated from shorter period averaged data. Section 6.2.2 of the document describes the vector averaging approach that was in AS2923:1987 which has been superseded by AS/NZS 3580.14:2014. A deviation to the vector method is the unit vector measurement which does not scale the vector components of the wind directions by the wind speed. The guidance comments that in general, the unit vector result will be comparable to the scalar average wind direction and may be used to model plume transport.

3.6.5 Deposition Monitoring Observations

Several of the results sheets (6 sites) note that the gauges have bird droppings in them. Bird repellent paste should be used or add spikes to the ring to reduce this effect. In addition, there were several occasions (twice on DG07 and DG17) where the dust gauge on Horse Flat Road DG07 was not accessible for changeover. Arrangements need to be made to ensure OGNZL has ongoing access to the monitoring site.

The consents incorrectly reference the dust deposition monitoring method draft ISO Standard ISO/SIS 4222.2. The correct reference is draft ISO Standard ISO/DIS 4222.2.

3.6.6 TSP Monitoring Observation

Condition 6(a)(d) of consent RM10.351.52.V1 requires that meteorological monitoring must be undertaken at the Macraes monitoring site (DG11). No additional monitoring has occurred, but the meteorological monitoring at DG15 is near the DG11 site and is suitable for comparison to this TSP monitoring.

Condition 5d of consent RM20.24.12 requires meteorological monitoring to be undertaken at Horse Flat Road (DG07) but this monitoring has not occurred. The meteorological monitoring sites at DG03 and DG15 are to the east of the Horse Flat Road valley and therefore, the correlation of wind direction to dust data may not be as accurate as if it was in the same location.

[5] Meteorological Monitoring Guidance for Regulatory Modelling Applications, EPA-454/R-99-005, 2000

4 Meteorological Monitoring Results

4.1 Meteorological Instrument Performance

4.1.1 Site DG03

Instrument performance at Site 3 was consistently high over the monitoring period as shown by the instrument performance record for the site reported by Watercare in **Table 4-1**.

Table 4-1. Site 3 instrument performance (percentage data capture) December 2021 – November 2022

Period	Wind Speed	Wind Direction	Ambient Temp (1.5 m)	Ambient Temp (6m)	Relative Humidity	Rainfall	Solar Radiation
Dec 21-Feb 22	100%	100%	100%	100%	100%	100%	100%
Mar-May 22	100%	100%	100%	100%	100%	100%	100%
Jun-Aug 22	100%	100%	100%	77%	100%	100%	100%
Sep-Nov 22	100%	100%	100%	100%	100%	100%	100%

4.1.2 Site DG015

Instrument performance reported by Watercare at Site 15 was consistently high over the 2022 monitoring period, as shown in **Table 4-2**.

Table 4-2. Site 15 instrument performance (percentage data capture) December 2021 – November 2022

Period	Wind Speed	Wind Direction	Ambient Temp	Rainfall	Continuous TSP (10-minute average)
Dec 21-Feb 22	100%	100%	100%	100%	84%
Mar-May 22	100%	100%	100%	100%	100%
Jun-Aug 22	99.8%	99.8%	100%	100%	100%
Sep-Nov 22	100%	100%	100%	100%	100%

4.2 Wind Speed and Direction

Figure 4-1 shows the distribution of hourly wind speeds and wind directions recorded at Sites DG03 and DG15 between 2018 and 2022. The DG03 windrose shows that winds experienced are predominantly from the east-northeast and west-southwest directions. The strongest winds come from the west-southwest direction. However, the DG15 windrose shows that the winds experienced at DG15 are predominantly east, northwest and southwest direction. The strongest winds come from the southwest direction.

Figure 4-2 shows the distribution of wind flows at monitoring sites DG03 and DG15 when wind speeds are greater than 5 m/s. Winds that exceed 5 m/s, which is the critical wind speed for the lifting of dust from unconsolidated surfaces, occur for approximately 25.8% of the time at DG03 and 15.8% of the time at DG15. At DG03, winds with speeds greater than 5 m/s are predominantly from the west-southwest (and occur for approximately 12.7% of the time) and south directions (and occur for approximately 7.1% of the time). At DG15, wind speeds greater than 5 m/s are predominantly from the southwest direction and occur approximately 6.8% of the time.

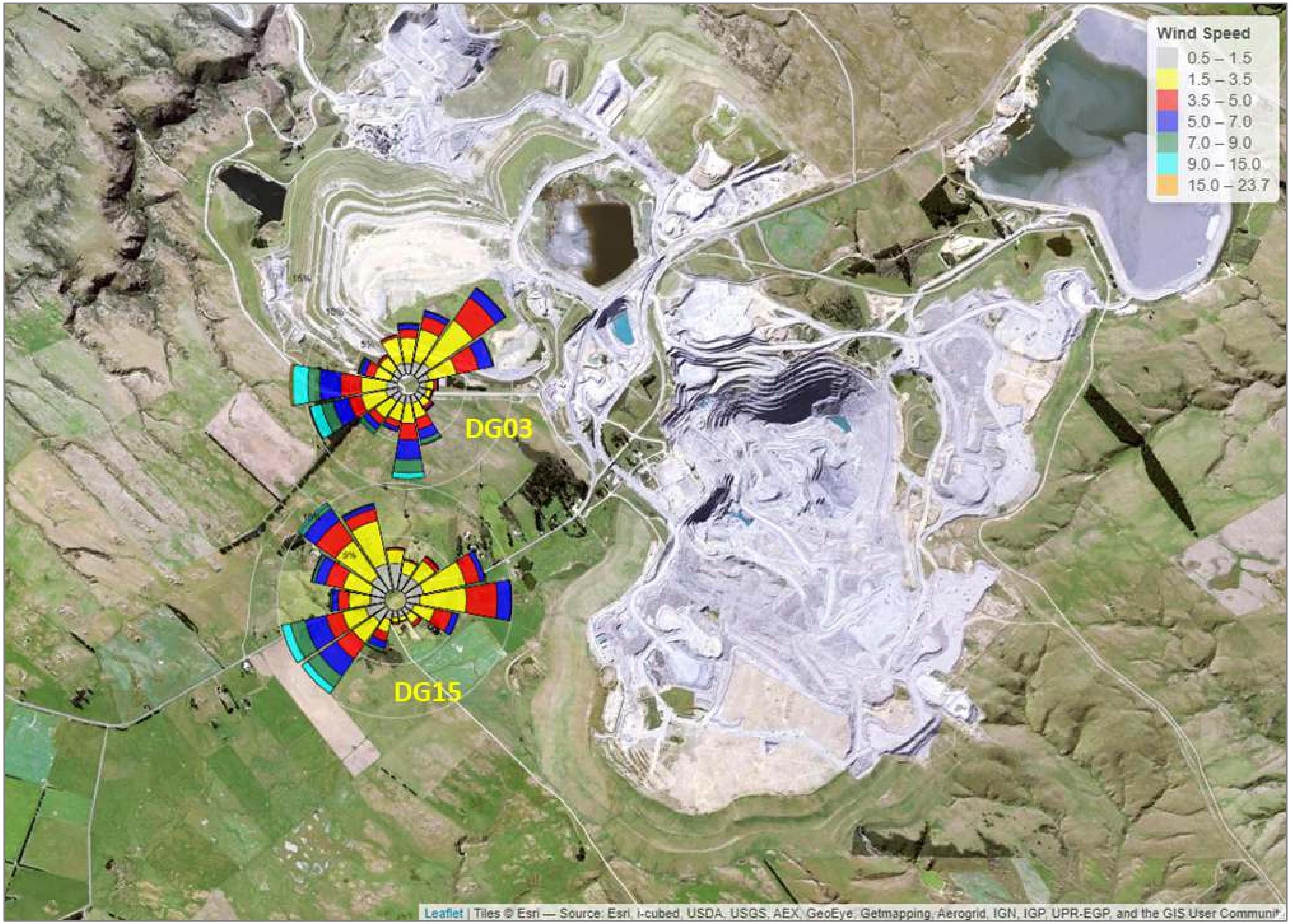

Figure 4-1. Site DG03 and DG15 annual windroses (hourly averages) from 1 January 2018 – 31 December 2022 (Met data provided by OGNZL)

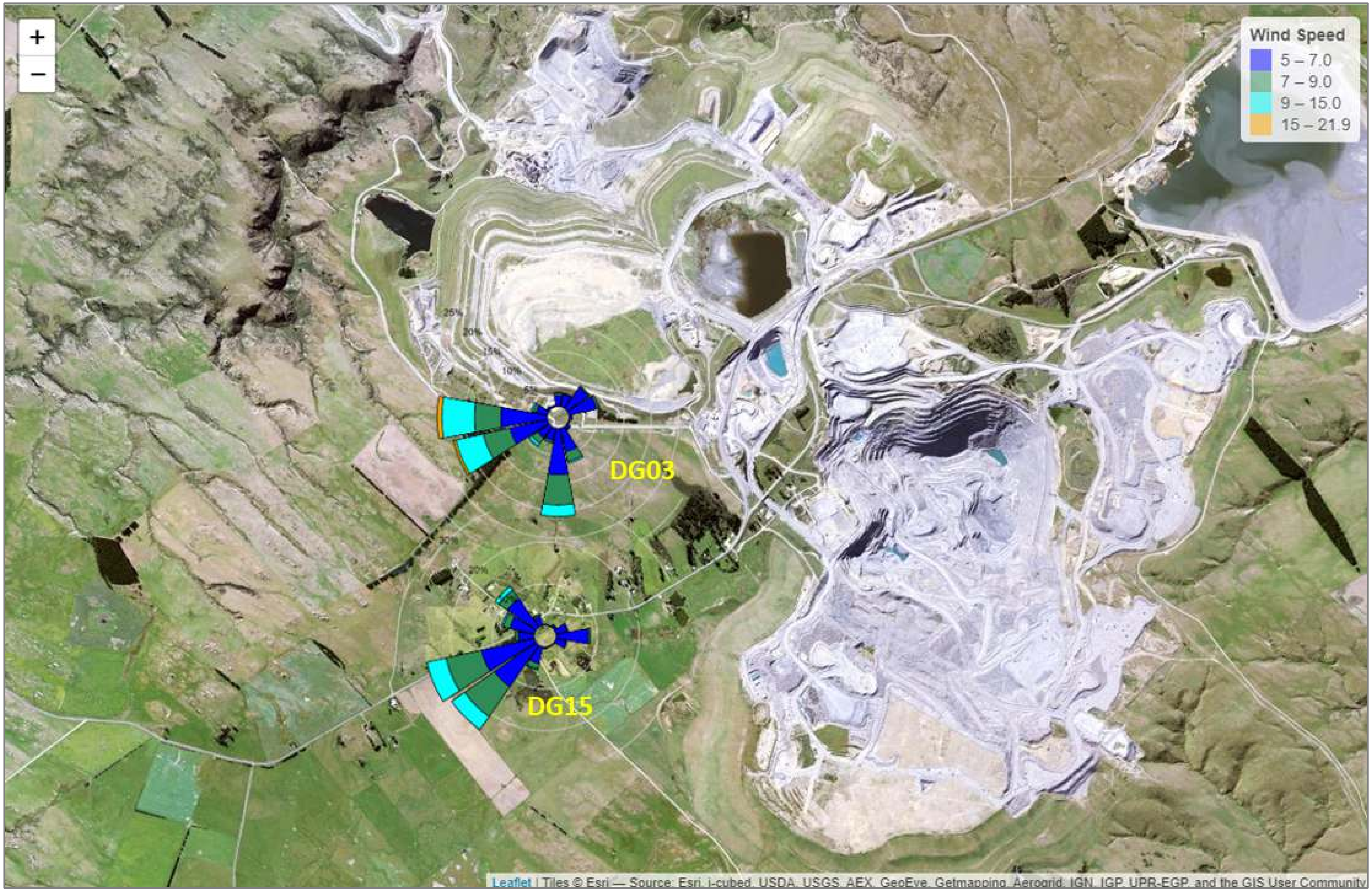

Figure 4-2. Site DG03 and DG15 annual windroses (hourly averages) of wind speeds >5m/s from 1 January 2018 – 31 December 2022 (Met data provided by OGNZL)

4.2.1 DG03 Wind Conditions for 2022

Figure 4-3 shows the distribution of hourly wind speeds and wind directions recorded at Site DG03 between 01 January 2022 and 31 December 2022. The windrose shows that winds are predominantly from the east-northeast and the west-southwest, similarly to the distribution shown in Figure 4-1.

The average hourly wind speed measured at the monitoring station for 2022 was 3.47 m/s and hourly wind speeds reached a maximum of 12.9 m/s. The average hourly wind speed measured at the station for 2022 was lower than that measured across the 2017 – 2022 period, at 3.77 m/s. Calm conditions (wind speeds <0.5 m/s) occurred for 0.1% of the time.

Similar wind direction patterns are also observed during the day and night, although average wind speeds tend to be higher during the day (average wind speed of 4.1 m/s compared to the night average wind speed of 2.8 m/s). Diurnal, quarterly and monthly windroses for DG03 are presented in **Appendix E.**

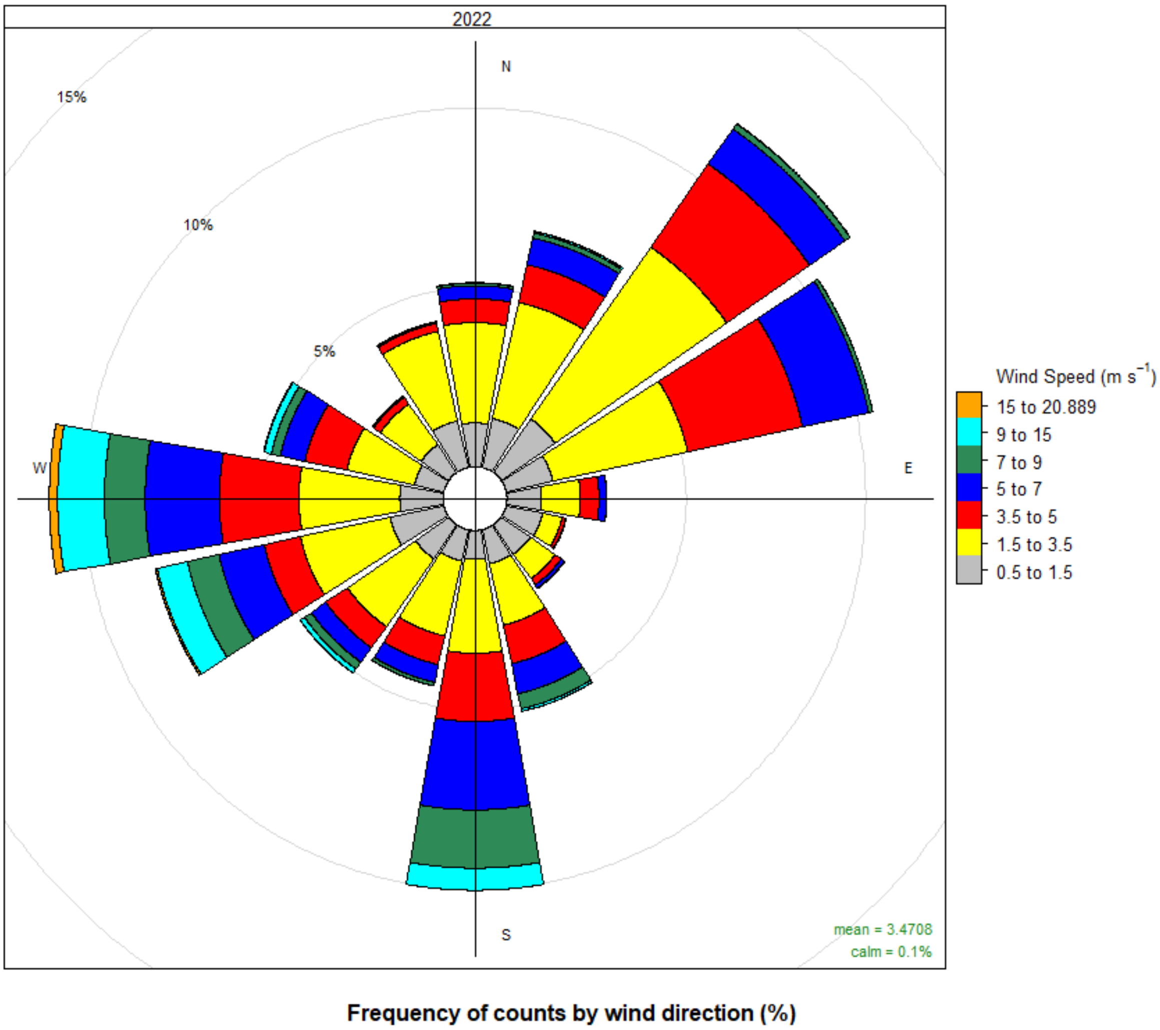

Figure 4-3. Site DG03 annual windrose (hourly averages) from 1 January 2022 – 31 December 2022 (Met data provided by OGNZL)

Table 4-3. Monthly summary of wind data for 2022 at DG03

Month	Maximum Hourly Wind Speed (m/s)	Average Hourly Wind Speed (m/s)	Predominant Wind Direction
January	11.4	3.3	ENE
February	10.5	3.1	NE
March	11.7	2.8	NE
April	15.2	3.2	S
May	15.2	3.3	W
June	15.1	3.7	W
July	19.2	4.1	SW - W
August	18.5	3.6	W
September	13.8	3.2	NE
October	15.7	4.1	NE
November	14.4	3.8	NE
December	10.6	3.4	ENE
Annual	**19.2**	**3.47**	**NE**

4.2.2 DG15 Wind Conditions for 2022

Figure 4-4 shows the distribution of hourly wind speeds and wind directions recorded at Site DG15 between 01 January 2022 and 31 December 2022. The windrose shows that winds are predominantly from the east and west-southwest directions. The strongest winds come from the southwest direction.

The average hourly wind speed measured at the monitoring station for 2022 was 2.8 m/s and the maximum hourly wind speed recorded was 12.9 m/s. The average hourly wind speed measured at the station for 2022 of 2.88 m/s was slightly lower than that measured across the 2017 – 2022 period. Calm conditions (wind speeds <0.5 m/s) occurred for 0.2% of the time.

Similar wind direction patterns are also observed during the day and night, although average wind speeds tend to be higher during the day (average wind speed of 3.5 m/s compared to the night average wind speed of 2.1 m/s). Diurnal, quarterly and monthly windroses for DG15 are presented in **Appendix E.**

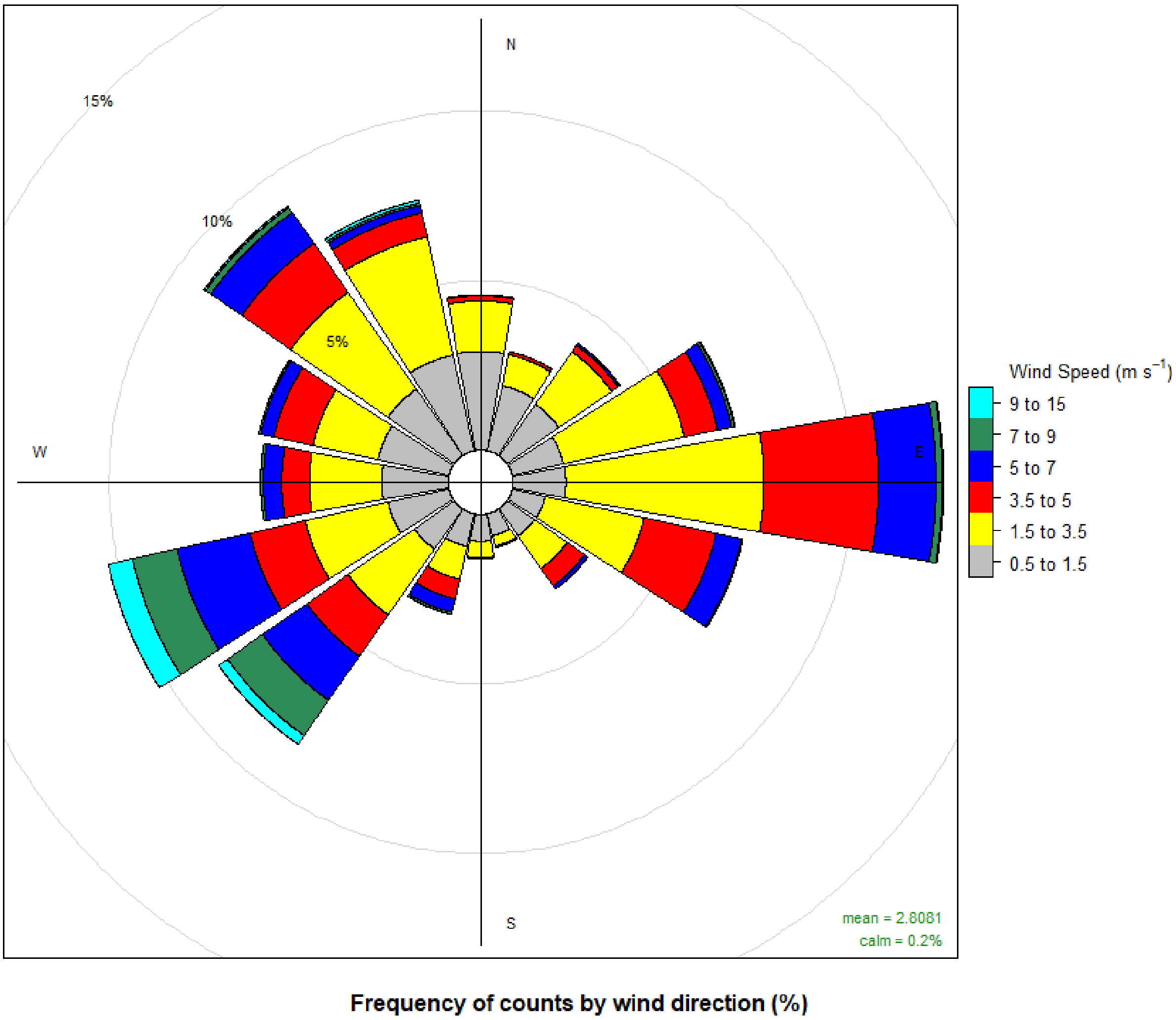

Figure 4-4. Site DG15 annual windrose (hourly averages) from 1 January 2022 – 31 December 2022 (Met data provided by OGNZL)

Table 4-4. Monthly summary of wind data for 2022 at DG15

Month	Maximum Hourly Wind Speed (m/s)	Average Hourly Wind Speed (m/s)	Predominant Wind Direction
January	11.8	3.0	E
February	8.7	2.6	E
March	9.3	2.4	E
April	10.6	2.6	WSW
May	11.9	2.5	NW
June	11.5	2.7	NNW
July	10.2	3.4	WSW
August	10.7	2.4	NW
September	12.1	2.7	E
October	12.9	3.4	E
November	9.0	3.0	E
December	8.8	3.0	E
Annual	**12.9**	**2.80**	**E**

4.3 Air Temperature and Solar Radiation

Air temperature is measured at Site DG03 and DG15 weather stations as 10-minute averages. Figure 4-5 shows the average daily temperature measured at DG03 (for both mast heights of 1.75 m and 6 m), DG15 and solar radiation measured at DG03 from 01 January 2022 to 31 December 2022. As would be expected, temperature and solar radiation were on average lowest in winter months (June – August) and highest during the summer months (December, January, and February). The temperatures measured at DG03 (at a mast height of 1.75 m) and DG15 are similar, however the air temperatures at DG15 throughout 2022 are on average 3.5ºC cooler than the temperatures measured at DG03 at 1.75 m.

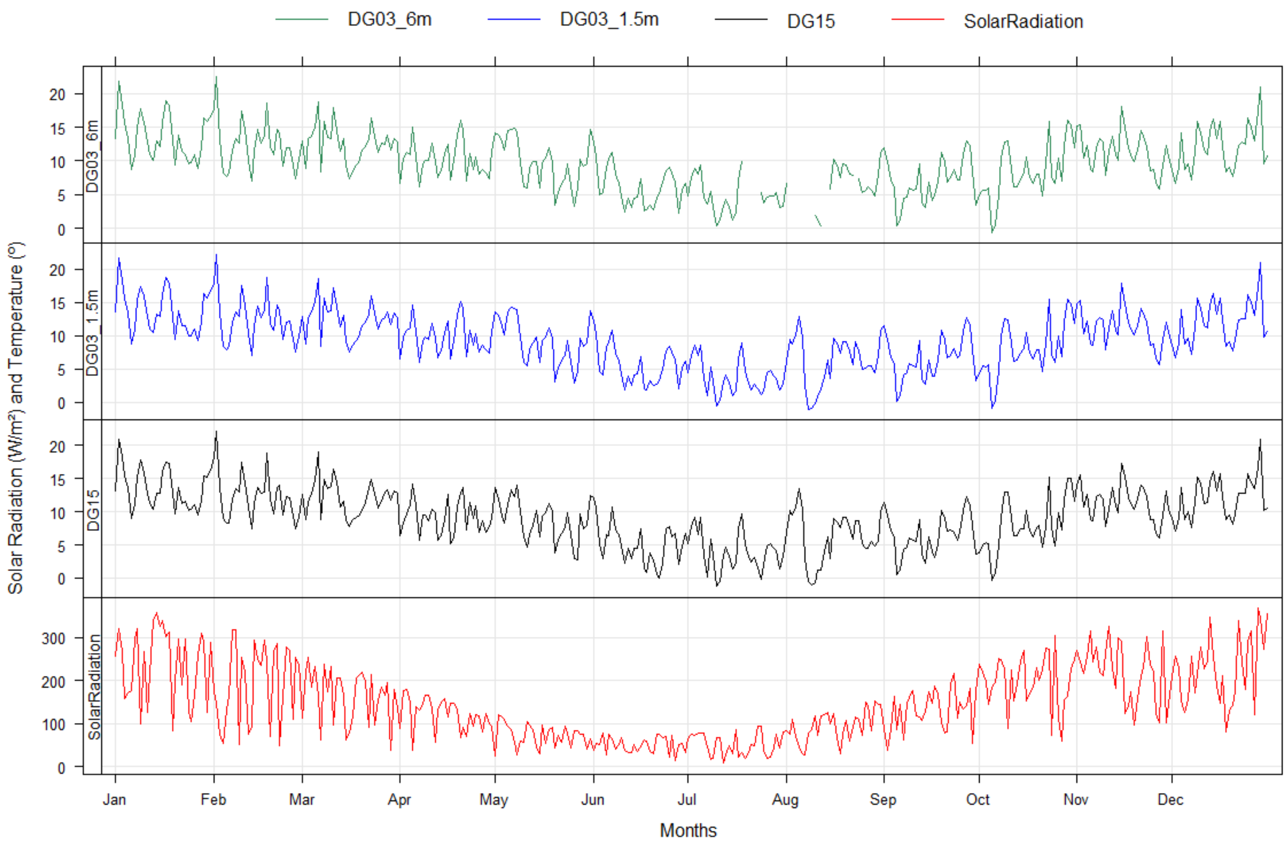

Figure 4-5. Site DG03 and DG15 daily average temperature and site DG03 solar radiation for 01 January 2022 – 31 December 2022 (Met data provided by OGNZL)

4.3.1 DG03 Temperature

A summary of the 2022 hourly ambient temperature for DG03, at a height of 1.75 m and 6 m, for 2022 is presented in Table 4-5. The annual average hourly temperature measured at DG03 at 1.75 m for 2022 was 9.2ºC, with a minimum of -3.9ºC and maximum of 28.8ºC. The 2022 annual hourly average temperature measured at DG03 at a height of 6 m was 9.6ºC, with a minimum of -3.3ºC and maximum of 28.3ºC.

Table 4-5. Hourly ambient temperature at DG03 for 01 January 2022 to 31 December 2022

Month	At 1.5 m			At 6 m		
	Minimum Hourly Average Temperature (°C)	Maximum Hourly Average Temperature (°C)	Average Hourly Average Temperature (°C)	Minimum Hourly Average Temperature (°C)	Maximum Hourly Average Temperature (°C)	Average Hourly Average Temperature (°C)
January	2.7	27.5	13.7	4.1	27.0	13.5
February	2.0	28.8	12.4	3.8	28.3	12.4
March	3.6	25.3	12.4	4.3	24.0	12.6
April	0.2	20.8	9.8	2.5	20.3	10.2
May	-0.6	20.2	9.1	0.9	19.5	9.7
June	-2.1	15.8	5.5	-0.9	15.2	6.2
July	-3.9	12.8	3.7	-2.3	12.7	4.6
August	-3.6	17.2	6.2	0.1	16.7	7.0
September	-3.8	18.9	6.6	-3.1	18.6	6.9
October	-3.7	22.7	8.0	-3.3	21.8	8.3
November	2.9	24.4	11.3	3.8	23.3	11.4
December	2.5	26.6	12.1	3.1	25.8	12.1
Annual	**-3.9**	**28.8**	**9.2**	**-3.3**	**28.3**	**9.6**

4.3.2 DG15 Temperature for 2022

A summary of the 2022 hourly ambient temperature measurements for DG15 at 1.5 m is presented in Table 4-6. The annual average hourly temperature at DG15 for 2022 was 9.1ºC. With a minimum hourly average temperature of -6.9ºC, measured in August, and a maximum hourly average of 28.5ºC, measured in February.

Table 4-6. Hourly ambient temperature summary at DG15 for 01 January 2022 to 31 December 2022

Month	Minimum Hourly Average Temperature (°C)	Maximum Hourly Average Temperature (°C)	Average Hourly Average Temperature (°C)
January	0.9	27.6	13.5
February	0.1	28.5	12.3
March	0.8	24.7	12.1
April	-1.6	21.1	9.1
May	-3.2	20.5	8.7
June	-6.1	16.0	5.1
July	-6.5	13.0	3.9
August	-6.9	17.2	6.2
September	-5.3	18.7	6.4
October	-4.0	22.4	7.9
November	1.3	23.9	11.4
December	2.8	26.5	12.1
Annual	**-6.9**	**28.5**	**9.1**

4.3.3 DG03 Solar Radiation for 2022

A summary of the hourly solar radiation for DG03 for 2022 is presented in Table 4-7. The maximum hourly solar radiation varies from 396 W/m^2 in winter (June) to a peak of 1043 W/m^2 in summer (December). The annual average hourly solar radiation for DG03 was 145.1 W/m^2.

Table 4-7. Hourly solar radiation at DG03 for 01 January 2022 to 31 December 2022

Month	Maximum Hourly Solar Radiation (W/m^2)	Average Hourly Solar Radiation (W/m^2)
January	953.5	236.5
February	897.8	190.2
March	810.5	162.8
April	624.1	119.9
May	448.2	71.7
June	396.0	49.4
July	420.2	49.9
August	595.4	93.3
September	706.5	129.6
October	862.3	196.3
November	986.7	216.8
December	1043.0	224.9
Annual	**1043.0**	**145.1**

4.4 Relative Humidity

Ten-minute average relatively humidity is only measured at the DG03 weather station. Table 4-8 summarises the hourly average humidity data for 01 January 2022 to 31 December 2022. Figure 4-6 shows the average daily relative humidity measured at DG03 from 01 January 2022 to 31 December 2022.

Table 4-8. Site DG03 relative humidity data summary for 2022 (1-hour average)

Month	Minimum Hourly Average Relative Humidity (%)	Maximum Hourly Average Relative Humidity (%)	Average Hourly Relative Humidity (%)
January	19.5	100	79.9
February	34.7	100	84.7
March	37.4	100	86.0
April	28.1	100	77.9
May	31.3	100	71.3
June	24.0	100	72.2
July	34.3	100	84.4
August	26.5	100	77.2
September	30.0	100	80.7
October	18.0	100	75.3
November	32.3	100	78.3
December	28.7	100	84.5
Annual	**18.0**	**100**	**79.4**

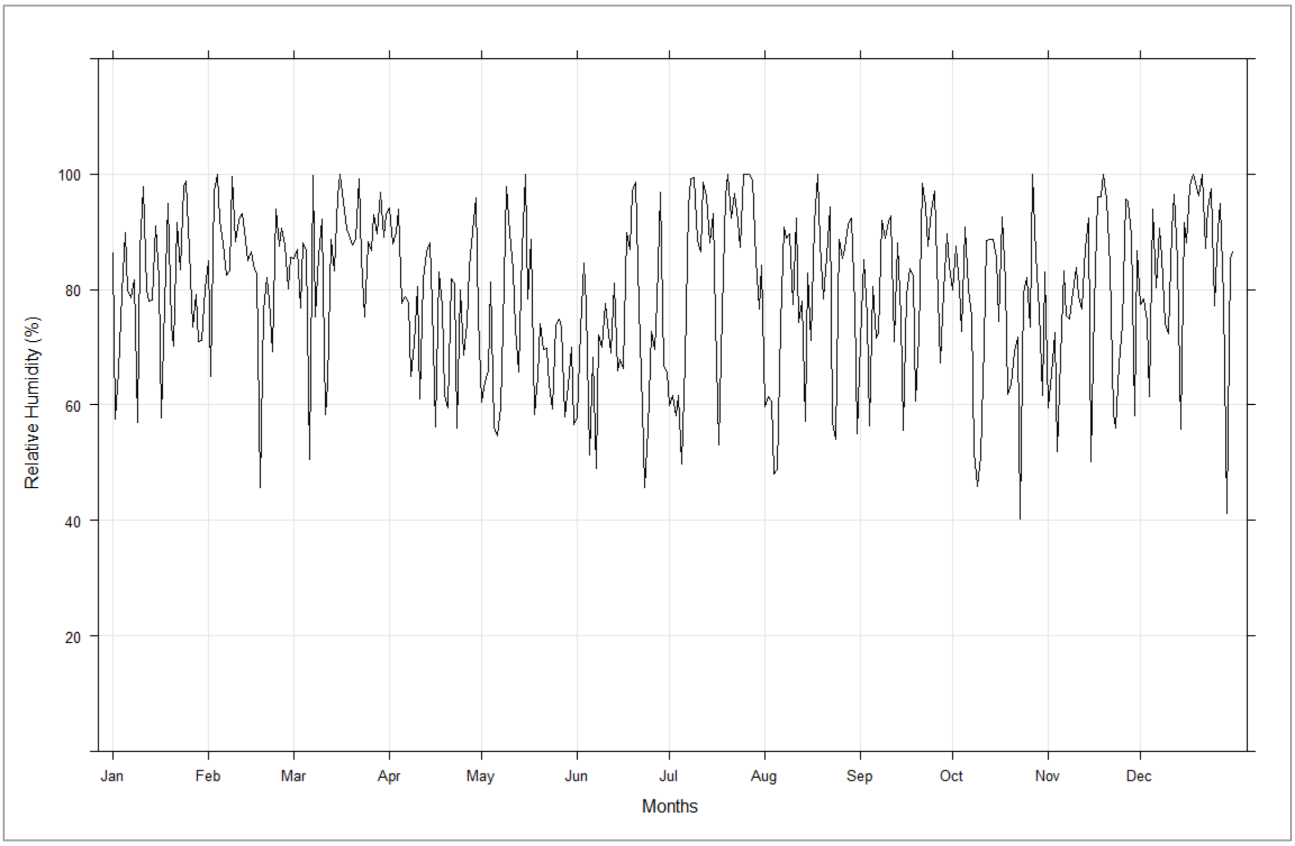

Figure 4-6. Site DG03 daily average relative humidity (%) for 01 January 2022 – 31 December 2022 (Met data provided by OGNZL)

4.5 Rainfall

Ten-minute average rainfall is recorded at DG03 and DG15 weather stations. Table 4-9 presents the percentage of 'rain days'[6] per year. Based on the rainfall data collected from 2018 – 2022, the annual rainfall for 2022 is the lowest in the five-year monitoring period measured at both the DG03 and DG15 weather stations.

According to the Oceanic Nino Index (ONI), 2022 was classified as a La Niña year by NIWA and NOAA[7]. In New Zealand, a La Niña event would typically result in reduced rainfall experienced in the lower and western parts of the South Island[8]. The decrease in annual rainfall measured across 2022 at DG03 and DG15 could be attributed to the La Niña event.

[6] A rain day is classified as a day with total rainfall exceeding 1 mm over a 24-hour period.

[7] NOAA, 2023, ENSO: Recent Evolution, Current Status and Predictions, https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

[8] NIWA, El Niño and La Niña, https://niwa.co.nz/climate/information-and-resources/elnino

Table 4-9. Rainfall at Sites DG03 and DG15

Year	DG03		DG15	
	No. of Days above 1 mm Rain	% Rain days over a year	No. of Days above 1 mm Rain	% Rain days over a year
2018	108	29.9	103	28.2
2019	104	28.5	94	25.8
2020	91	24.9	82	22.5
2021	101	27.7	94	25.8
2022	78	21.4	78	21.4

A summary of the 2022 rainfall data for both Sites DG03 and DG15 is presented in Table 4-10. The data shows that approximately 30% of the annual rainfall recorded at DG03 fell in July, with a total rainfall of 184.6 mm for the month. A similar trend was observed at the neighbouring monitoring station DG15, with 144.6 mm measured over the month (28% of the total annual rainfall). The driest month measured at DG03 for 2022 was in June, with only 6.2 mm rain measured for the month. While at DG15, May was the driest month with 16.4 mm of rain measured.

Table 4-10. Rainfall data summary for 2022 for Sites DG03 and DG15 (24-hour average)

Month	DG03			DG15		
	No. of Rain Days per Month	Daily Maximum Rainfall (mm)	Total Rainfall (mm)	No. of Rain Days per Month	Daily Maximum Rainfall (mm)	Total Rainfall (mm)
January	3	15.2	26.2	2	13.8	24.6
February	6	37.0	69.8	7	32.6	66.4
March	4	12.6	20.6	3	14.0	23.4
April	3	12.4	23.0	4	12.0	23.6
May	4	10.4	17.6	3	8.0	16.4
June	2	3.2	6.2	6	8.8	23.8
July	12	45.4	184.6	12	37.0	144.6
August	6	6.0	24.8	5	6.8	24.0
September	7	9.6	36.0	4	5.4	19.8
October	9	27.2	81.0	7	14.6	42.8
November	8	27.0	54.6	6	13.6	28.2
December	10	30.4	78.2	9	38.8	82.6
Annual	**74**	**45.4**	**622.6**	**68**	**38.8**	**520.2**

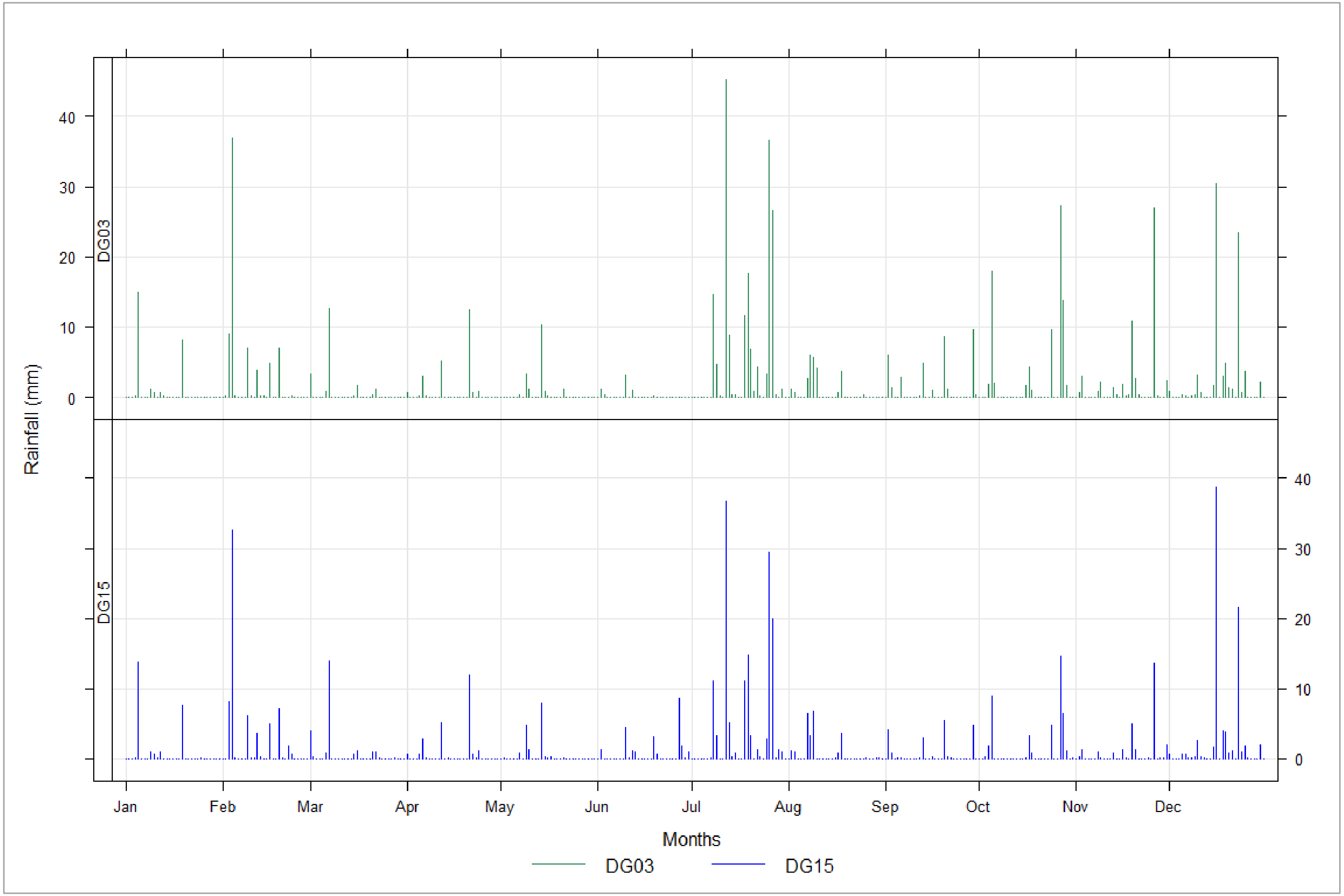

Figure 4-7. Daily Rainfall for 2022 at DG03 and DG15

5 Deposited Dust Monitoring Results

5.1 Overview

Table 5-1 summarises the existing air discharge consent requirements with regards to dust deposition rates compared to two different sets of background sites. The background deposition rate used for calculating the relative difference between deposition is similar for most consents (listed as “A” in Table 5-1) but consent RM10.351.52.V1 (listed as “B” in Table 5-1) uses site DG17 rather than DG24. The same deposition rate consent limit (of 3 g/m^2/30 days above background) applies to all of the monitoring sites. At some sites the deposition limit is allowed to be exceeded twice per calendar year.

The dust deposition monitoring sites listed in Table 5-2 are for monitoring purposes only (i.e., not for consent compliance). Table 5-3 summarises the dust deposition rates compared to both background sites.

Table 5-1. Summary of Consent Dust Deposition Monitoring Limits

Site	Monitoring Limit, g/m^2/30 days above background	Background Applied	No of Exceedences allowed per year
DG02	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	0
DG07	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	2
DG11	3	B: Average of DG 9, 10 and 17	2
DG15	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	0
DG17	3	A: Average of DG 9, 10 and 24	2
DG20	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	2
DG21	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	2
DG22	3	A: Average of DG 9, 10 and 24	2
DG25	3	A: Average of DG 9, 10 and 24	2

Table 5-2. Additional Dust Deposition Monitoring

Site	Background Applied
DG03	A: Average of DG 9, 10 and 24
DG13	A: Average of DG 9, 10 and 24
DG18	A: Average of DG 9, 10 and 24
DG19	A: Average of DG 9, 10 and 24

5.2 Dust Deposition Results

Table 5-3 shows the insoluble dust deposition rates above background levels at monitoring sites for 2022. The results that are annotated as NR mean no result was recorded at that site for the month. There was a problem with access to site DG07 and DG17 in September and October 2022 and therefore no sample was taken. There was also a dead bird in the deposition gauge at site DG20 in November 2022. Figures 5-1 to 5-4 show the dust deposition rates at the different sites for the two consent limit backgrounds for 2022 and Figures 5-5 and 5-6 show results from 2018 - 2022.

There was one dust deposition exceedance at DG15 in January 2022 for background A and B related to bird droppings, and one exceedance at DG21 in December 2022 for background B related to the presence of lots of flies. High deposition rates were measured at DG03 as the site is beside the OGNZL gravel road entrance to their offices and the unsealed Golden Point Road.

Table 5-3. Deposition monitoring results for 2022 (g/m^2 over 30 days above background)

Site	Limit, Backgrnd, No x	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Most Consents													
DG02	3, A	0.95	0.28	0.67	0.19	0.15	0.01	0.01	0.32	0.01	0.01	0.01	0.01
DG07	3, A, 2x	1.42	1.77	1.69	0.48	0.78	2.15	1.06	1.34	NR	NR	0.01	0.01
DG15	3, A	3.71	0.32	0.32	0.20	0.18	0.05	0.01	0.16	0.01	0.01	0.01	0.01
DG17	3, A, 2x	1.26	0.28	2.82	1.06	1.15	1.41	0.01	0.89	NR	NR	0.54	0.01
DG20	3, A, 2x	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NR	1.30
DG21	3, A, 2x	0.01	0.01	0.01	0.01	0.26	0.13	0.01	0.06	0.01	0.04	0.01	2.50
DG22	3, A, 2x	0.49	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.56	0.01
DG25	3, A, 2x	0.31	2.01	0.39	0.01	0.01	1.33	0.01	0.01	0.01	0.01	0.01	0.01
Under Consent RM10.351.52.V1													
DG02	3, B	0.61	0.34	0.01	0.10	0.01	0.01	0.01	0.01	0.50	0.31	0.01	0.01
DG07	3, B, 2x	1.08	1.83	0.86	0.39	0.49	1.81	1.10	1.00	NR	NR	0.01	0.05
DG11	3, B, 2x	1.61	0.76	0.18	0.48	0.37	0.24	0.07	0.34	0.78	0.71	0.01	0.01
DG15	3, B	3.37	0.38	0.01	0.11	0.01	0.01	0.01	0.01	0.56	0.39	0.01	0.01
DG20	3, B, 2x	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.01	NR	2.02
DG21	3, B, 2x	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.12	0.52	0.01	3.22
Additonal Monitoring (not a consent requirement)													
DG03	A	22.23	15.91	16.88	12.17	8.77	5.60	2.57	10.75	10.55	10.86	10.33	10.18
DG13	A	NR	0.28	0.01	0.15	0.01	0.01	0.01	0.10	0.01	0.01	0.60	0.01
DG18	A	0.07	1.53	0.01	0.01	0.01	0.01	0.01	0.01	NR	0.01	2.45	0.01
DG19	A	0.42	0.01	0.01	0.37	0.04	0.01	0.01	0.01	0.01	0.01	0.01	1.53

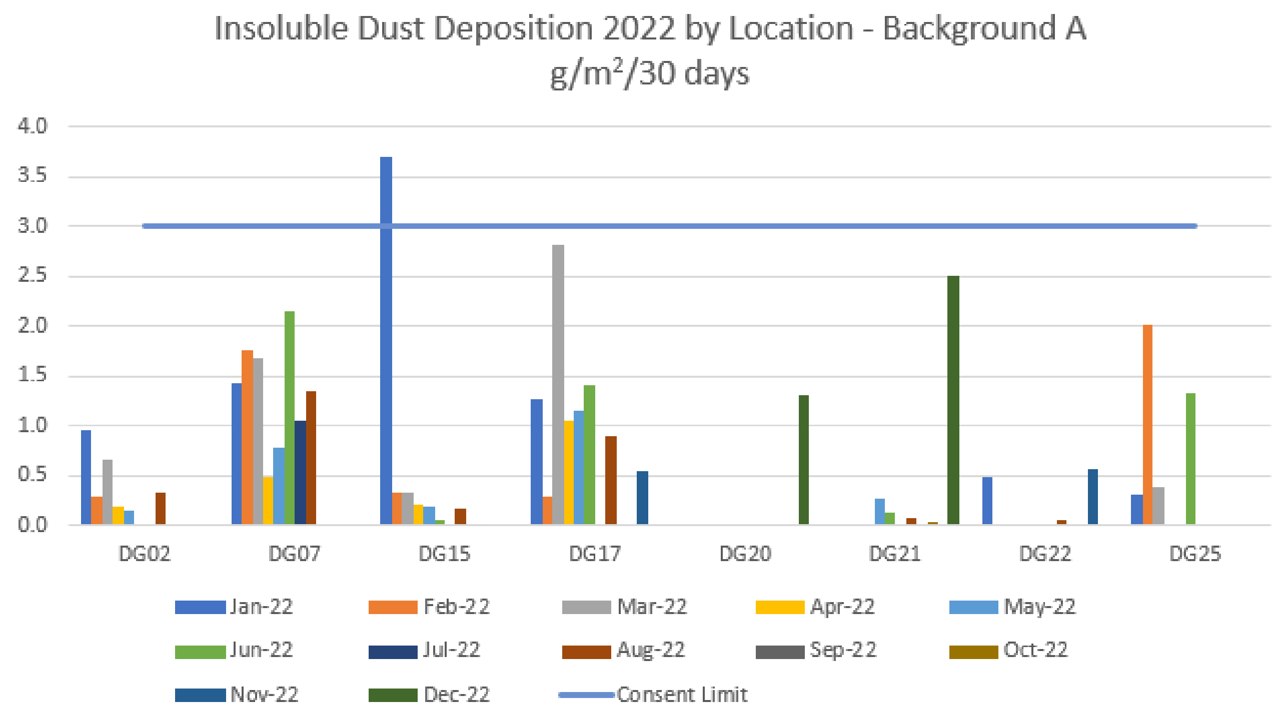

Figure 5-1. Insoluble Dust Deposition Monitoring by Location for 2022 most consents background

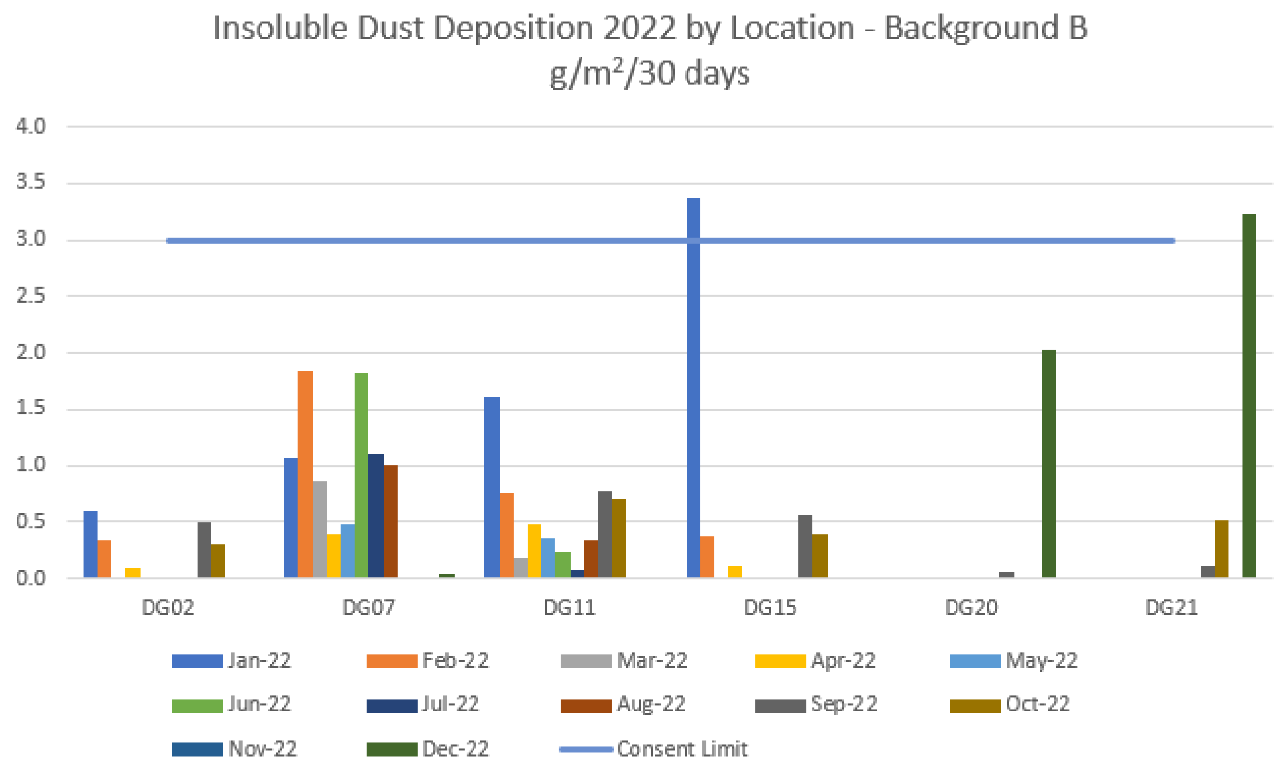

Figure 5-2. Insoluble Dust Deposition Monitoring by Location for 2022 consent RM10.351.52.V1 background

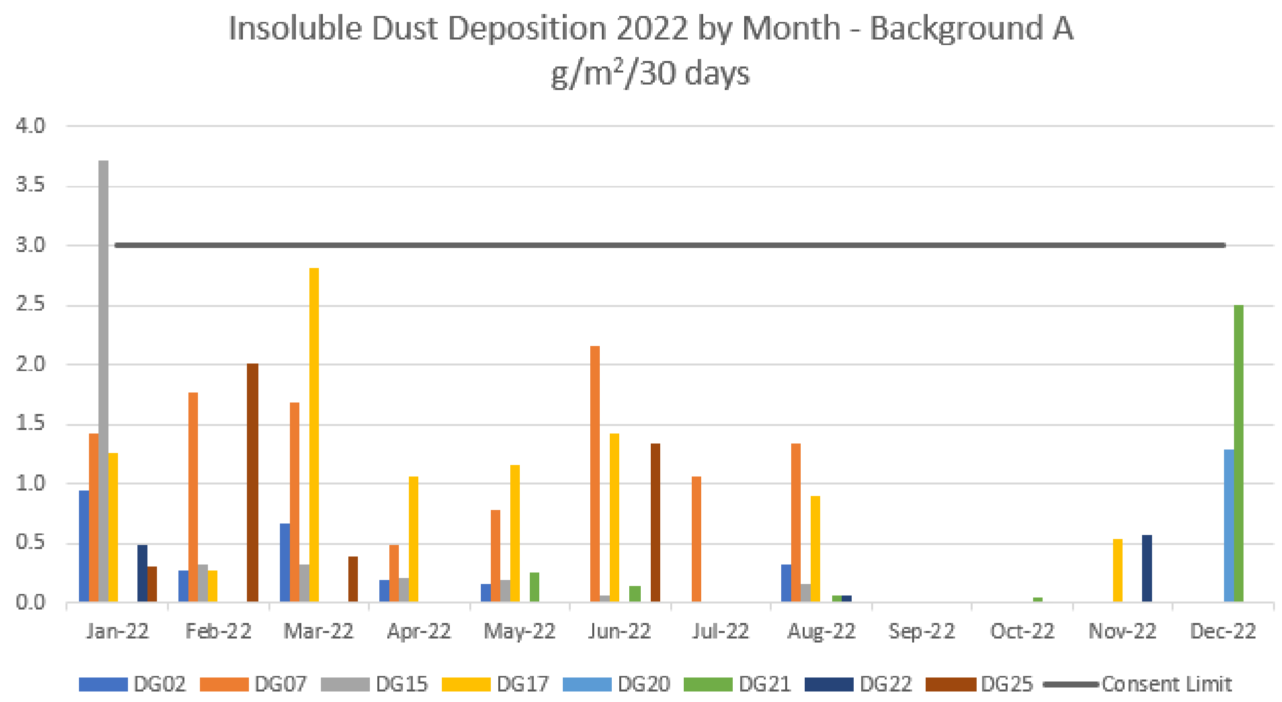

Figure 5-3. Insoluble Dust Deposition Monitoring by Month for 2022 most consents background.

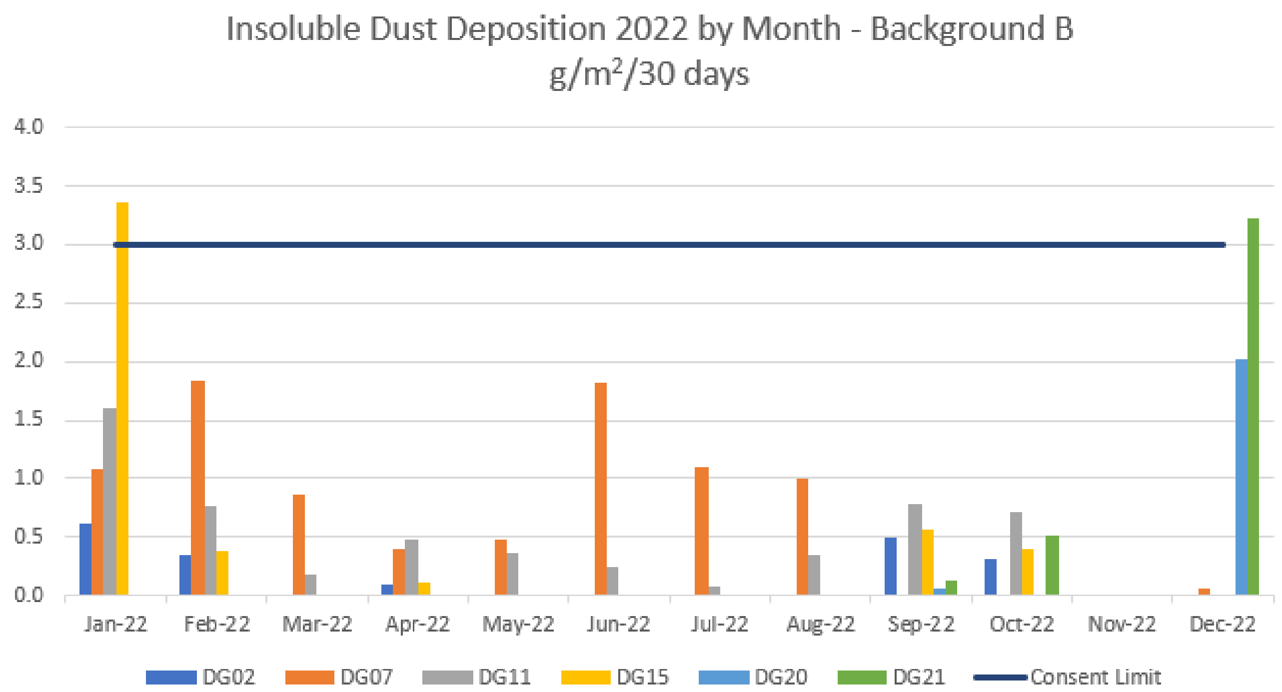

Figure 5-4. Insoluble Dust Deposition Monitoring by Month for 2022 consent RM10.351.52.V1 background.

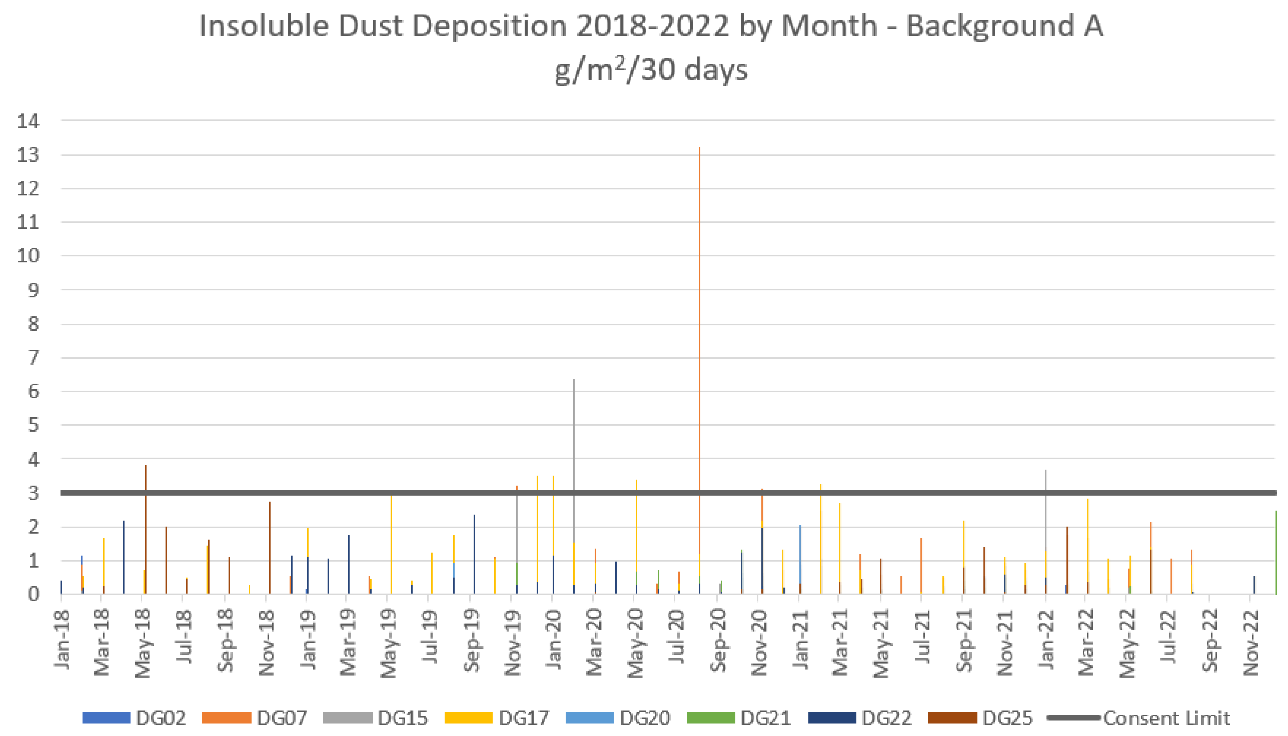

Figure 5-5. Historic Insoluble Deposited Deposition Monitoring 2018 – 2022, most consents background.

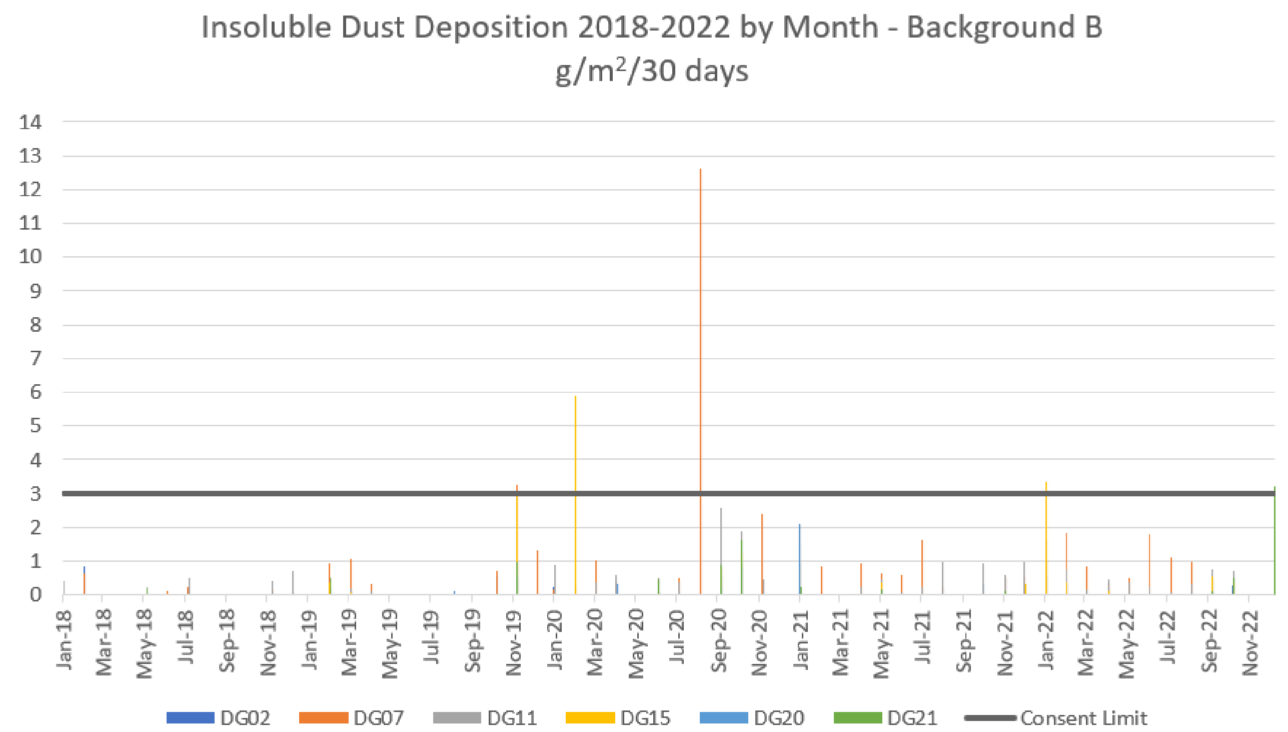

Figure 5-6. Historic Insoluble Deposited Deposition Monitoring 2018 – 2022, consent RM10.351.52.V1 background.

6 Total Suspended Particulate Monitoring

6.1 Instrument Performance

The performance of the TSP monitor at DG15 is presented in Table 4-2. The percentage of data acquired at the other two TSP monitoring sites is presented in Table 6-1.

Table 6-1. TSP instrument performance (percentage data capture) for 01 January 2022 – 31 December 2022

	DG07 (%)	Reason for <100% data collection	DG11 (%)	Reason for <100% data collection
January 22	53	Repairs and communication errors	100	-
February 22	99	-	93	Communication errors
March 22	90	Communication errors	100	-
April 22	89	Communication errors	100	-
May 22	95	Instrument fault	100	-
June 22	36	Instrument fault – unit replaced, low voltage	100	-
July 22	44	Low voltage	100	-
August 22	44	Low voltage, communication issues	81	Communication issues
September 22	55	Communication issues	100	-
October 22	89	Communication issues	100	-
November 22	100	-	96	Communication issues, analogue data
December 22	61	Instrument error, faulty pump, communication error	76	Instrument error

6.2 TSP Monitoring Results

The 24-hour average TSP concentrations for 2022 for the three sites is presented in Figure 6-1 alongside the relative humidity measured at DG03. There are instances of high humidity which correspond with high TSP levels recorded at the three sites, notably in July. They indicate that high levels of moisture can give rise to anomalous high TSP readings. The tables in Appendix F show the strong correlation of humidity and high TSP results.

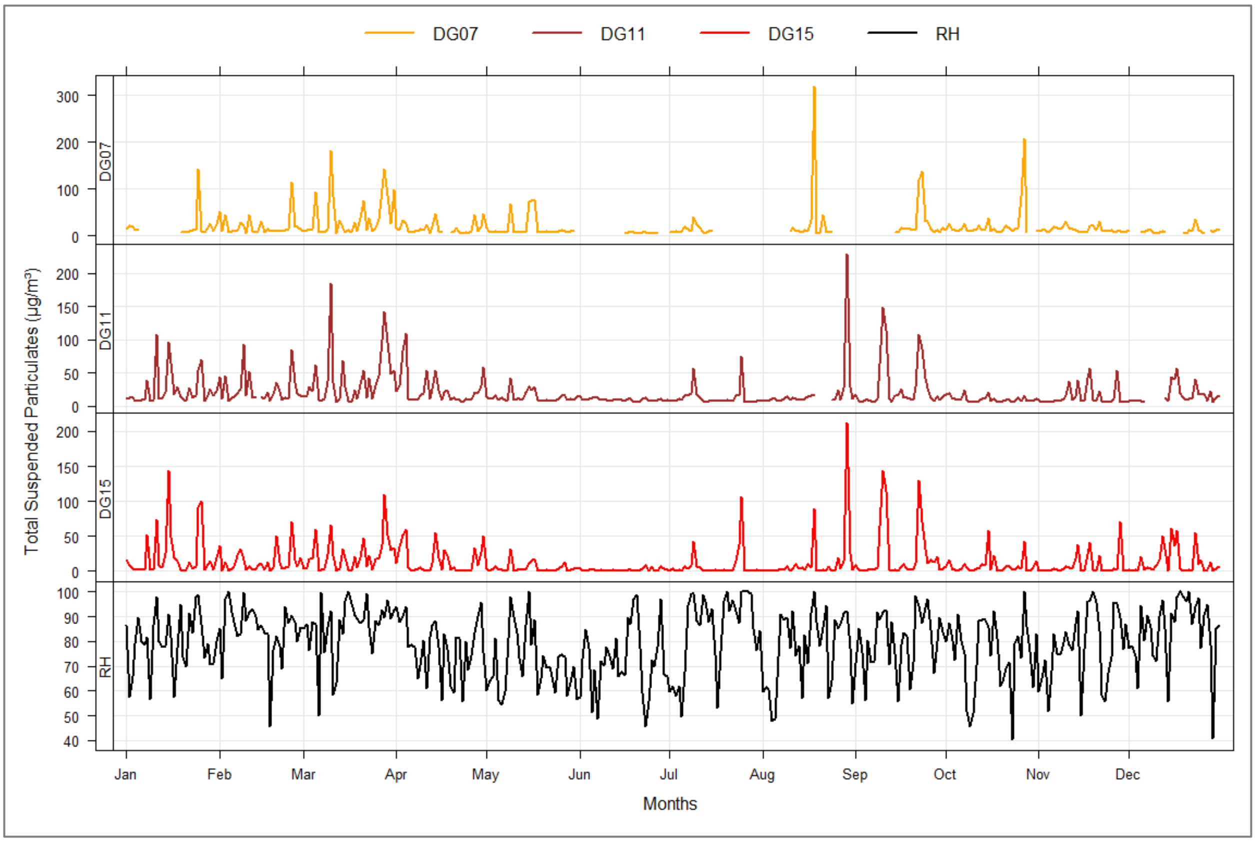

Figure 6-1: Overview of the 24-hour average TSP concentrations at DG07, DG11 and DG15 in relation to the relative humidity recorded at DG03

6.2.1 DG07 TSP Monitoring 1 hour Average Results

The 1-hour average TSP concentrations at DG07 for 2022 are presented in Figure 6-2, alongside the 250 µg/m^3 consent limit. Table 6-2 presents a summary of the 1-hour average TSP data for 2022. The annual hourly average of TSP measured for 2022 was 21.8 µg/m^3. The maximum TSP 1-hour average concentration for 2022 was 1528.4 µg/m^3. There were a total of 102 exceedances of the 250 µg/m^3 1-hour average consent limit throughout the year.

Table F-1 in **Appendix F** presents the exceedances of the hourly consent limit recorded for DG07 alongside the hourly relative humidity measurements at DG03. For all but two of the exceedances, the relative humidity measured at the monitoring station was 99% or above. The correlation between a TSP exceedance and the relative humility would suggest that during these periods the instrument was reporting water aerosol (fog) concentrations rather than dust from mining activities.

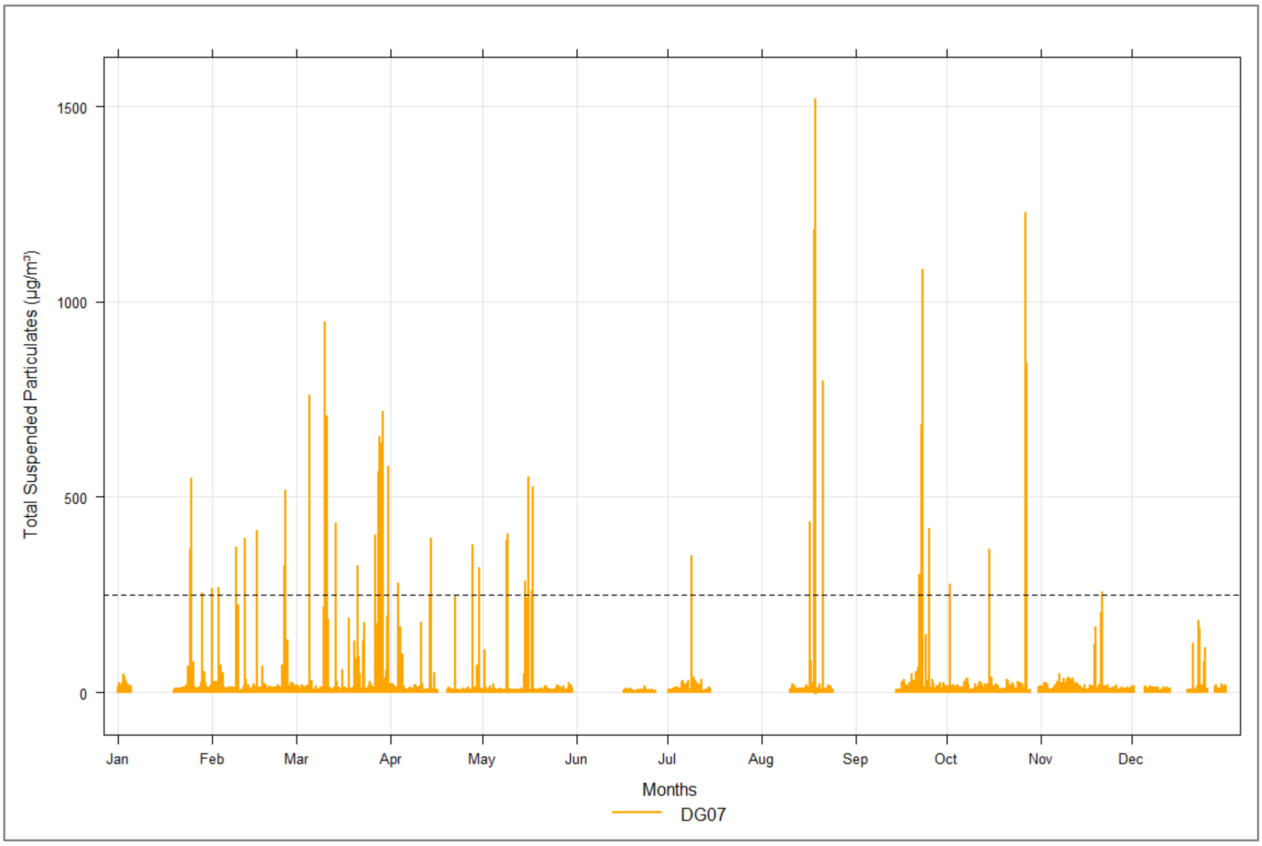

Figure 6-2. 1-hour average measured TSP concentrations recorded at Site DG07 for 2022

Table 6-2. Summary of 1-hour average measured TSP concentrations (µg/m³) at Site DG07 for 2022

Month	Minimum Hourly Concentration (µg/m³)	Maximum Hourly Concentration (µg/m³)	Average Hourly Concentration (µg/m³)	Number of Exceedances (> 250 µg/m³)
January	4.0	549.0	22.2	8
February	3.7	552.3	20.4	12
March	5.1	926.1	40.9	34
April	5.0	373.2	17.0	10
May	5.8	620.6	17.6	10
June	4.4	22.5	6.9	0
July	0.3	369.0	14.3	1
August	0.0	1528.4	35.8	9
September	5.6	1095.4	28.9	9
October	4.6	1126.4	24.8	8
November	4.8	331.6	14.1	1
December	3.6	213.1	11.4	0
Annual	**0.0**	**1528.4**	**21.2**	**102**

6.2.2 DG07 TSP Monitoring 24-hour Average Results

The 24-hour average TSP concentrations for 2022 at DG07 are presented in Figure 6-3, alongside the 24-hour consent limit (of 80 µg/m³). Table 6-3 presents a summary of the 24-hour average TSP data for 2022. The maximum 24-hour average concentration at DG07 for 2022 was 317.7 µg/m³, while the annual average 24-hour concentration for 2022 was 20.7 µg/m³.

There were 14 exceedances of the 24-hour consent limit, the majority of these exceedances were recorded in March. These exceedances can be attributed to the nephelometer over reporting TSP concentration when high relative humidity conditions occur.

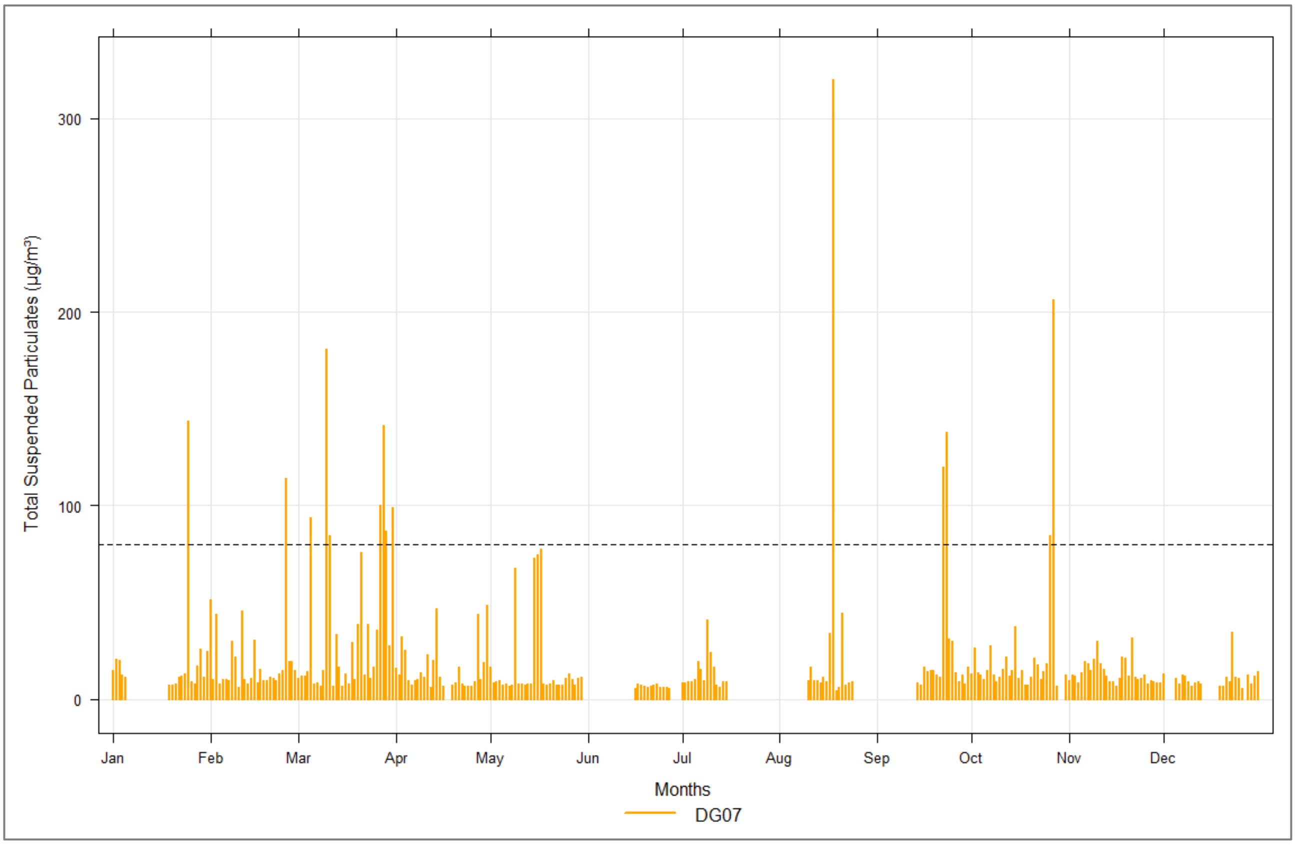

Figure 6-3. 24-hour average measured TSP concentrations recorded at Site DG07 for 2022

Table 6-3. Summary of 24-hour average measured TSP concentrations (µg/m³) at Site DG07 for 2022

Month	Minimum Daily Concentration (µg/m³)	Maximum Daily Concentration (µg/m³)	Average Daily Concentration (µg/m³)	Number of Exceedances (> 80 µg/m³)
January	7.5	136.6	21.1	1
February	6.1	113.3	20.7	1
March	6.7	183.8	40.9	7
April	6.6	48.3	16.5	0
May	7.1	77.4	17.5	0
June	5.9	8.3	6.8	0
July	6.1	41.1	13.7	0
August	4.6	317.7	33.7	1

Month	Minimum Daily Concentration (µg/m³)	Maximum Daily Concentration (µg/m³)	Average Daily Concentration (µg/m³)	Number of Exceedances (> 80 µg/m³)
September	7.5	137.1	28.3	2
October	6.6	205.1	24.3	2
November	7.2	31.5	14.1	0
December	6.1	34.7	11.1	0
Annual	**4.6**	**317.7**	**20.7**	**14**

6.2.3 DG11 TSP Monitoring 1-Hour Average Results

The 1-hour average TSP concentrations for 2022 at DG11 are presented in Figure 6-4, alongside the 250 µg/m³ consent limit. Table 6-4 presents a summary of the measured TSP data for 2022 for DG11. The annual hourly average TSP concentration measured for 2022 was 20.8 µg/m³. The maximum TSP concentration measured for 2022 was 1318.0 µg/m³. There was a total of 103 exceedances of the 250 µg/m³ consent limit through the year, with most of these exceedances occurring in the first three months of the year.

Table F-2 in **Appendix F** presents the exceedances of the hourly consent limit recorded for DG11 and the relative humidity measurements from DG03. As previously mentioned, these exceedances can be attributed to the nephelometer over reporting TSP concentrations when high relative humidity conditions occur rather than dust from mining activities.

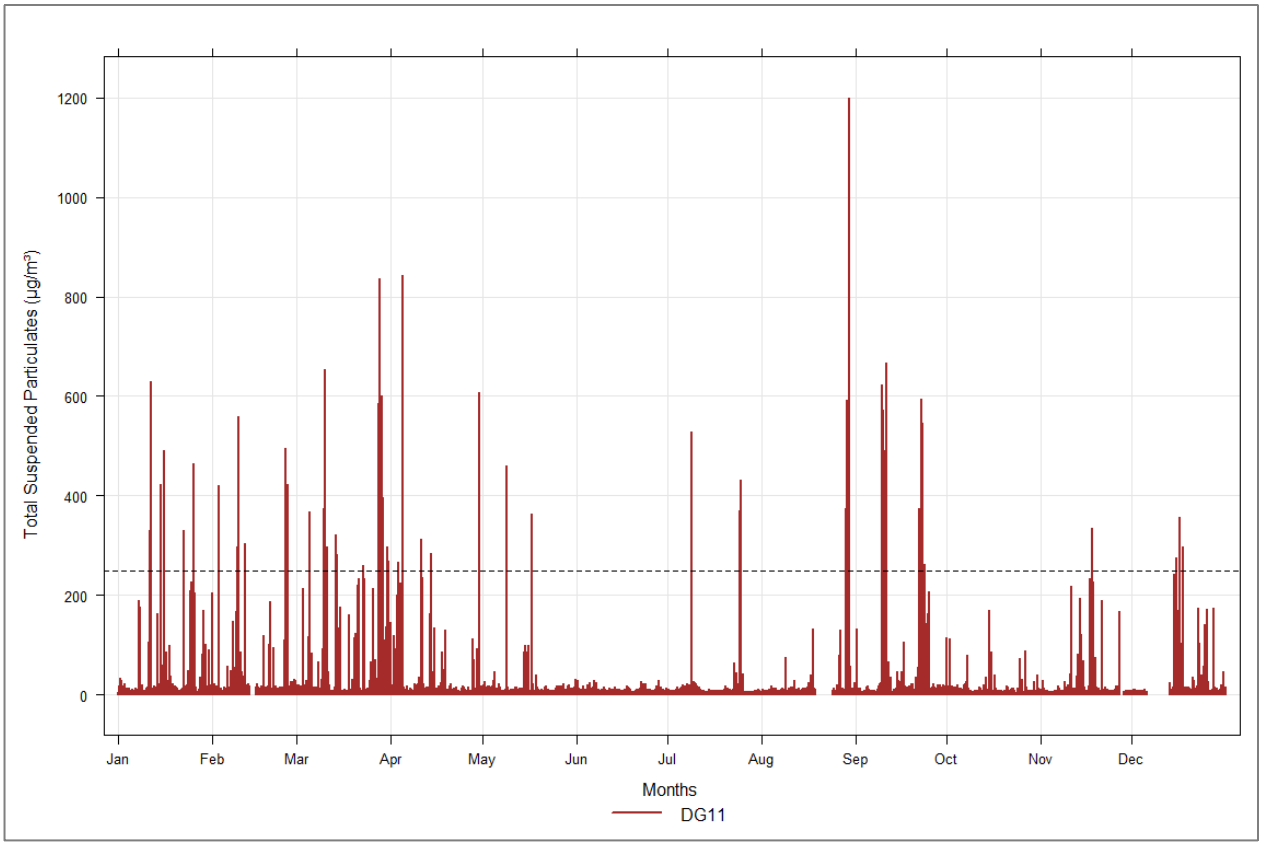

Figure 6-4. 1-hour average ambient TSP concentrations recorded at Site DG11 for 2022

Table 6-4. Summary of 1-hour average measured TSP concentrations (µg/m³) at Site DG11 for 2022

Month	Minimum Hourly Concentration (µg/m³)	Maximum Hourly Concentration (µg/m³)	Average Hourly Concentration (µg/m³)	Number of Exceedances (> 250 µg/m³)
January	3.5	624.6	25.7	13
February	5.1	612.6	26.0	9
March	3.1	692.3	41.1	26
April	4.2	862.5	25.3	10
May	5.3	485.1	13.7	3
June	3.9	38.6	10.0	0
July	3.7	530.8	13.6	4
August	4.5	1318.0	21.6	11
September	3.8	646.8	29.4	21
October	4.8	170.2	10.7	0
November	2.0	331.0	14.4	2
December	3.6	334.6	18.1	4
Annual	**2.0**	**1318.0**	**20.8**	**103**

6.2.4 DG11 TSP Monitoring 24-Hour Average Results

The 24-hour average measured TSP for 2022 measured at DG11 is presented in Figure 6-5, alongside the 24-hour consent limit of 80 µg/m³. Table 6-5 presents a summary of the 24-hour average TSP data for 2022. The annual daily average concentration for 2022 was 20.5 µg/m³, with a maximum daily average concentration of 235.2 µg/m³.

There were 14 exceedances of the 24-hour consent limit (of 80 µg/m³) over 2022, with the majority of the exceedances occurring between January and April 2022. Similarly, these exceedances can be attributed to the nephelometer over reporting TSP concentration when high relative humidity conditions occur.

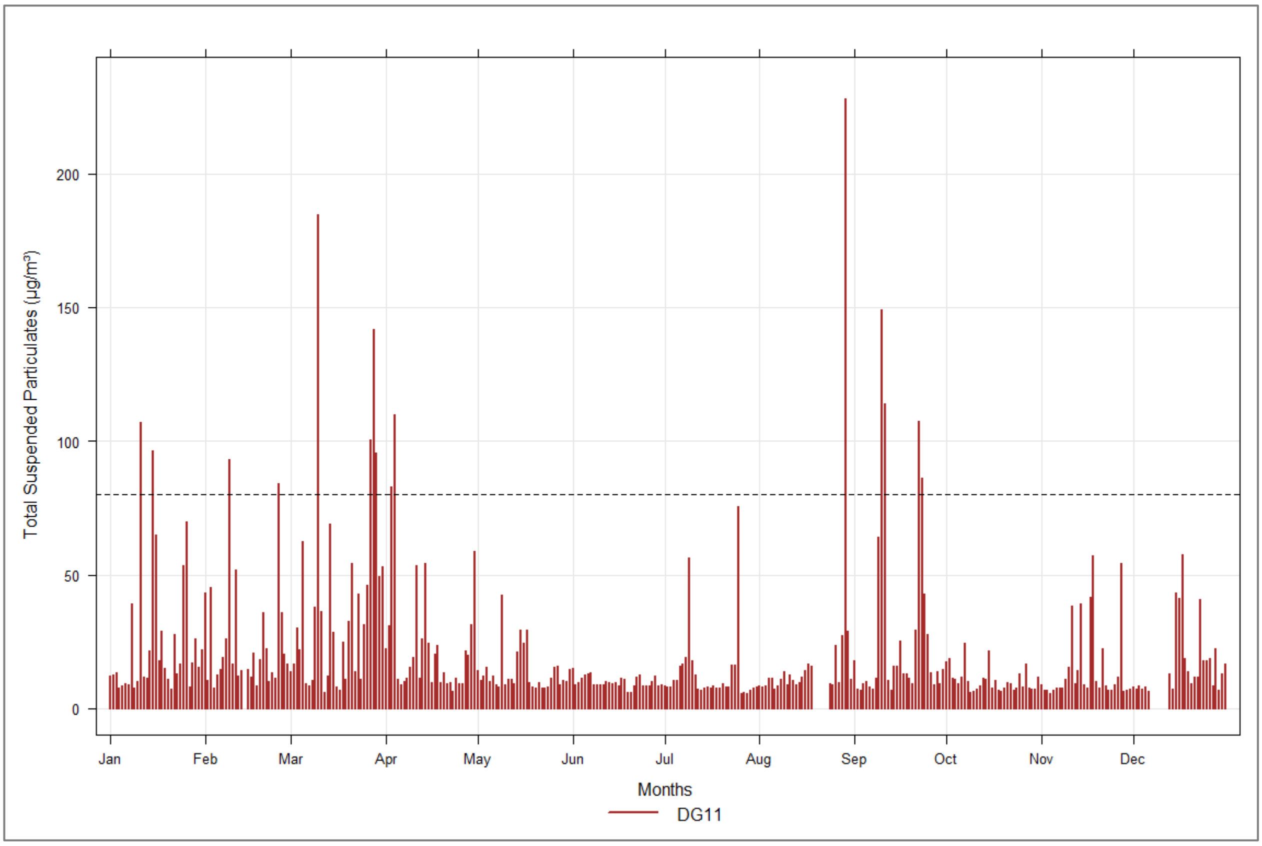

Figure 6-5. 24-hour average ambient TSP concentrations recorded at Site DG11 for 2022

Table 6-5. Summary of 24-hour average measured TSP concentrations (µg/m³) at Site DG11 for 2022

Month	Minimum Daily Concentration (µg/m³)	Maximum Daily Concentration (µg/m³)	Average Daily Concentration (µg/m³)	Number of Exceedances (> 80 µg/m³)
January	7.5	107.3	23.3	1
February	0.0	92.7	24.2	2
March	6.2	185.3	41.1	4
April	6.5	109.1	25.3	2
May	7.7	42.3	13.7	0
June	6.0	14.9	10.0	0
July	5.7	75.0	13.6	0
August	7.4	235.2	21.3	1
September	6.8	151.1	29.4	4
October	6.1	25.0	10.7	0
November	5.7	56.9	15.3	0
December	6.3	57.5	17.6	0
Annual	**0.0**	**235.2**	**20.5**	**14**

6.2.5 DG15 1 Hour Average TSP Monitoring Results

The hourly average ambient TSP concentrations measured at DG15 for 2022 are presented in Figure 6-6. There is no 1-hour TSP consent limit in any of the resource consents regarding DG15. Table 6-6 presents a summary of the measured TSP data for 2022 for DG15. The results show the annual 1-hour average TSP concentration for 2022 was 13 µg/m³, however the maximum 1-hour average TSP concentration was 720.3 µg/m³. The results indicate that, in the winter months (June – August), the TSP measurements decreased, which would coincide with higher rainfall during this period.

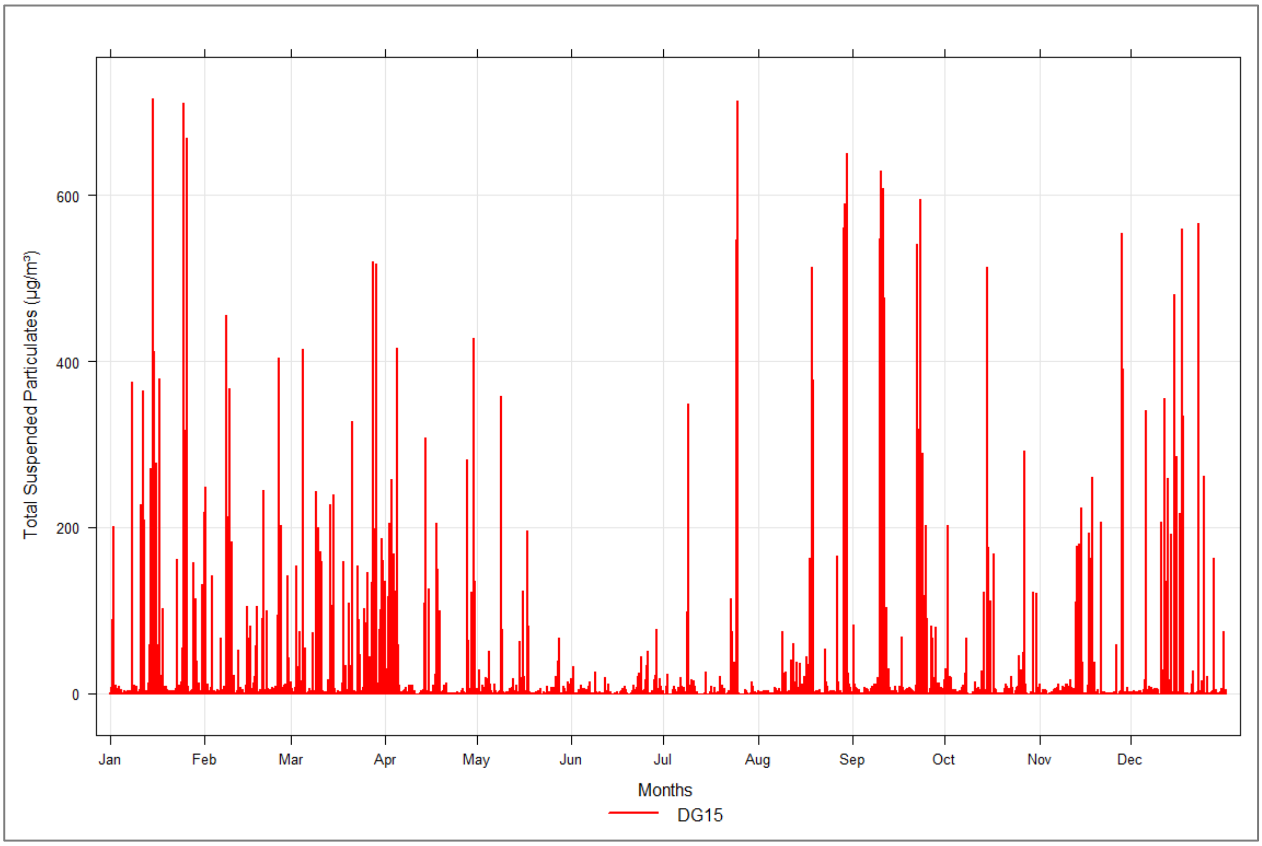

Figure 6-6. Hourly average ambient TSP concentrations recorded at Site DG15 from 2022

Table 6-6. Summary of 1-hour average measured TSP concentrations (µg/m³) at Site DG15 for 2022

Month	Minimum Hourly Concentration (µg/m³)	Maximum Hourly Concentration (µg/m³)	Average Hourly Concentration (µg/m³)
January	0.0	720.3	22.7
February	0.0	452.9	13.3
March	0.0	492.0	22.7
April	0.0	433.9	15.1
May	0.0	313.1	4.5
June	0.0	59.1	2.1
July	0.0	655.9	8.2
August	0.0	648.9	14.2
September	0.0	636.6	23.1

Month	Minimum Hourly Concentration ($\mu g/m^3$)	Maximum Hourly Concentration ($\mu g/m^3$)	Average Hourly Concentration ($\mu g/m^3$)
October	0.0	417.4	8.1
November	0.0	506.1	8.7
December	0.0	520.6	13.6
Annual	**0.0**	**720.3**	**13.0**

6.2.6 DG15 24 Hour Average TSP Monitoring Results

Figure 6-7 shows the 24-hour average TSP concentrations observed at Site DG15 for 2022 alongside the 24-hour consent limit (of 120 µg/m³). A summary of the 24-hour data is presented in Table 6-7. The results show that there were four exceedances of the 24-hour consent limit of 120 µg/m³ in 2022. The TSP levels at Site DG15 were otherwise well below the consent limit, with an annual 24-hour average of 13.0 µg/m³.

As previously mentioned, the nephelometer uses an optical monitoring method, and TSP concentrations during high humidity events may be over-estimated as the airborne water aerosols would be measured by the instrument as TSP.

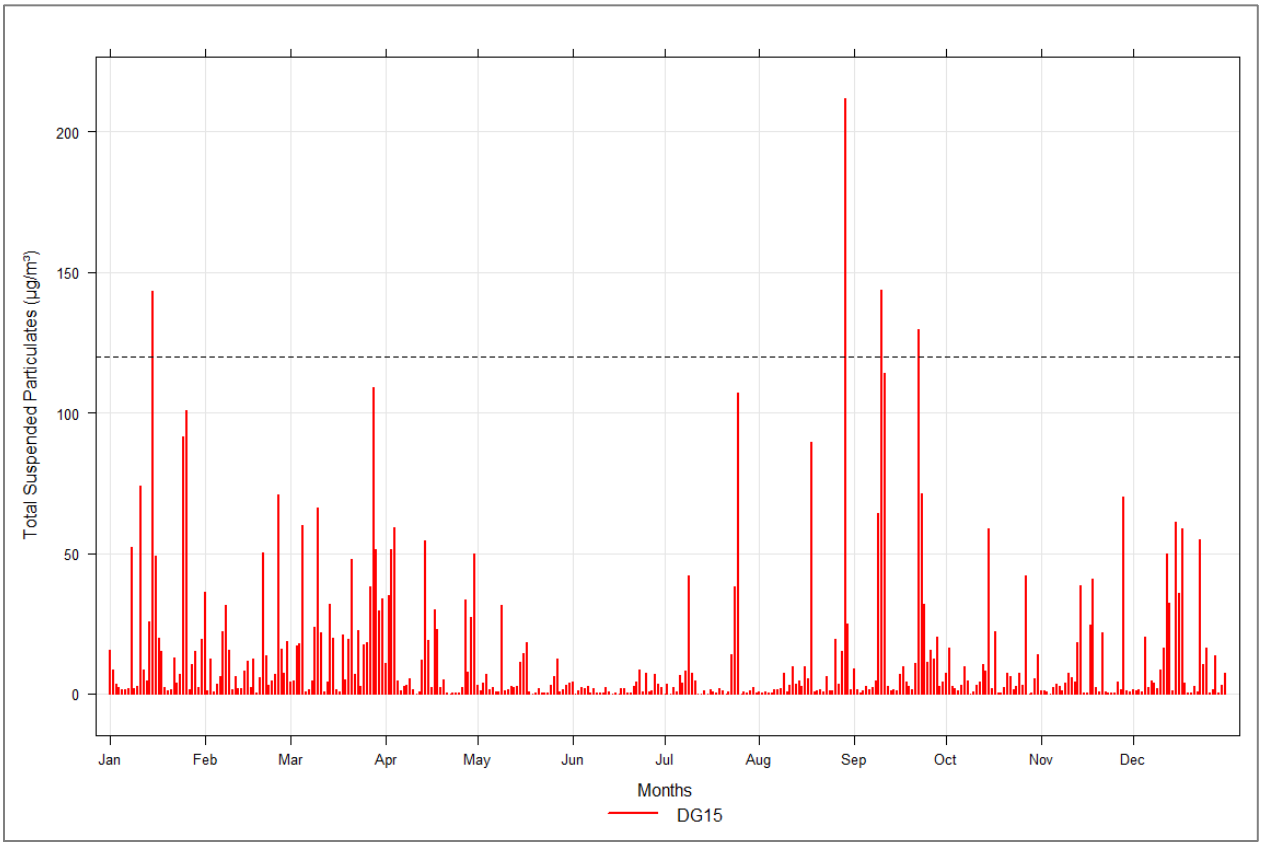

Figure 6-7. 24-hour average ambient TSP concentrations recorded at Site DG15 from 2022

Table 6-7. Summary of 24-hour average measured TSP concentrations (μg/m^3) at Site DG15 for 2022

Month	Minimum Daily Concentration (μg/m^3)	Maximum Daily Concentration (μg/m^3)	Average Daily Concentration (μg/m^3)	Number of Exceedances (> 120 μg/m^3)
January	1.2	142.4	22.7	1
February	0.5	70.4	13.3	0
March	0.7	108.7	22.7	0
April	0.0	58.9	14.9	0
May	0.1	31.4	4.5	0
June	0.0	8.6	2.1	0
July	0.0	106.4	8.2	0
August	0.2	214.9	14.2	1
September	0.2	146.6	23.1	2
October	0.0	58.4	8.1	0
November	0.1	69.8	8.7	0
December	0.2	62.4	13.6	0
Annual	**0.0**	**214.9**	**13.0**	**4**

7 Evaluation of Dust Mitigation Measures

7.1 Main Dust Control Measures

The current dust control measures on-site include reducing vehicle speeds, ceasing overburden stripping and bund construction activities and increasing the quantity of water used as a dust suppressant during dry and windy conditions.

7.2 Summary of 2022 Mining Activities

Open pit mining and processing activities from 1 January 2022 - 31 December 2022 included:

- Processing of low-grade ore stockpiles;
- Ore haulage back to the processing plant from the Coronation North, Deepdell North and Frasers operations;
- Processing Run of Mine (ROM) ore from Coronation North, Deepdell North, Frasers and underground mine sources;
- Ongoing mining in Coronation North, Deepdell North and Frasers pits.
- Ongoing construction of the Coronation North, Deepdell East, and Frasers East Waste Rock Stack (WRS);
- Partial backfill of Coronation North, Frasers and Gay Tans pits, Frasers West pit and Deepdell North Pit;
- Ongoing construction of the Top Tipperary Tailings Storage Facility Embankment;
- Progressive rehabilitation of Trimbells Gully WRS, Coronation North, Frasers East and Deepdell East WRS,

7.2.1 Mining 2023

In summary for the calendar 2023 year, OGNZL intends using the current mining fleet and mining practices to mine 8.1 Mt @ 0.80g gold/t of ore from Deepdell North, Frasers West, Gay Tan, Frasers Underground and Golden Point Underground. Approximately 2 Mt will be added to stockpiles. This ore will be fed into the existing processing plant using the same gold recovery methodologies as used in 2022.

7.3 Control Level Indicated by Dust Monitoring Results

Dust is being managed effectively as:

- The majority of the dust deposition results were less than the consent limit. There was only one exceedance of the consent limit of 3 g/m^2/30 days. The deposition rate during this period was calculated to be 3.4 g/m^2/30 days.
- Although several TSP exceedances were recorded at each of the monitoring sites DG07, DG11 and DG15, nearly all of them can be attributed to the monitoring instrument being affected by fog during high relative humidity conditions.
- The monthly average of 24-hourly average TSP ranges from 6.8 - 40.9 µg/m^3 for DG07, 10 – 41.1 µg/m^3 for DG11 and 2.1 – 23.1 µg/m^3 for DG15, indicating that for much of the time TSP concentrations are low compared to the consent limit.

7.4 Ongoing TSP Monitoring at DG07 and DG11

Condition 5(e) of consent RM20.24.12 allows for review of the need for ongoing monitoring at DG07. Similarly, condition 6(a)(e) of consent RM10.351.52.V1 allows for review of the need for ongoing monitoring at DG11. In both cases, the total suspended particulate monitoring may be amended or suspended if such agreement is provided in writing by the Consent Authority.

The TSP monitor at DG07 had a reasonably low data collection rate and therefore, did not provide a full set of monitoring data over the year. Generally, the dust emissions are low as shown by the monthly average 24-hour average results. This site is in a separate valley to DG11 and DG15 and therefore provides monitoring data representative of that separate location. It is recommended this site continues to assist in the monitoring and management of mine dust in that area. In addition, a local meteorological station should be installed at DG07 to allow for determination of windy conditions (>5 m/s) to aid in dust management in that valley.

The TSP monitor at DG11 is located close to DG15 (843 m away WSW see Figure 7-1) and therefore the monitoring results are similar as shown in Figure 6-1. It is recommended that DG11 is decommissioned as DG15 is representative of the TSP concentrations in the Macraes area.

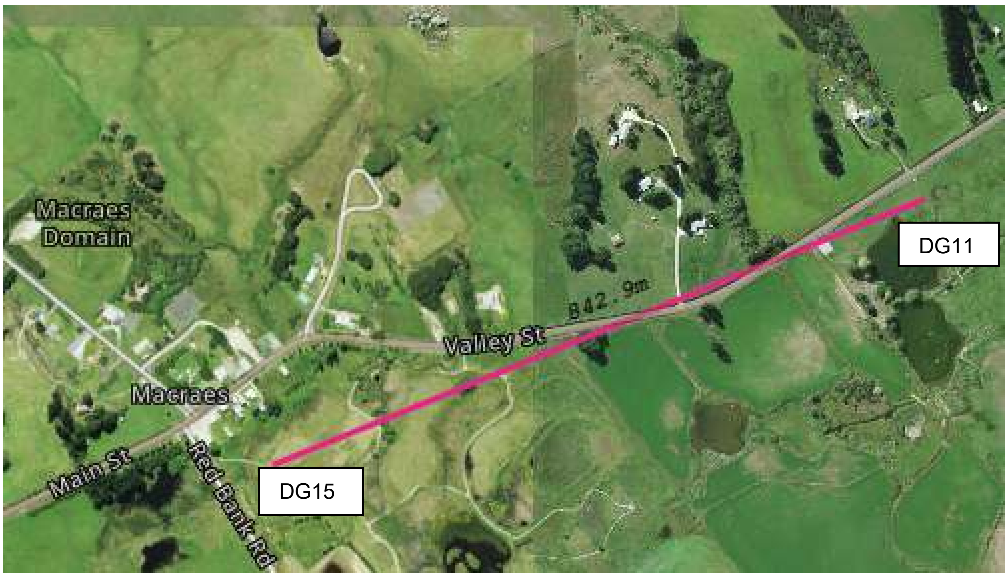

Figure 7-1. Relative locations of DG11 and DG15

A

Appendix A – Consent Monitoring Requirements

Consent Monitoring Requirements

The monitoring requirements for each consent and the consent limits are summarised in Table A1 for dust deposition and Table A2 for total suspended particulate matter. The dust deposition monitoring method is ISO Standard ISO/DIS 4222.2. TSP monitoring is undertaken using a nephelometer sited in accordance with AS/NZS 3580.1.1:2007. For the first year of the consents Hi-vol monitoring has been required at several sites, it is assumed that this monitoring has been undertaken and there is no further monitoring required using that method.

Table A1. Summary of Dust Deposition Monitoring Consent requirements

Consent Number	Cnd No	Insoluble Dust Deposition sites	Dust Limit, $g/m^2/30$ days above background
96785_V5 most of site	7	DG07, DG20 and DG21	≤3 for no more than twice per year
	8	DG02 and DG15	≤3
	8a	DG09, DG10 and DG24 averaged	Background
RM10.351.52.V1 Frasers Pit	6	DG07, DG11, DG20 and DG21	≤3 for no more than twice per year
	7	DG02 and DG15	≤3
	8	DG09, DG10 and DG17 averaged	Background
RM12.378.15 Coronation	4	DG07, DG20, DG21, DG22 and DG23	≤3 for no more than twice per year
	5	DG02 and DG15	≤3
	6	DG09, DG10 and DG24 averaged	Background
RM16.138.19.V1 Coronation	4	DG07, DG20, DG21, DG22 and DG25	≤3 for no more than twice per year
	5	DG02 and DG15	≤3
	6	DG09, DG10 and DG24 averaged	Background
RM20.24.12 Deepdell	7	DG07 and DG17	≤3 for no more than twice per year
	9	DG09, DG10 and DG24 averaged	Background

Table A2. Summary of Total Suspended Particulate Matter Monitoring Consent requirements

Consent Number	Cnd No	TSP sites	Dust Limit and Averaging Period
96785_V5 most of site	9 and 12c	DG15	120 $\mu g/m^3$ 24hr average
RM10.351.52.V1	6a	DG11	80 $\mu g/m^3$ 24hr average, 250 1 hourly
	9 and 12c	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly
RM12.378.15	7 and 10c	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly
RM16.138.19.V1	7 and 10c	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly
RM20.24.12	5c	DG07 Howard Res[9]	80 $\mu g/m^3$ 24hr average, 250 1 hourly
	10 and 13b	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly

[9] 406 Horse Flat Road

Meteorological Monitoring requirements are presented in Table A3.

Table A3. Summary of Meteorological Monitoring Consent requirements

Consent Number	Condition No	Met sites	Wind speed	Wind Dir.	Temperature	Rainfall	Solar Radiation	Humidity
96785_V5 most of site	14a	DG03	Y	Y	Y, 2 heights[10]	Y	Y	Extra
	14b	DG15	Y	Y	Y	Y		
RM10.351.52.V1	13a	DG03	Y	Y	Y, 2 heights	Y	Y	Extra
	6a(d)	DG11	Y	Y				
	13b	DG15	Y	Y	Y	Y		
RM12.378.15	11a	DG03	Y	Y	Y, 2 heights	Y	Y	Extra
	11b	DG15	Y	Y	Y	Y		
RM16.138.19.V1	11a	DG03	Y	Y	Y, 2 heights	Y	Y	Extra
	11b	DG15	Y	Y	Y	Y		
RM20.24.12	5d	DG07	Y	Y				

Note: meteorological monitoring was not undertaken at DG07 and DG11.

[10] Used to estimate atmospheric stability with solar radiation.

B

Appendix B – Reviewer's Qualifications

Reviewer's Experience

Rhys Kevern has over 30 years' engineering experience with over 24 years of specialist knowledge with air quality issues arising from industrial operations such as timber processors and chemical industries. He has worked for a Regional Council, Consultancy and Industry. His experience includes reviewing site operations for regulatory compliance and the preparation and processing of consent applications, the use of air dispersion modelling, reviewing the appropriateness of air pollution control technologies and has undertaken source and ambient monitoring. He has facilitated location compliance certificates for hazardous substance storage locations and assessed bulk storage tank compliance against API650. Rhys is also familiar with international food contact material regulations and FSSC22000.

C

Appendix C – Watercare Quarterly Reports

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Summer 2022

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2022-057

Ambient Air Quality Monitoring
Quarterly Summary Report
Summer 2022

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

25 March 2022

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

Watercare report number: AQ-2022-057
Watercare reference: 15-54681

Author

Kath McLeod
Senior Air Quality Technician
Data Management Team
Watercare Services Ltd

Peer Reviewer & Authoriser

Vilani Abeyratne
Ambient Data - Team Leader
Data Management Team
Watercare Services Ltd

Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Summer 2022 (December 2021 to February 2022) showed:

At DG15:

- There was one exceedence of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 84%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 142 µg/m³ was on 15 January 2022.
- There were higher (>200 µg/m³) TSP E-Sampler hourly concentrations from all directions except south east to south-southeast, west-southwest and northwest.
- Elevated (>20 µg/m³) diurnal TSP hourly concentrations occurred from 01:00 to 06:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the east.

At DG03:

- Valid data captured for ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%
- The predominant wind direction was from the east.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Summer 2022
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Summer 2022.

Table 2: Site performance Summer 2022

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	84	No valid data from 09/09/2021 to 15/12/2021 due to an instrument fault. Due to covid-19 restrictions there were limited site visits.
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Summer 2022. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there were four exceedences of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration of 142 µg/m³ was on 15 January 2022. The 1-hour TSP concentrations greater than 200 µg/m³ (Figure 3) came from all directions except south east to south-southeast, west-southwest and northwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred from 01:00 to 06:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
December 2021	0	6	38
January 2022	1	23	142
February 2022	1	13	70
Summer 2022	**0**	**16**	**142 15/01/2022**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		15/01/2022 – 142 µg/m³	
Wind direction (DG15)			
Hourly TSP >300 µg/m³		NNW-E, S, SW & WSW	
Diurnal variation			
Hourly Diurnal TSP >20 µg/m³		01:00 – 06:00	

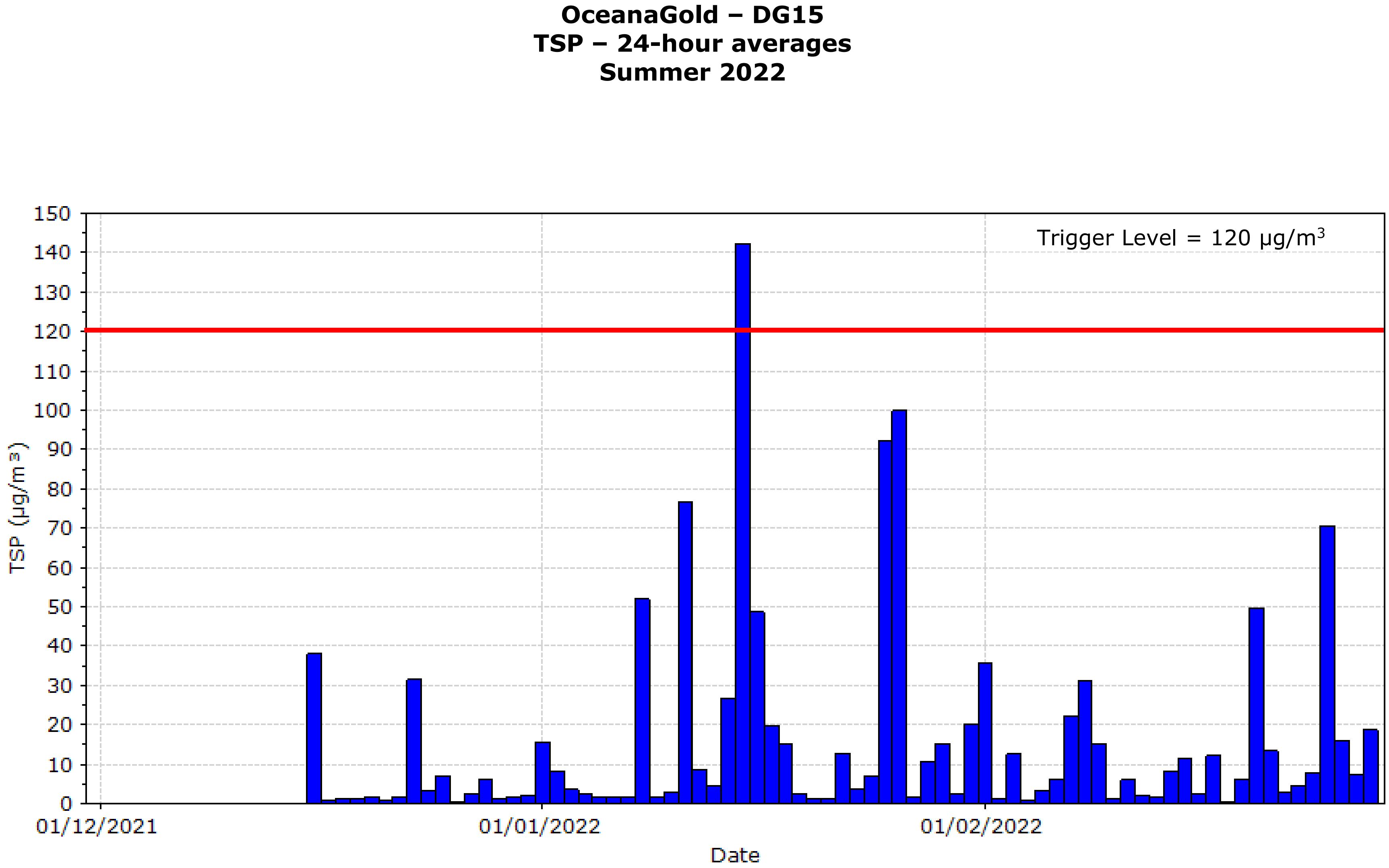

Figure 2: OceanaGold – DG15: TSP E-Sampler (24-hour averages)

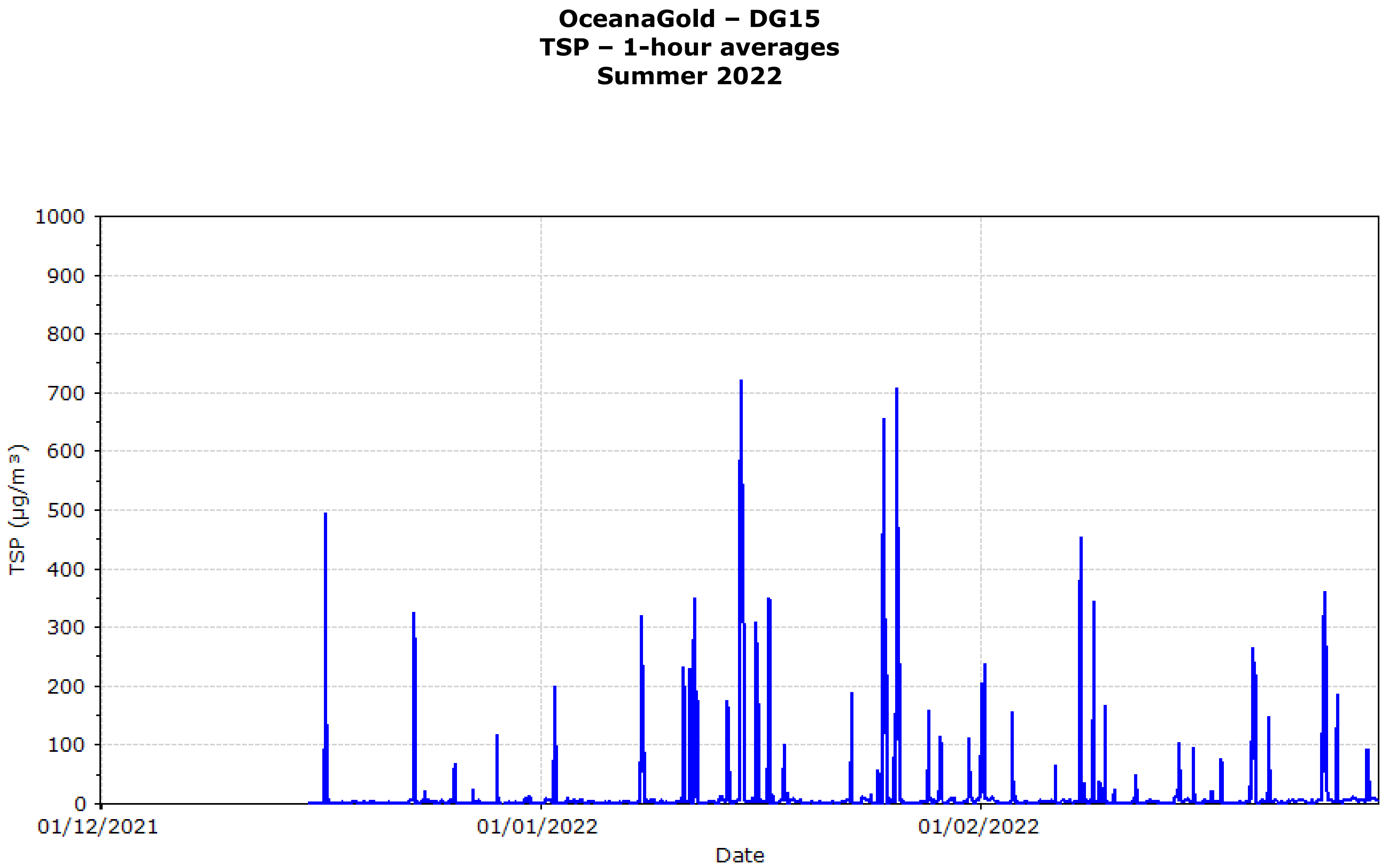

Figure 3: OceanaGold – DG15: TSP E-Sampler (1-hour averages)

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Summer 2022

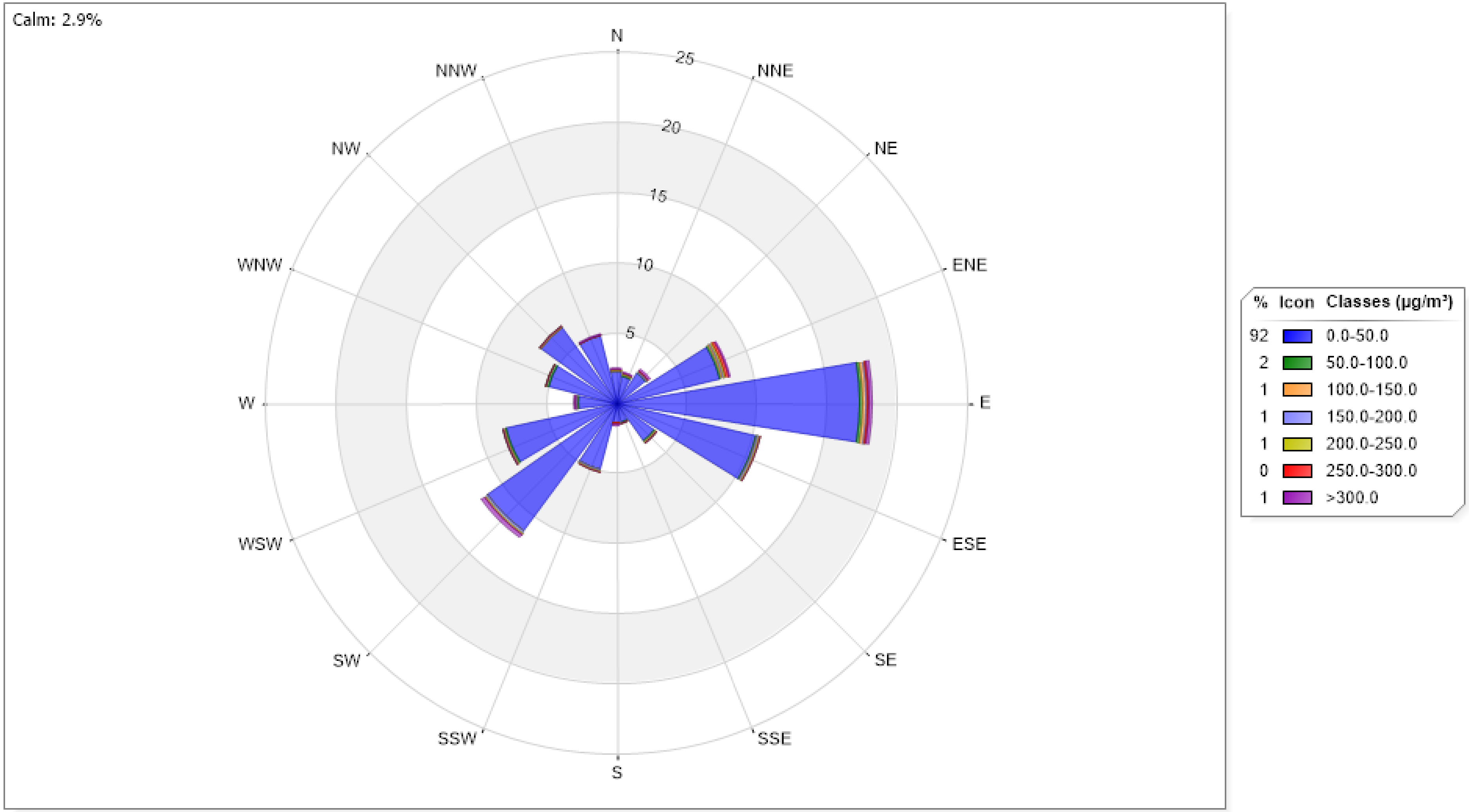

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

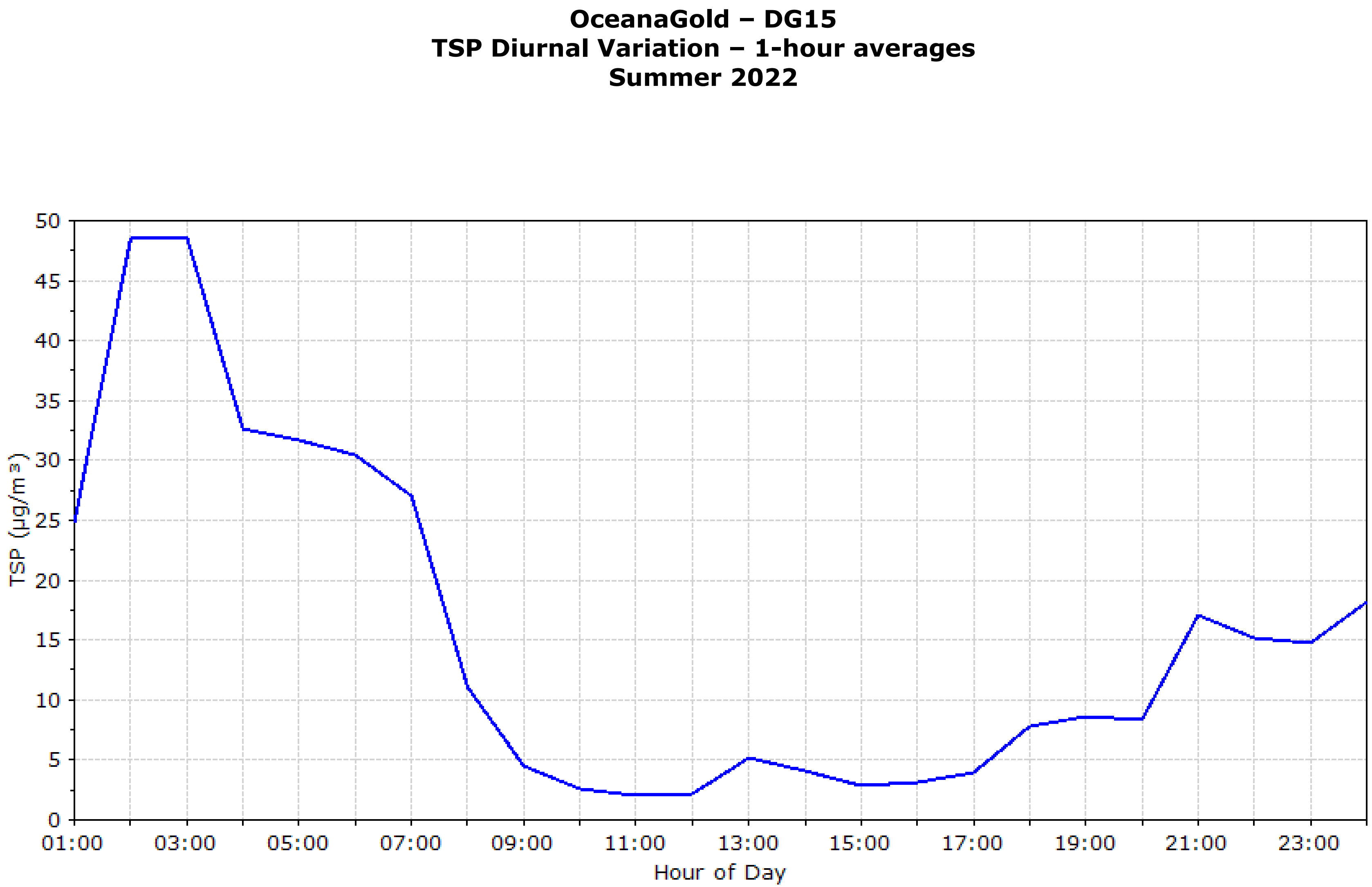

Figure 5: **OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)**

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Summer 2022 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	4.1	12.1	24.5
January 2022	0.9	13.5	27.6
February 2022	0.1	12.3	28.5
Summer 2022	**0.1 28/02/2022 06:00**	**12.7**	**28.5 02/02/2022 15:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	6.4	12.1	18.6
January 2022	9.0	13.5	20.9
February 2022	7.3	12.3	22.2
Summer 2022	**6.4 06/12/2021**	**12.7**	**22.2 02/02/2022**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
December 2021	E	1.9	3.2	11.3
January 2022	E	2.3	3.0	11.8
February 2022	E	4.9	2.6	8.7
Summer 2022	**E**	**3.0**	**2.9**	**11.8**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
December 2021	3.1	26.6	96.8	16
January 2022	0.8	13.8	24.6	8
February 2022	2.4	32.6	66.4	13
Summer 2022	**2.1**	**32.6**	**187.8**	**37**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Summer 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	41	10	1	0	0	0	52	2.4
NNE	36	6	3	0	0	0	45	2.1
NE	45	13	4	0	0	0	62	2.9
ENE	75	104	27	1	0	0	208	9.6
E	74	218	129	11	0	0	432	20.0
ESE	52	98	83	1	0	0	235	10.9
SE	41	31	2	0	0	0	74	3.4
SSE	19	12	1	0	0	0	32	1.5
S	23	7	3	0	0	0	33	1.5
SSW	34	41	26	15	0	0	116	5.4
SW	59	91	48	39	16	1	255	11.8
WSW	58	38	34	22	5	0	157	7.3
W	34	20	5	0	0	0	59	2.7
WNW	39	27	22	7	1	0	96	4.5
NW	44	30	35	15	3	2	129	6.0
NNW	56	43	6	3	0	0	108	5.0
All	**732**	**790**	**431**	**115**	**25**	**3**	**2096**	**97**
Calm	64						64	3.0

Table 8 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from the southwest and northwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the east.

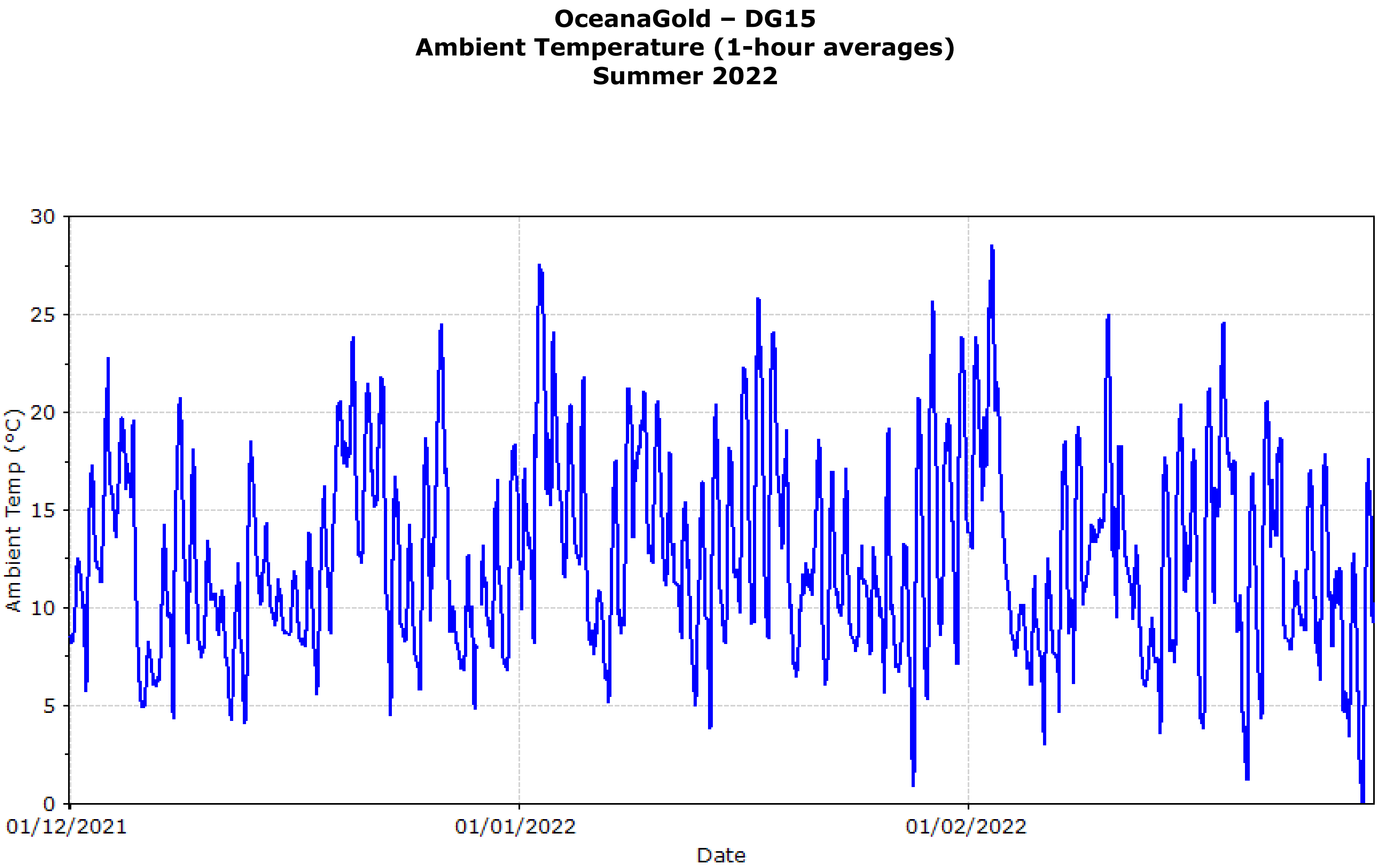

Figure 6: OceanaGold – DG15: Ambient Temperature (1-hour averages)

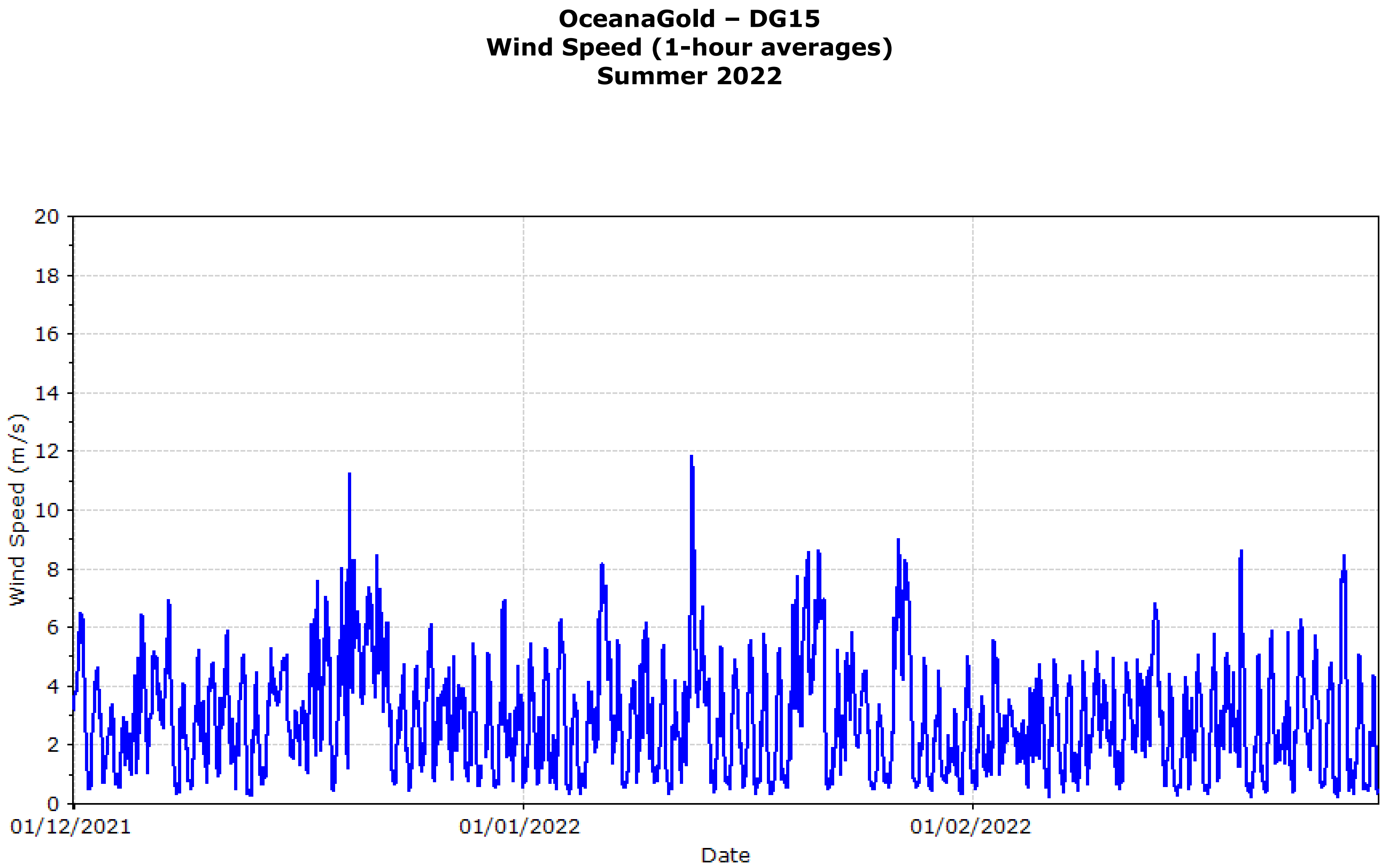

Figure 7: **OceanaGold – DG15: Wind Speed (1-hour averages)**

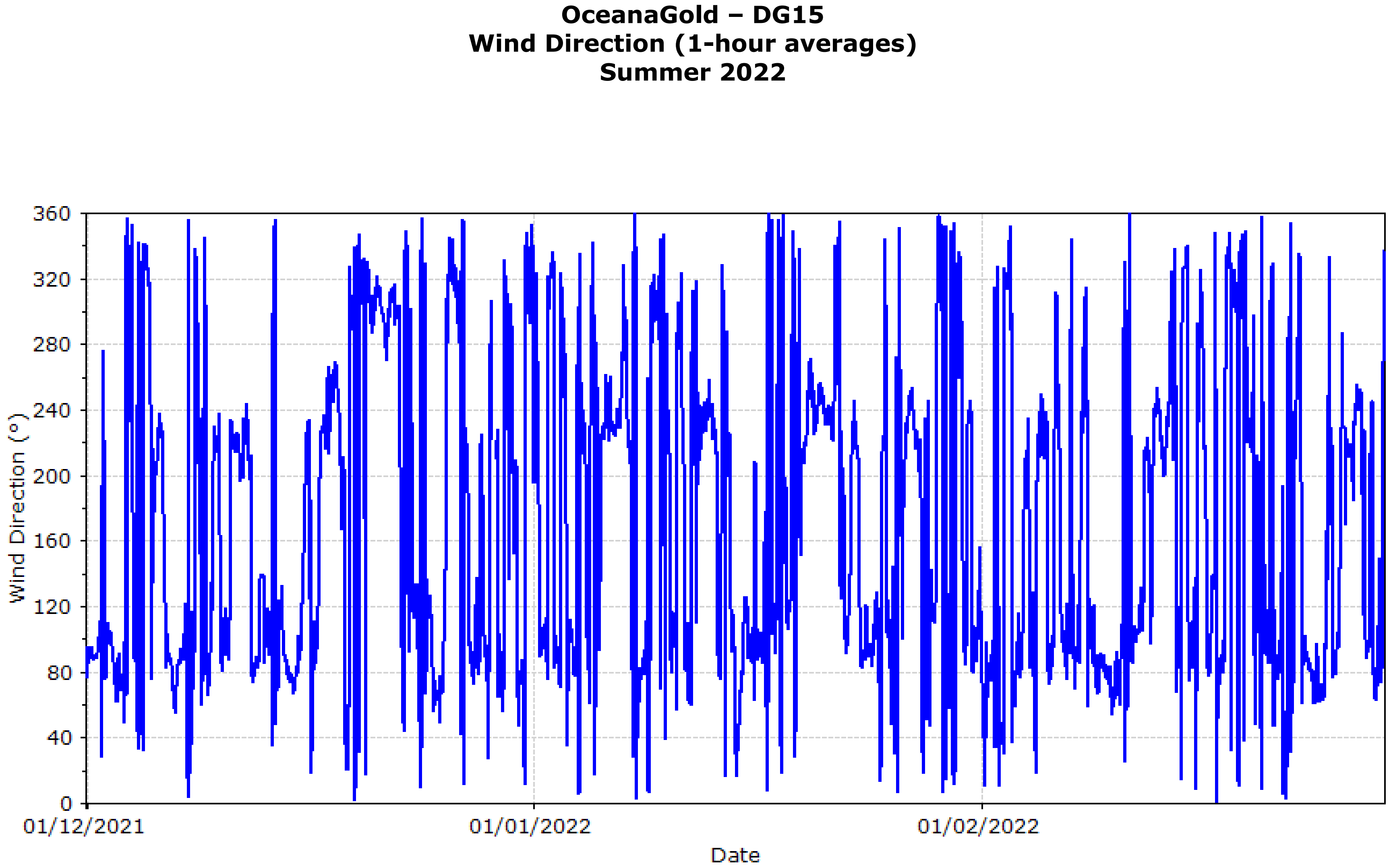

Figure 8: **OceanaGold – DG15: Wind Direction (1-hour averages)**

OceanaGold – DG15
Wind Rose (1-hour averages)
Summer 2022

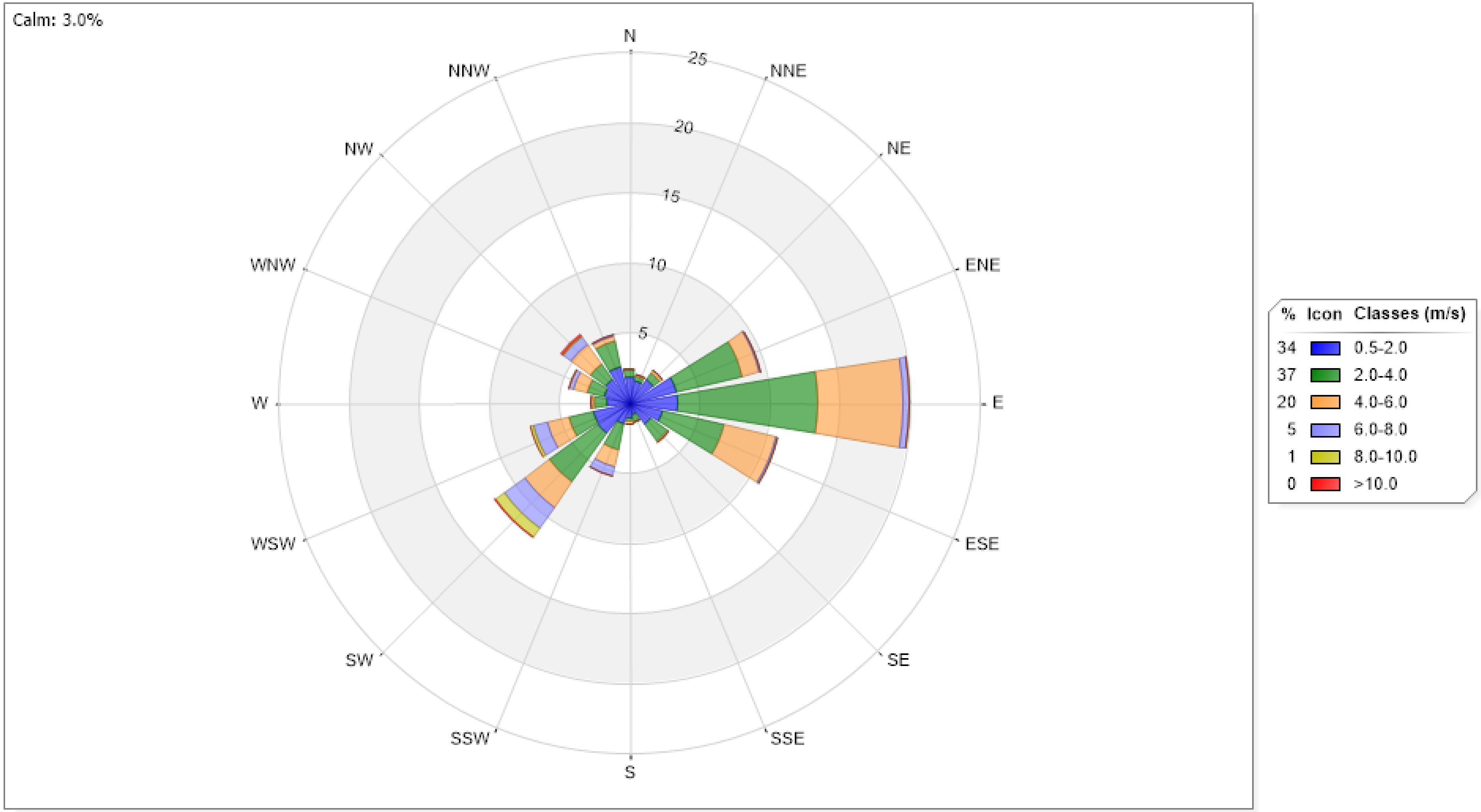

Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

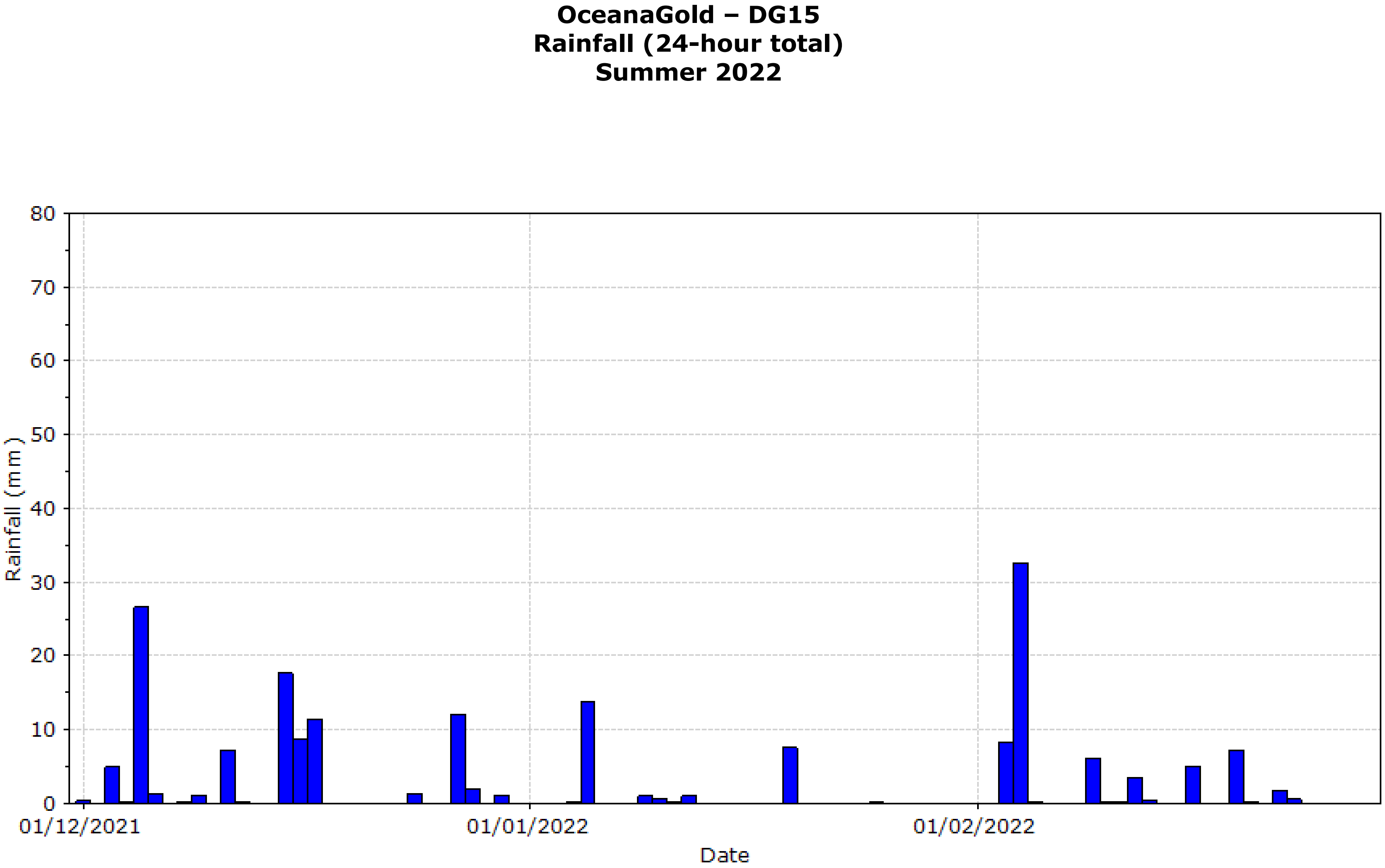

Figure 10: **OceanaGold – DG15: Rainfall (24-hour total)**

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Summer 2022 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	4.0	11.9	25.0
January 2022	2.7	13.7	27.5
February 2022	2.0	12.4	28.8
Summer 2022	**2.0** **28/02/2022 06:00**	**12.7**	**28.8** **02/02/2022 15:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	4.2	11.8	23.7
January 2022	4.1	13.5	27.0
February 2022	3.8	12.4	28.3
Summer 2022	**3.8** **28/02/2022 04:00**	**12.6**	**28.3** **02/02/2022 15:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
December 2021	30.6	82.5	100.0
January 2022	19.5	79.9	100.0
February 2022	34.7	84.7	100.0
Summer 2022	**19.5**	**82.3**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	6.0	11.9	18.2
January 2022	8.7	13.7	21.6
February 2022	7.0	12.4	22.3
Summer 2022	**6.0** **06/12/2021**	**12.7**	**22.3** **02/02/2022**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	5.8	11.8	18.2
January 2022	8.6	13.5	21.8
February 2022	6.9	12.4	22.5
Summer 2022	**5.8** **06/12/2021**	**12.6**	**22.5** **02/02/2022**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2021	43.8	82.5	99.5
January 2022	57.0	79.9	98.8
February 2022	45.6	84.7	100.0
Summer 2022	**43.8**	**82.3**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
December 2021	E	0.3	4.1	18.9
January 2022	E	0.7	3.3	11.4
February 2022	E	1.8	3.1	10.5
Summer 2022	E	**0.9**	**3.5**	**18.9**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
December 2021	2.7	22.8	83.6	17
January 2022	0.8	15.2	26.2	7
February 2022	2.5	37.0	69.8	12
Summer 2022	**2.0**	**37.0**	**179.6**	**36**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
December 2021	55.3	201.6	371.2
January 2022	81.2	236.7	356.0
February 2022	48.3	190.4	315.0
Summer 2022	**48.3 22/02/2022**	**210.2**	**371.2 25/12/2021**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Summer 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	38	23	1	1	0	0	63	2.9
NNE	67	47	5	1	0	0	120	5.6
NE	58	69	29	1	0	0	157	7.3
ENE	64	167	60	0	0	0	291	13.5
E	56	188	174	12	0	0	430	19.9
ESE	32	32	9	0	0	0	73	3.4
SE	41	9	1	0	0	0	51	2.4
SSE	18	16	6	0	0	0	40	1.9
S	35	63	35	20	4	0	157	7.3
SSW	42	84	54	50	6	1	237	11.0
SW	32	39	19	2	0	0	92	4.3
WSW	33	22	7	4	0	0	66	3.1
W	30	22	14	12	8	13	99	4.6
WNW	23	22	28	40	29	29	171	7.9
NW	15	27	21	5	2	1	71	3.3
NNW	13	8	1	1	0	0	23	1.1
All	**597**	**838**	**464**	**149**	**49**	**44**	**2142**	**99**
Calm	18						18	0.8

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from south-southwest, west to northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the east.

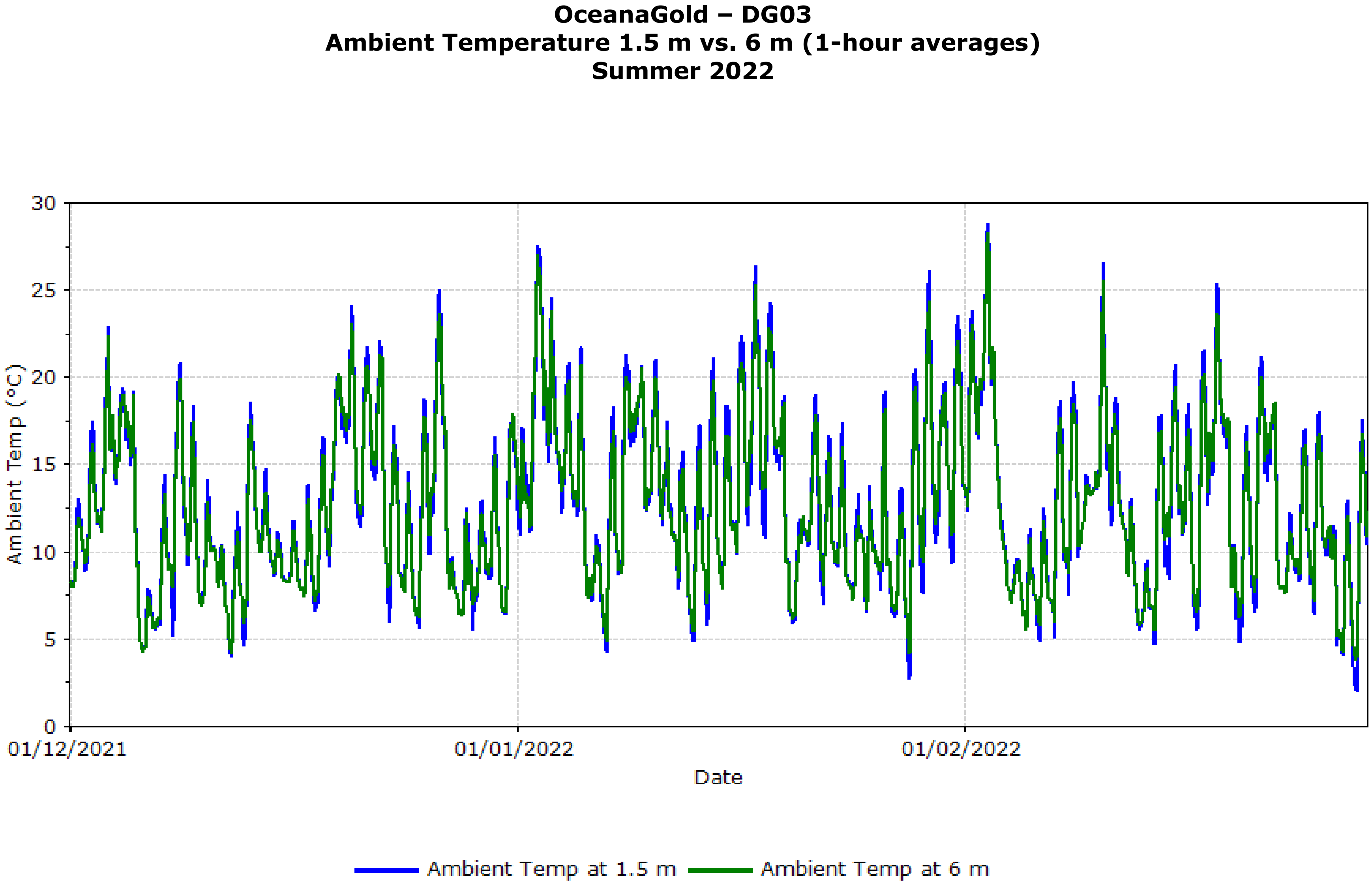

Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

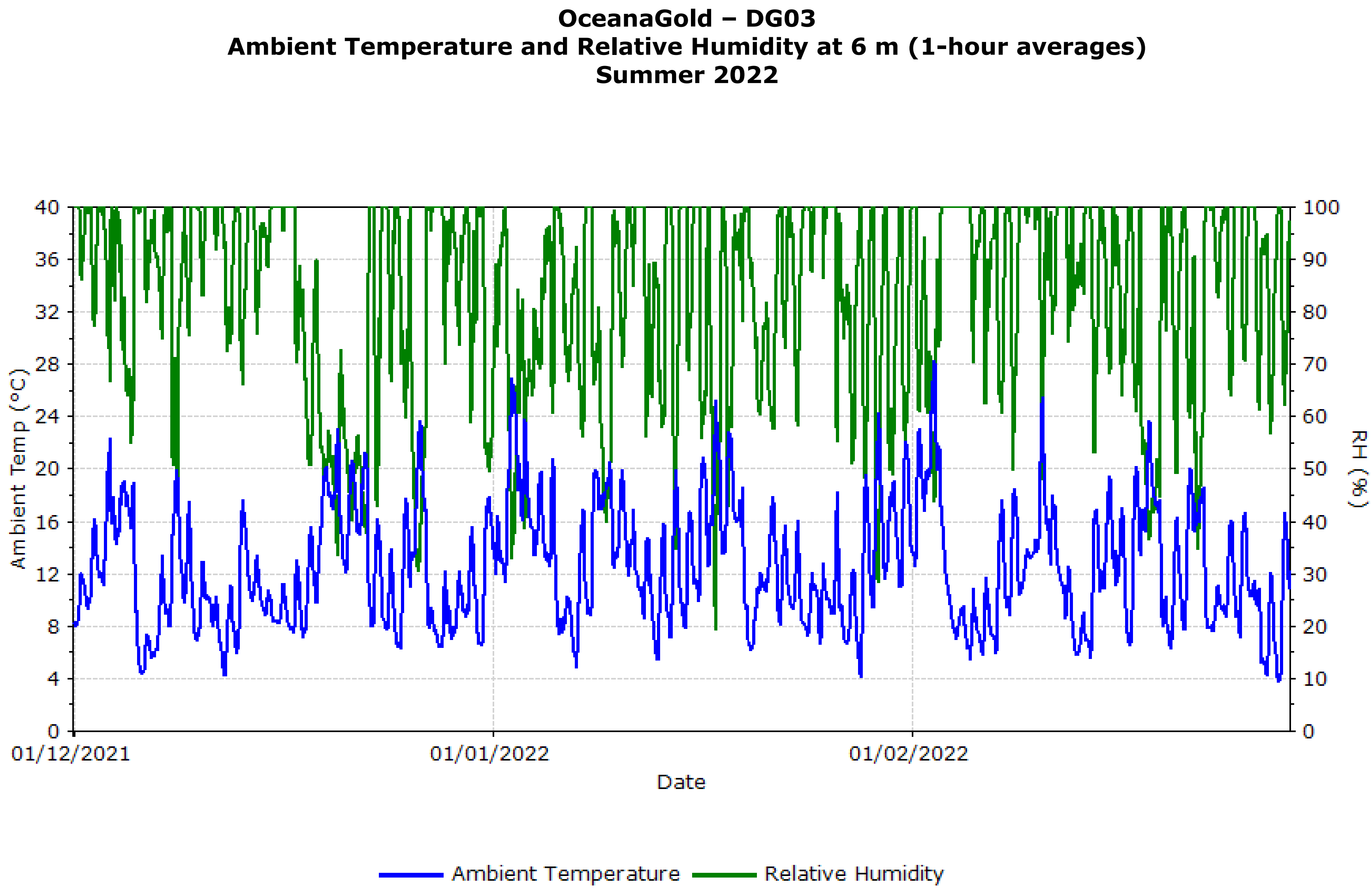

Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

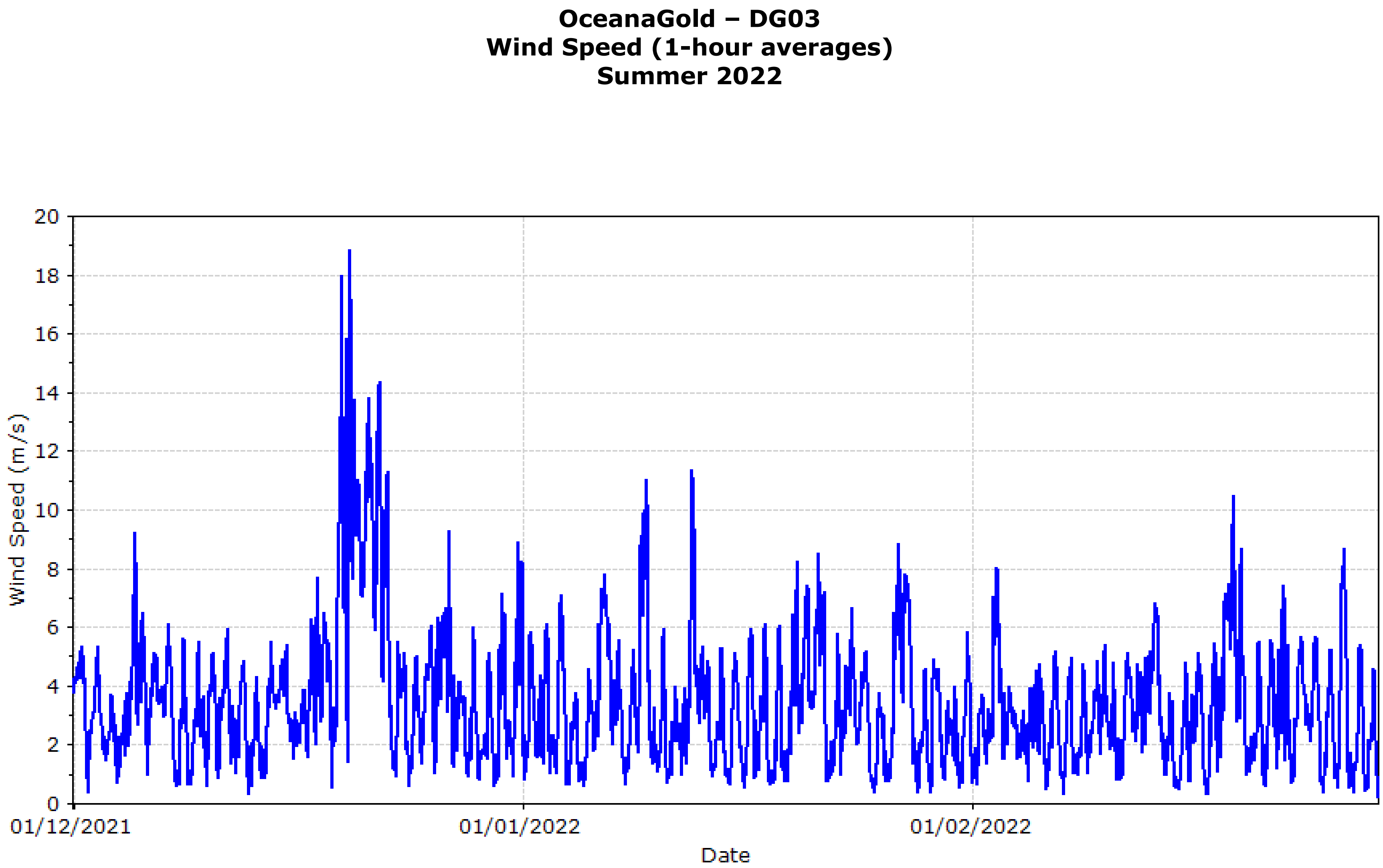

Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

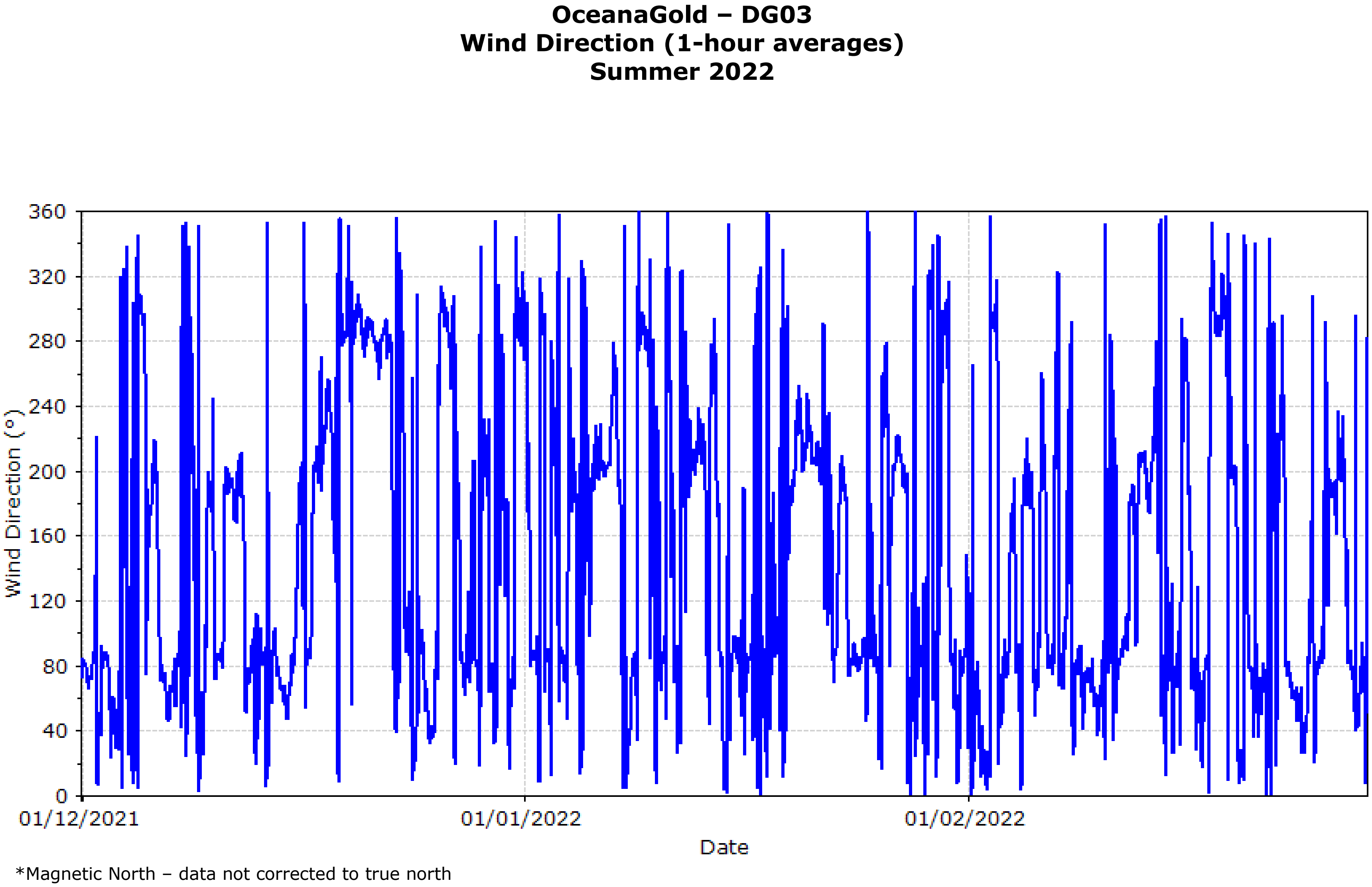

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

OceanaGold – DG03
Wind Rose (1-hour averages)
Summer 2022

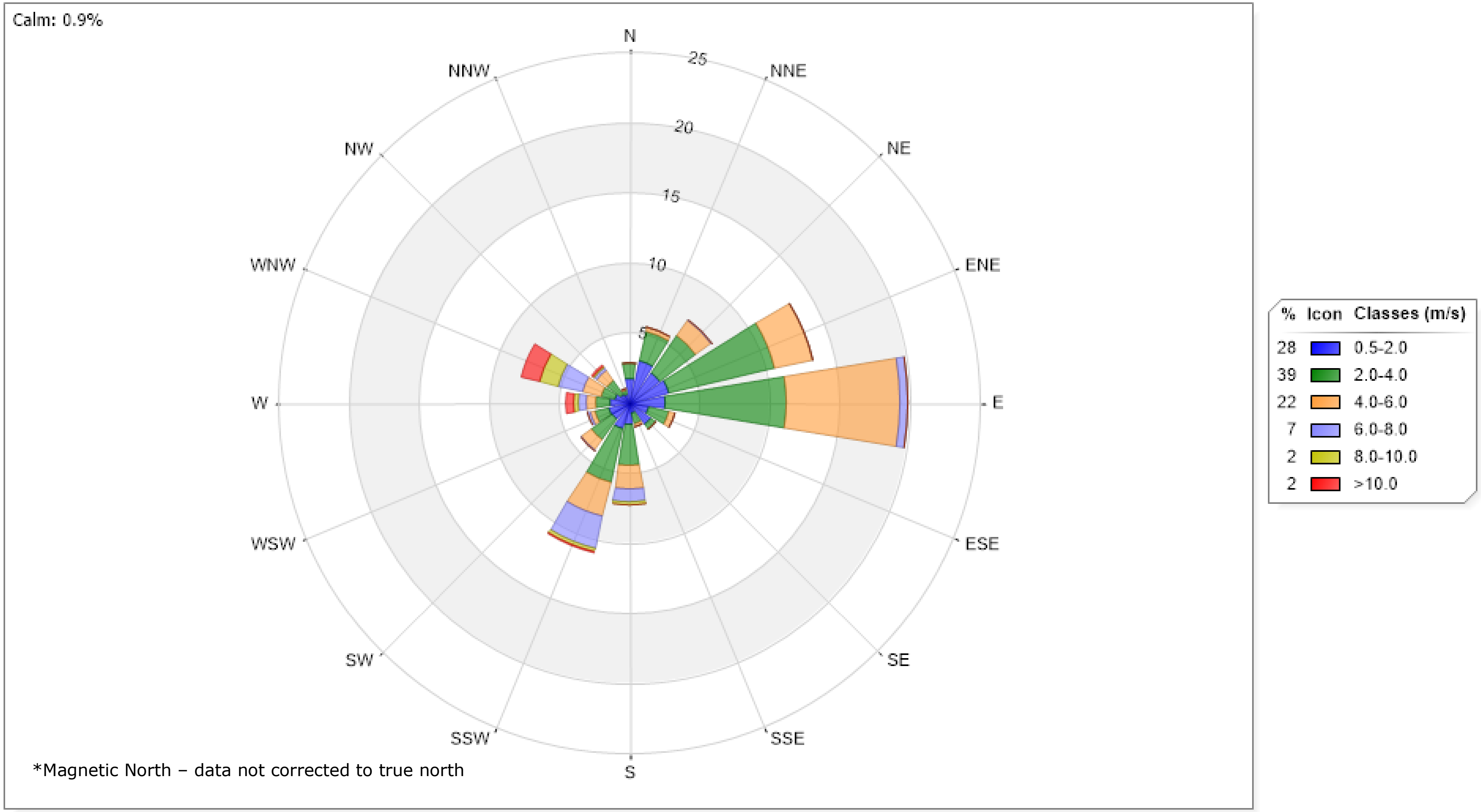

Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

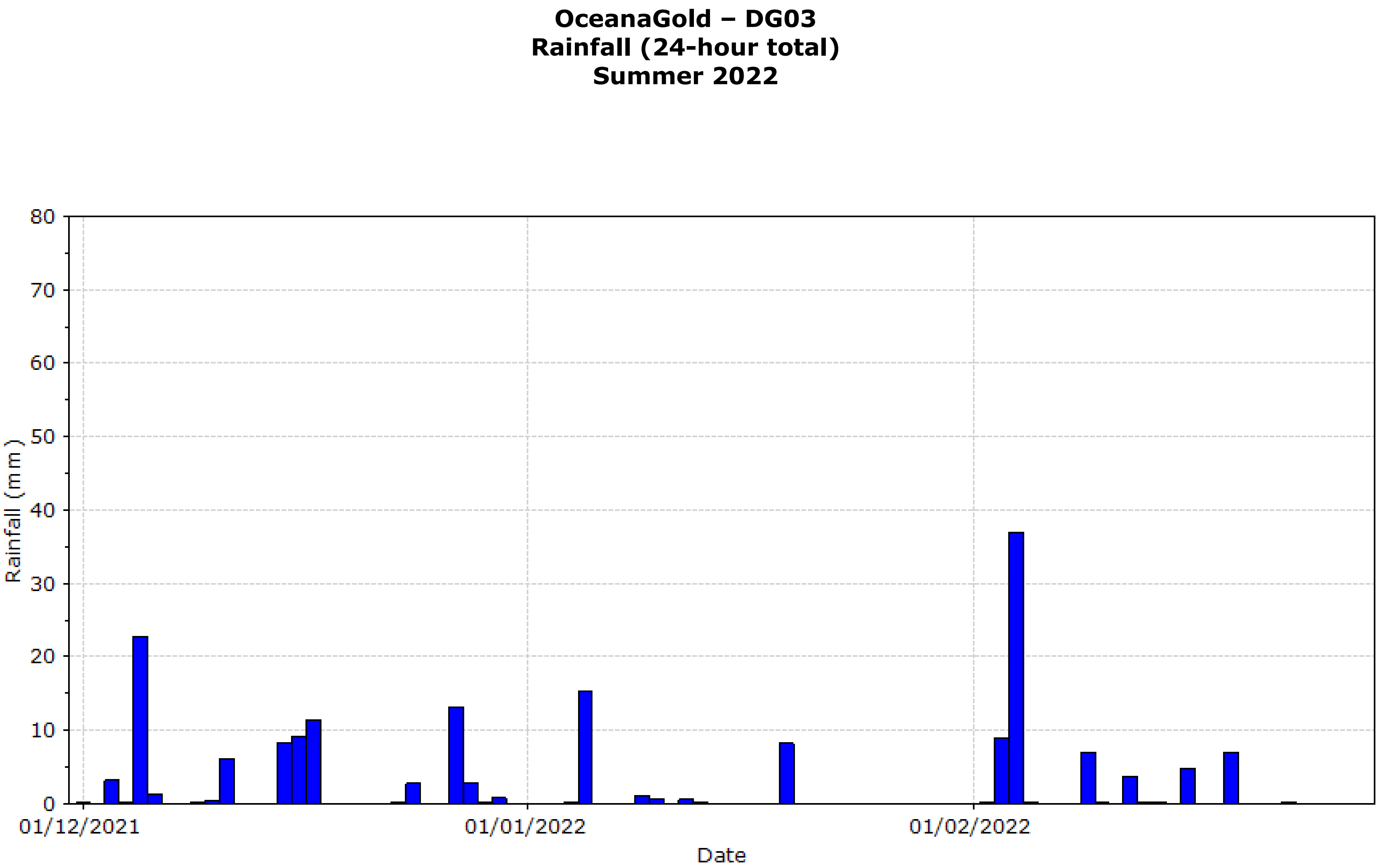

Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

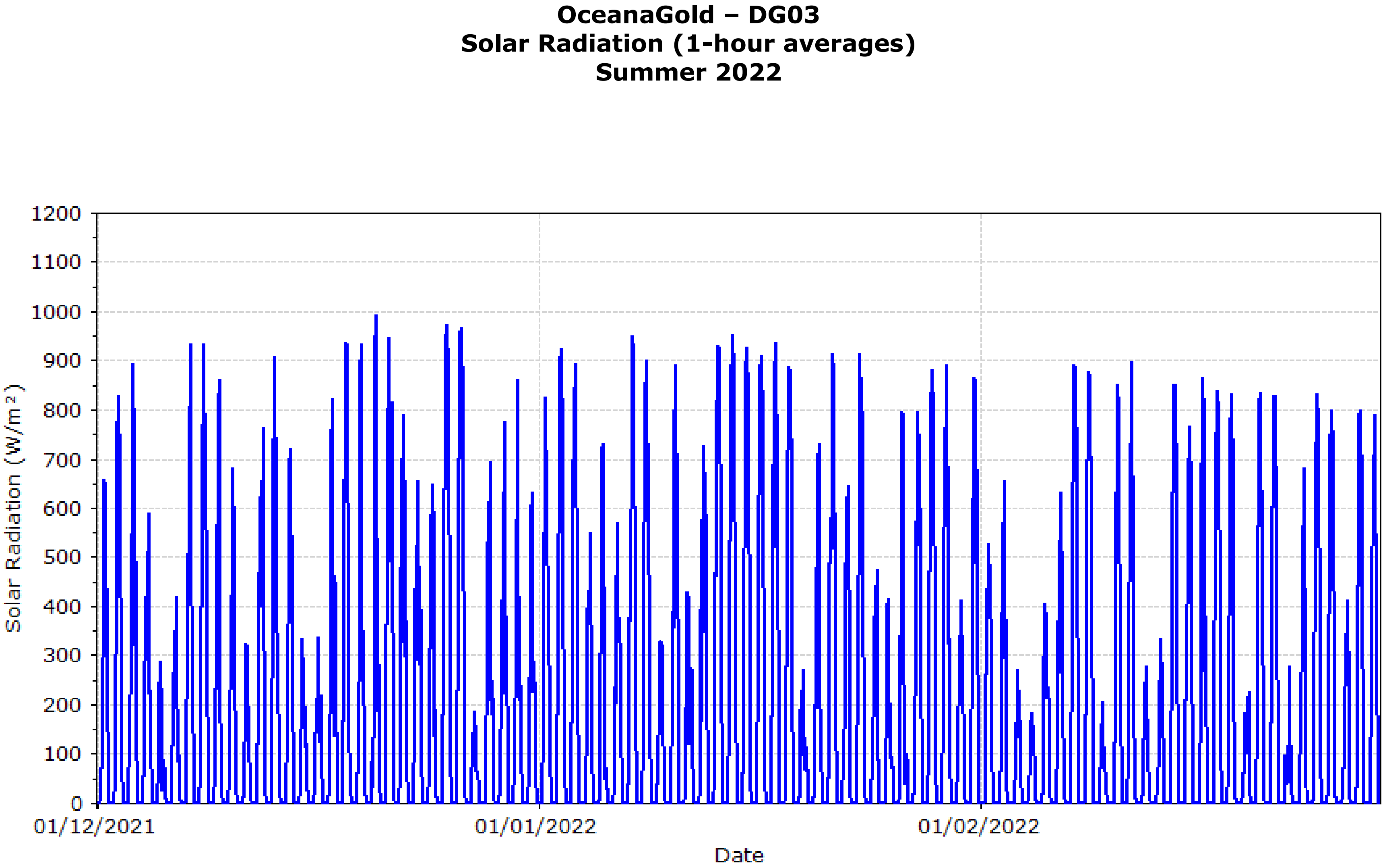

Figure 17: OceanaGold – DG03: Solar Radiation (1-hour averages)

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Ministry for the Environment (2002). *2002a. Ambient Air Quality Guidelines*. MfE, Wellington, New Zealand.

Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	10-12-20	2415	Annual Maintenance	Parameter Check	B Kaushal
	14-01-21	2415	Callout	Clean & Repair	H MdAli
	10-02-21	2415	Callout	Removed	J Abraham
	24-02-21	2415	Callout	Installed	J Abraham
	09-06-21	2415	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2415	Callout	Installed	H MdAli
Temperature sensor – Campbell Scientific 107					
	10-12-20	2418	Six-Monthly Maintenance	Parameter Check	B Kaushal
	09-06-21	2418	Six-Monthly Maintenance	Parameter Check	H MdAli
Anemometer – Vector A101M					
	10-12-20	2417	Six-Monthly Maintenance	Parameter Check	B Kaushal
	25-02-21	2417	Quarterly Maintenance	Parameter Check	J Abraham
	09-06-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
Wind vane – Vector W200P					
	10-12-20	2416	Six-Monthly Maintenance	Parameter Check	B Kaushal
	25-02-21	2416	Quarterly Maintenance	Parameter Check	J Abraham
	09-06-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
Rain gauge – TB3-0.2/P					
	10-12-20	2419	Six-Monthly Maintenance	Parameter Check	B Kaushal
	25-02-21	2419	Quarterly Maintenance	Parameter Check	J Abraham
	09-06-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli

OceanaGold NZ Limited

Ambient Air Quality Monitoring Quarterly Summary Report Autumn 2022

Prepared for

OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2022-101

Ambient Air Quality Monitoring
Quarterly Summary Report
Autumn 2022

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

16 June 2022

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

Watercare report number: AQ-2022-101
Watercare reference: 15-54681

Author

Kath McLeod
Senior Air Quality Technician
Data Management Team
Watercare Services Ltd

Peer Reviewer & Authoriser

Vilani Abeyratne
Ambient Data - Team Leader
Data Management Team
Watercare Services Ltd

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Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Autumn 2022 (March 2022 to May 2022) showed:

At DG15:

- There were no exceedences of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 100%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 109 µg/m³ was on 28 March 2022.
- There were higher (>200 µg/m³) TSP E-Sampler hourly concentrations from all directions except south-southwest to west-southwest.
- Elevated (>20 µg/m³) diurnal TSP hourly concentrations occurred from 22:00 to 07:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the east and west-southwest.

At DG03:

- Valid data captured for ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%
- The predominant wind direction was from the east-northeast.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Autumn 2022
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Autumn 2022.

Table 2: Site performance Autumn 2022

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	100	-
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Autumn 2022. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there were no exceedences of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration of 109 µg/m³ was on 28 March 2022. The 1-hour TSP concentrations greater than 200 µg/m³ (Figure 3) came from south-southwest to west-southwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred from 22:00 to 07:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
March 2022	1	23	109
April 2022	0	15	59
May 2022	0	5	31
Autumn 2022	**0**	**14**	**109 28/03/2022**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		–	
Wind direction (DG15)			
Hourly TSP >200 µg/m³		all except SSW-WSW	
Diurnal variation			
Hourly Diurnal TSP >20 µg/m³		22:00 – 07:00	

OceanaGold – DG15
TSP – 24-hour averages
Autumn 2022

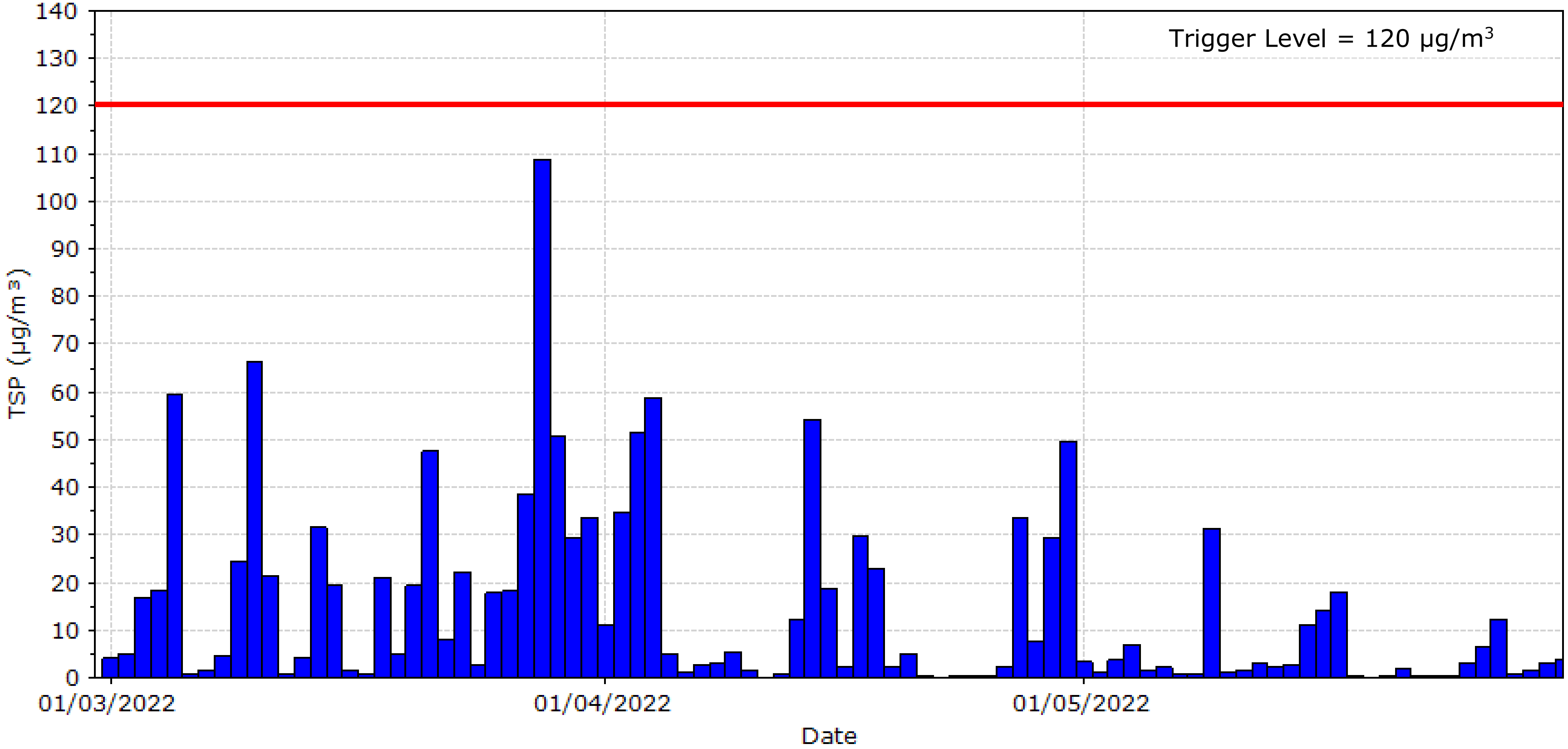

Figure 2: **OceanaGold – DG15: TSP E-Sampler (24-hour averages)**

OceanaGold – DG15
TSP – 1-hour averages
Autumn 2022

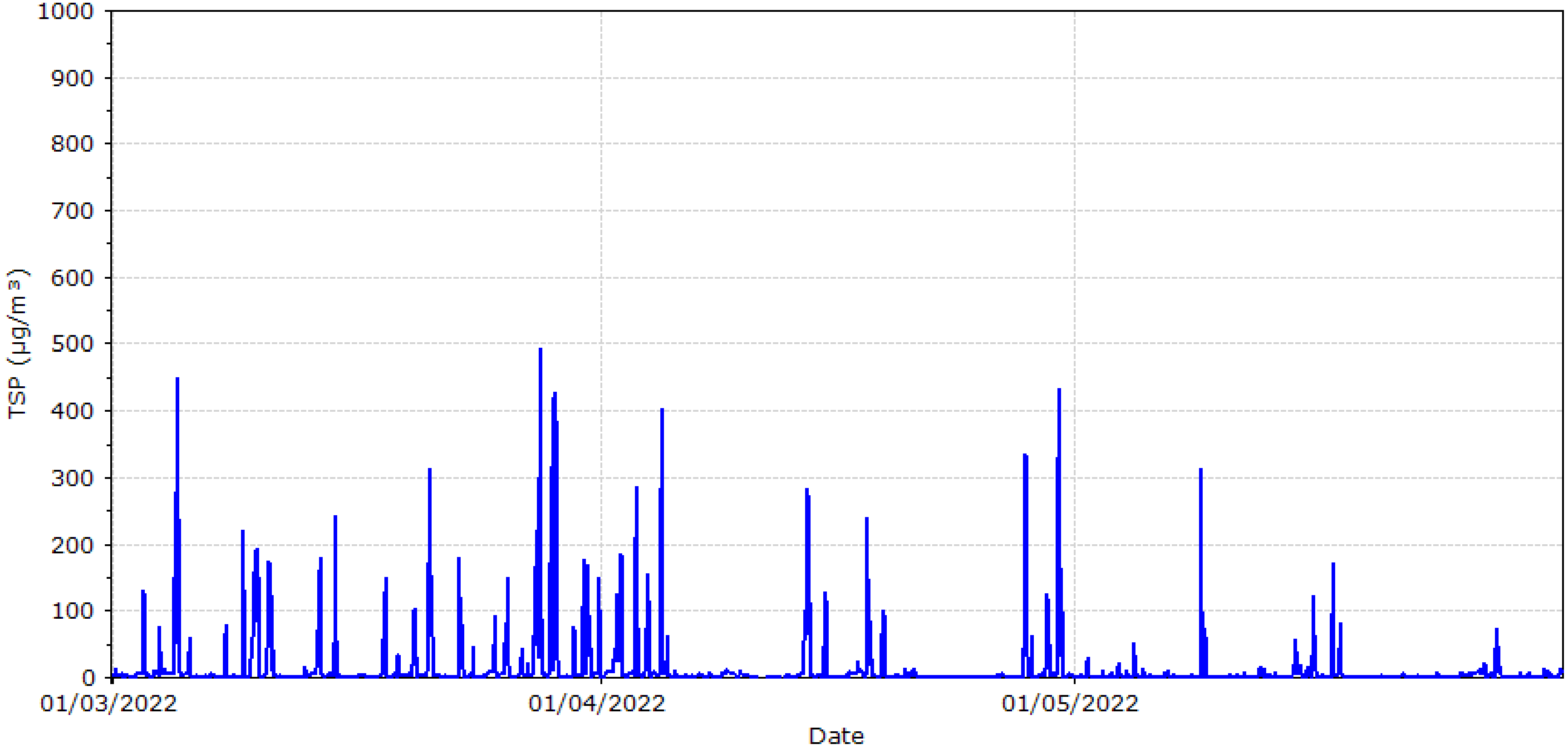

Figure 3: OceanaGold – DG15: TSP E-Sampler (1-hour averages)

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Autumn 2022

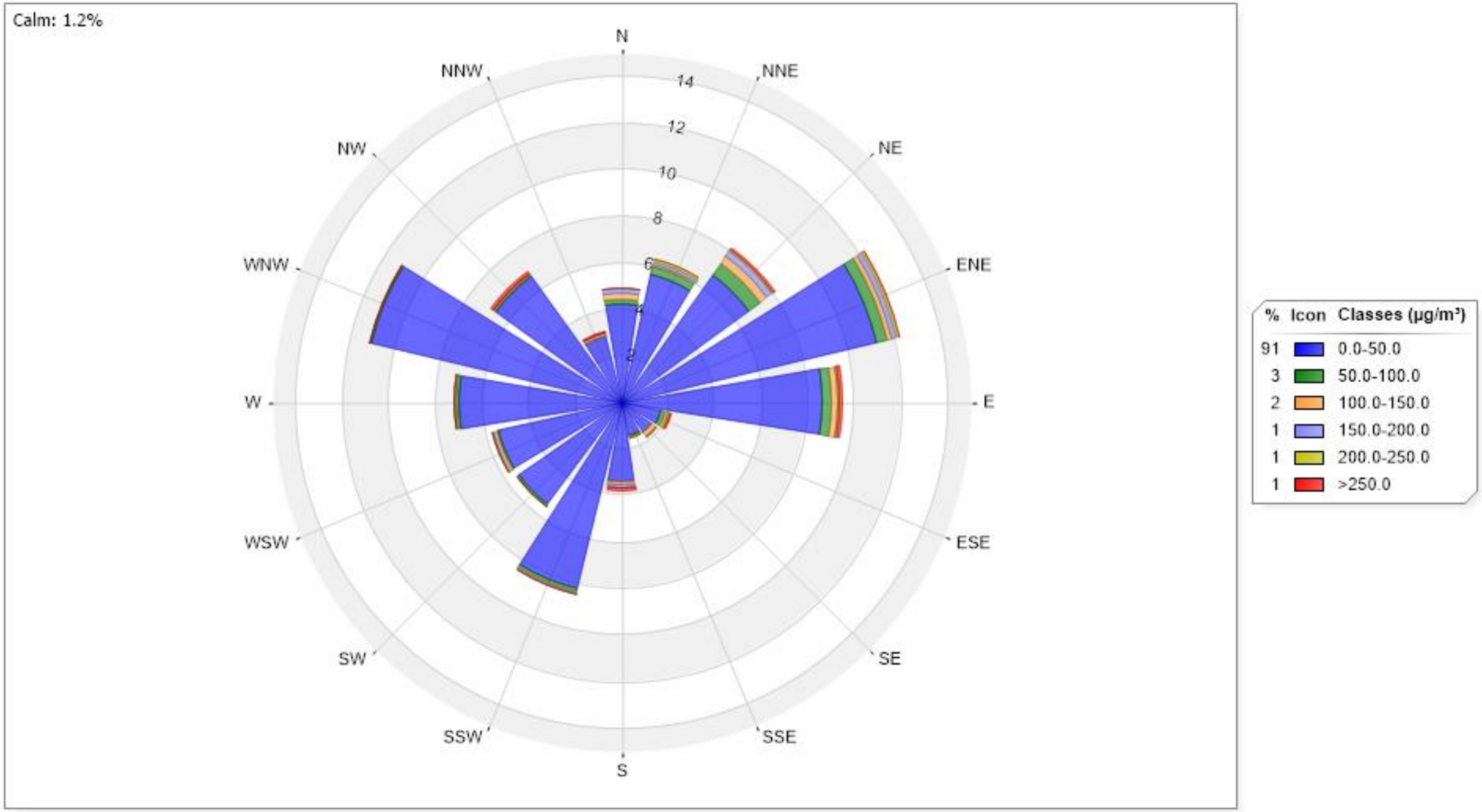

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

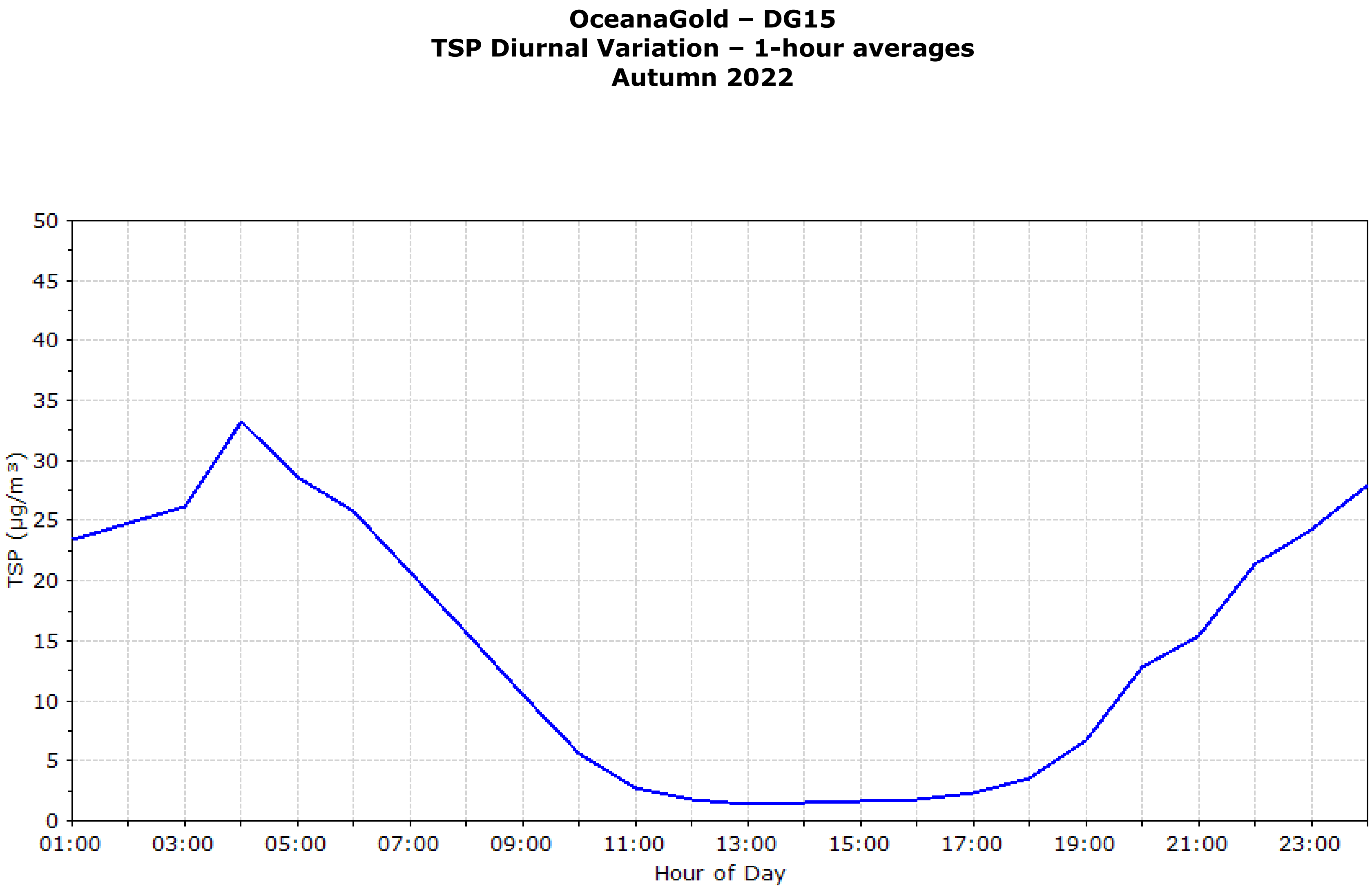

Figure 5: OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Autumn 2022 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	0.8	12.1	24.7
April 2022	-1.6	9.1	21.1
May 2022	-3.2	8.7	20.5
Autumn 2022	**-3.2 27/05/2022 08:00**	**10.0**	**24.7 06/03/2022 14:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	7.8	12.1	18.9
April 2022	5.1	9.1	14.1
May 2022	2.6	8.7	14.0
Autumn 2022	**2.6 27/05/2022**	**10.0**	**18.9 06/03/2022**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
March 2022	E	4.8	2.4	9.3
April 2022	WSW	6.5	2.6	10.6
May 2022	WSW	5.2	2.5	11.9
Autumn 2022	**E & WSW**	**5.5**	**2.5**	**11.9**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
March 2022	0.8	14.0	23.4	10
April 2022	0.8	12.0	23.6	10
May 2022	0.5	8.0	16.4	9
Autumn 2022	**0.7**	**14.0**	**63.4**	**29**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Autumn 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	91	13	1	0	0	0	105	4.8
NNE	82	7	0	0	0	0	89	4.0
NE	65	23	3	0	0	0	91	4.1
ENE	67	81	32	2	0	0	182	8.2
E	70	116	58	2	0	0	246	**11.1**
ESE	43	63	17	0	0	0	123	5.6
SE	27	5	3	0	0	0	35	1.6
SSE	20	3	0	0	0	0	23	1.1
S	24	5	0	0	0	0	29	1.3
SSW	28	21	11	3	0	0	63	2.9
SW	53	44	30	26	17	3	173	7.8
WSW	82	32	55	42	25	11	247	**11.2**
W	66	41	27	2	0	0	136	6.2
WNW	75	46	24	3	0	0	148	6.7
NW	85	80	19	12	1	0	197	8.9
NNW	127	69	2	1	0	0	199	9.0
All	**1005**	**649**	**282**	**93**	**43**	**14**	**2087**	**95**
Calm	121						121	5.5

Table 8 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from the southwest to west-southwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the east and west-southwest.

OceanaGold – DG15
Ambient Temperature (1-hour averages)
Autumn 2022

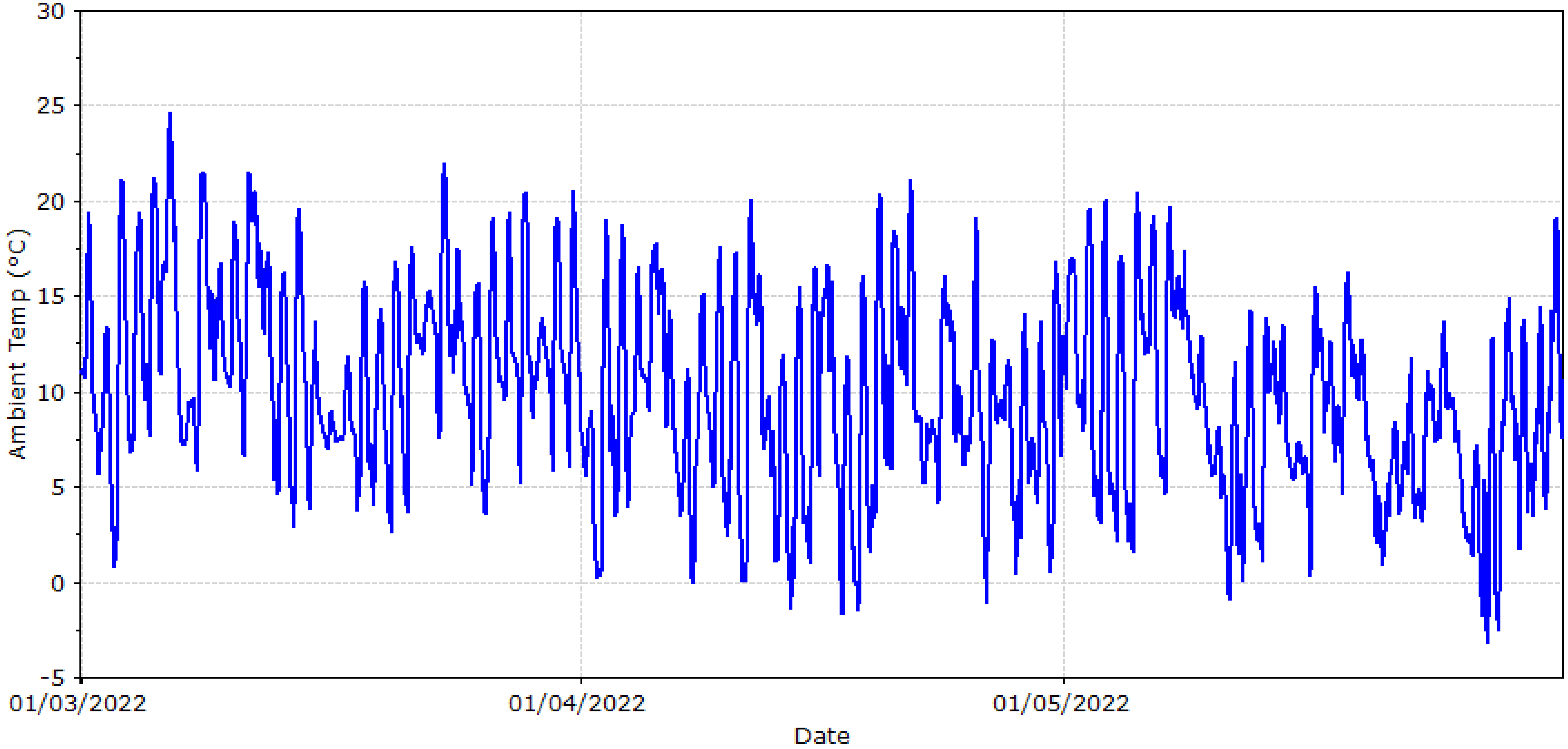

Figure 6: **OceanaGold – DG15: Ambient Temperature (1-hour averages)**

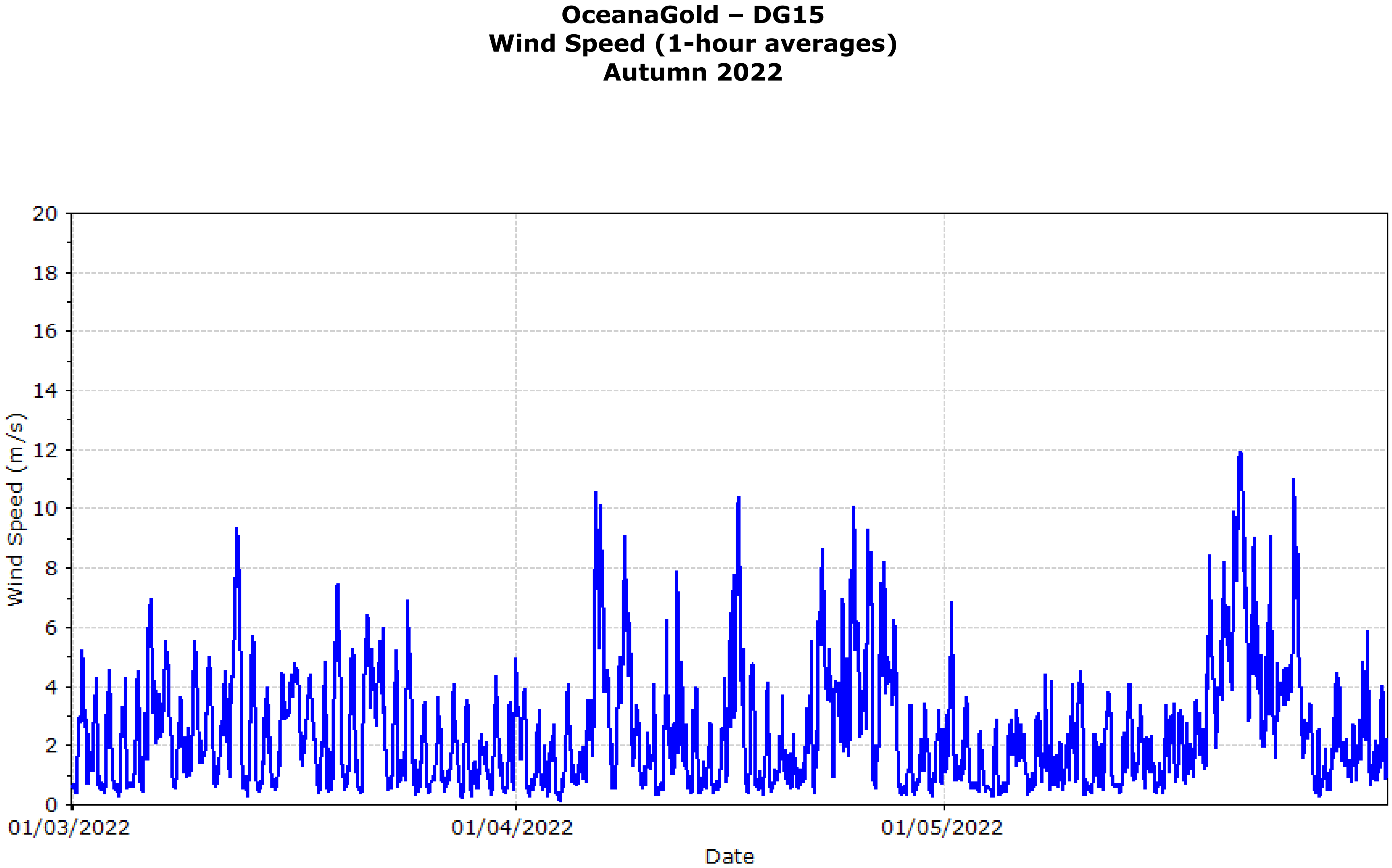

Figure 7: **OceanaGold – DG15: Wind Speed (1-hour averages)**

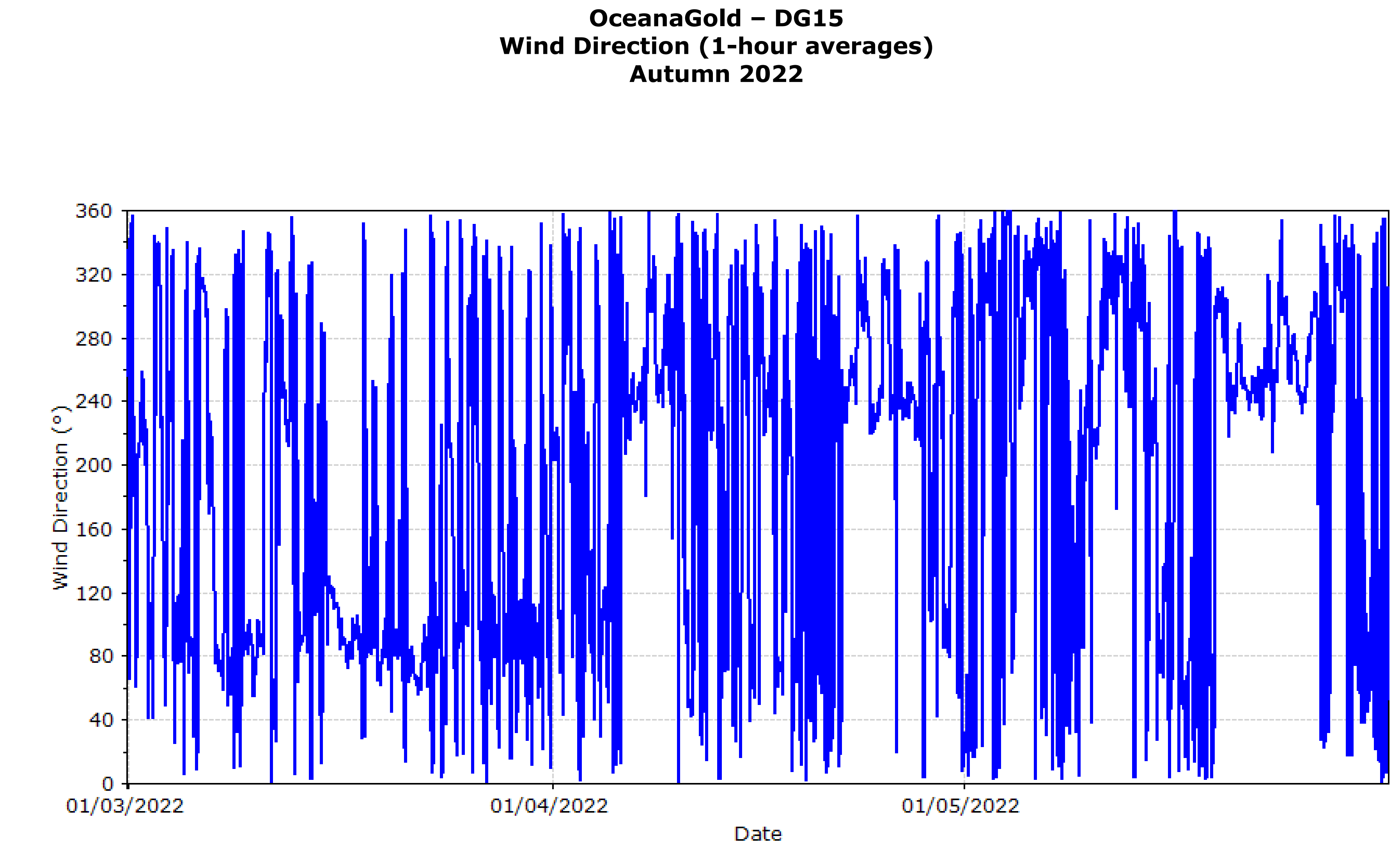

Figure 8: **OceanaGold – DG15: Wind Direction (1-hour averages)**

OceanaGold – DG15
Wind Rose (1-hour averages)
Autumn 2022

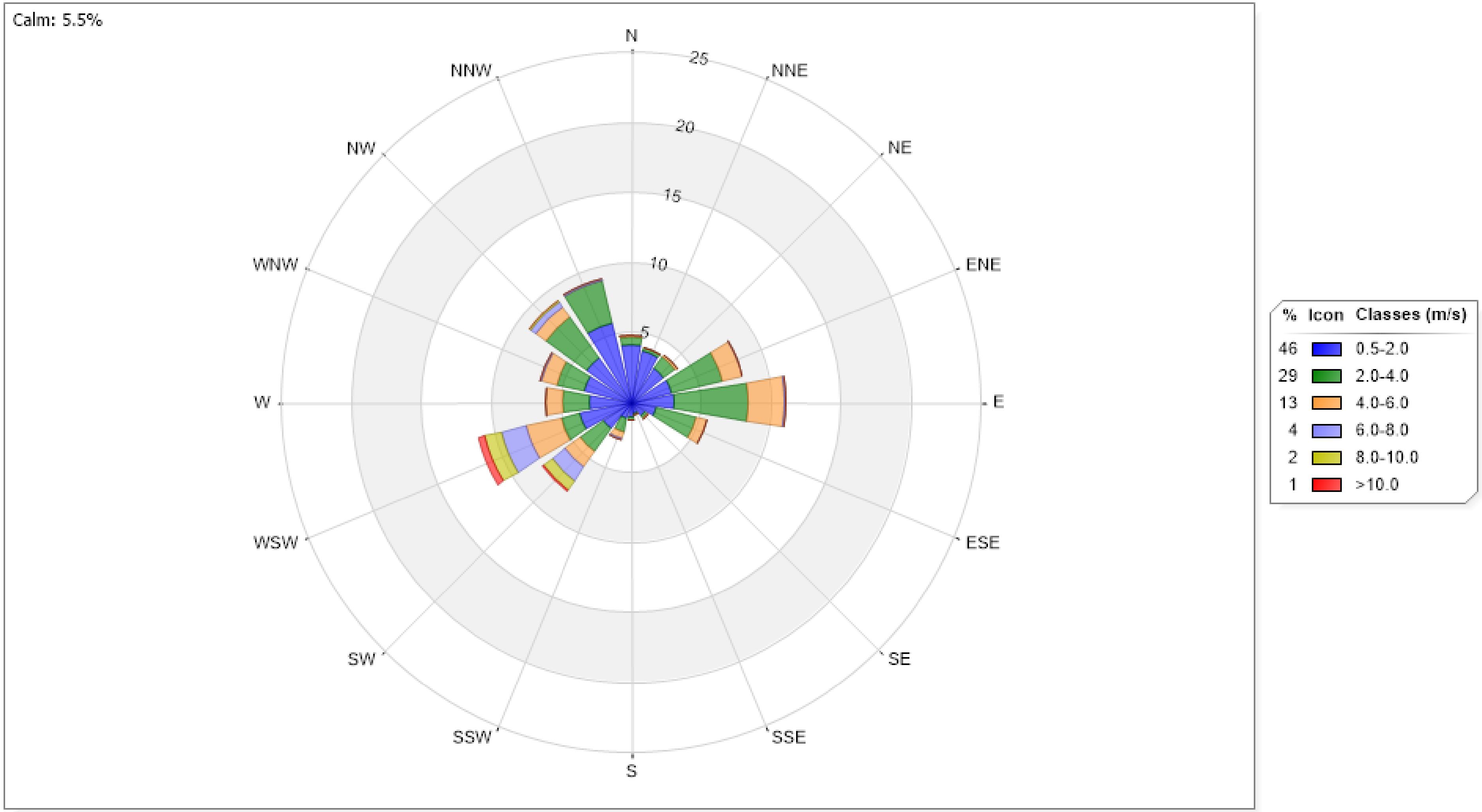

Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

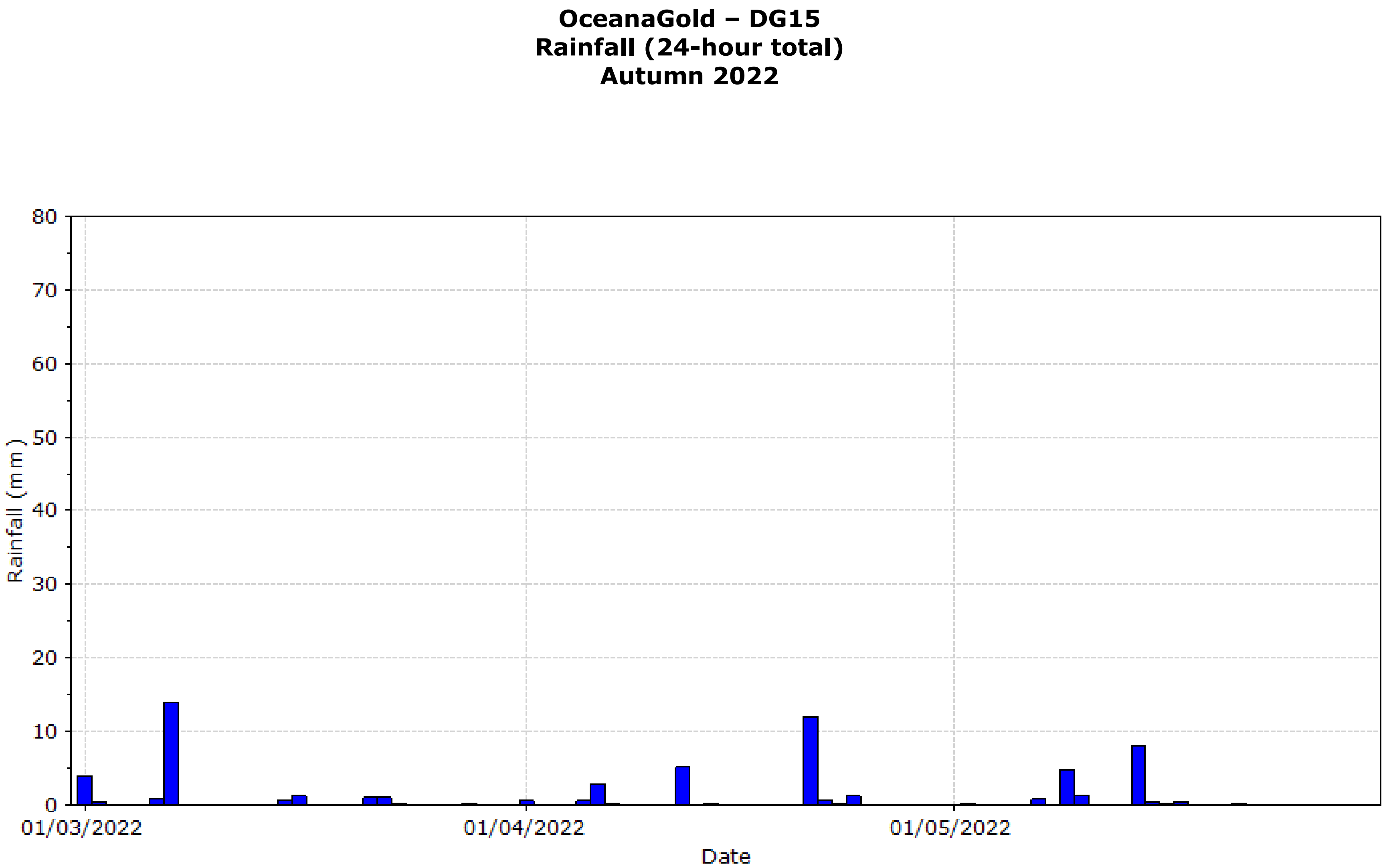

Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Autumn 2022 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	3.6	12.4	25.3
April 2022	0.2	9.8	20.8
May 2022	-0.6	9.1	20.2
Autumn 2022	**-0.6 27/05/2022 09:00**	**10.5**	**25.3 06/03/2022 14:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	4.3	12.6	24.0
April 2022	2.5	10.2	20.3
May 2022	0.9	9.7	19.5
Autumn 2022	**0.9 26/05/2022 09:00**	**10.8**	**24.0 06/03/2022 14:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
March 2022	37.4	86.0	100.0
April 2022	28.1	77.9	100.0
May 2022	31.3	71.3	100.0
Autumn 2022	**28.1**	**78.4**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	7.5	12.4	18.6
April 2022	6.0	9.8	15.1
May 2022	2.9	9.1	14.2
Autumn 2022	**2.9 26/05/2022**	**10.5**	**18.6 06/03/2022**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	7.3	12.6	18.8
April 2022	6.2	10.2	16.0
May 2022	3.2	9.7	14.9
Autumn 2022	**3.2 26/05/2022**	**10.8**	**18.8 06/03/2022**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2022	50.5	86.0	100.0
April 2022	55.9	77.9	96.0
May 2022	54.6	71.3	100.0
Autumn 2022	**50.5**	**78.4**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
March 2022	ENE	1.6	2.8	11.7
April 2022	SSW	1.1	3.2	15.2
May 2022	WNW	0.9	3.3	15.2
Autumn 2022	ENE	**1.2**	**3.1**	**15.2**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
March 2022	0.7	12.6	20.6	7
April 2022	0.8	12.4	23.0	8
May 2022	0.6	10.4	17.6	7
Autumn 2022	**0.7**	**12.6**	**61.2**	**22**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
March 2022	38.6	162.9	252.5
April 2022	36.9	120.2	178.0
May 2022	23.5	71.9	119.6
Autumn 2022	**23.5 01/05/2022**	**118.3**	**252.5 03/03/2022**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Autumn 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	61	47	1	0	0	0	109	4.9
NNE	74	55	8	1	0	0	138	6.3
NE	92	57	26	4	0	0	179	8.1
ENE	78	144	47	1	0	0	270	**12.2**
E	60	93	54	2	0	0	209	9.5
ESE	34	11	4	0	0	0	49	2.2
SE	41	4	0	0	0	0	45	2.0
SSE	28	8	1	0	0	0	37	1.7
S	33	28	19	4	0	0	84	3.8
SSW	31	41	47	43	20	5	187	8.5
SW	32	37	36	15	1	0	121	5.5
WSW	44	40	32	8	2	0	126	5.7
W	47	44	23	32	9	3	158	7.2
WNW	59	69	61	22	14	20	245	11.1
NW	51	67	29	7	1	0	155	7.0
NNW	40	24	4	1	0	0	69	3.1
All	**805**	**769**	**392**	**140**	**47**	**28**	**2182**	**99**
Calm	26						26	1.2

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from south-southwest and west to west-northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the east-northeast.

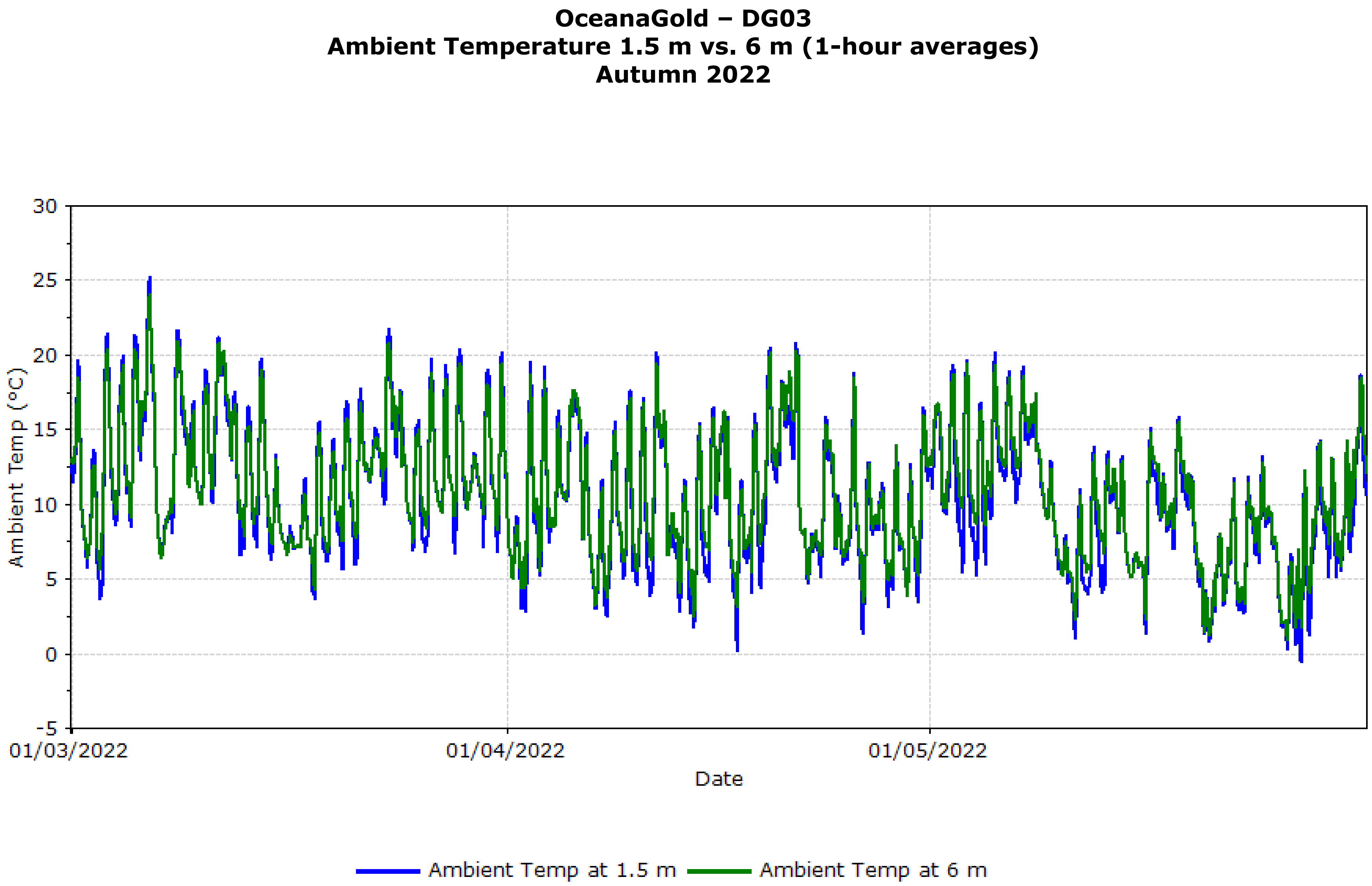

Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

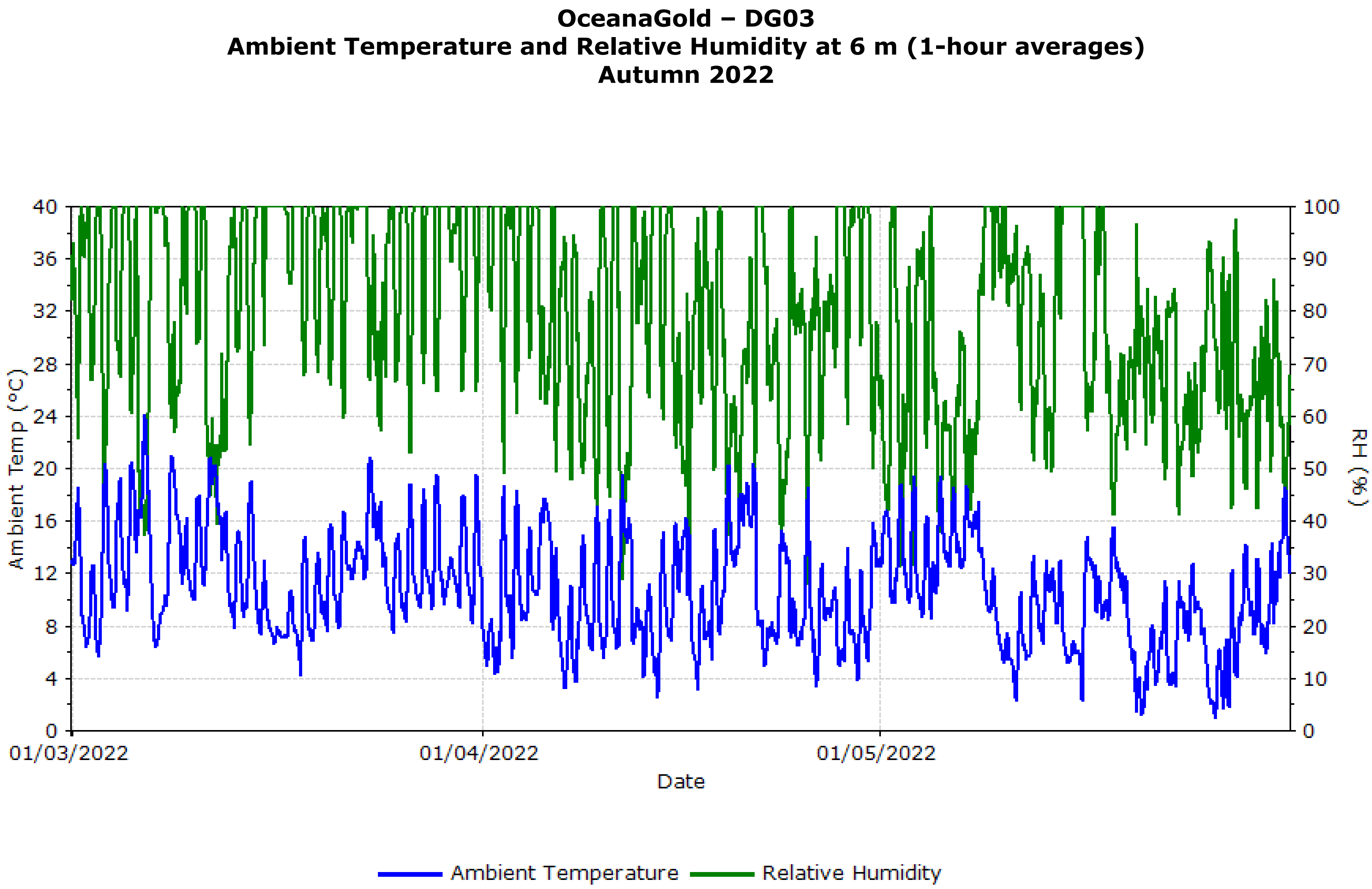

Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

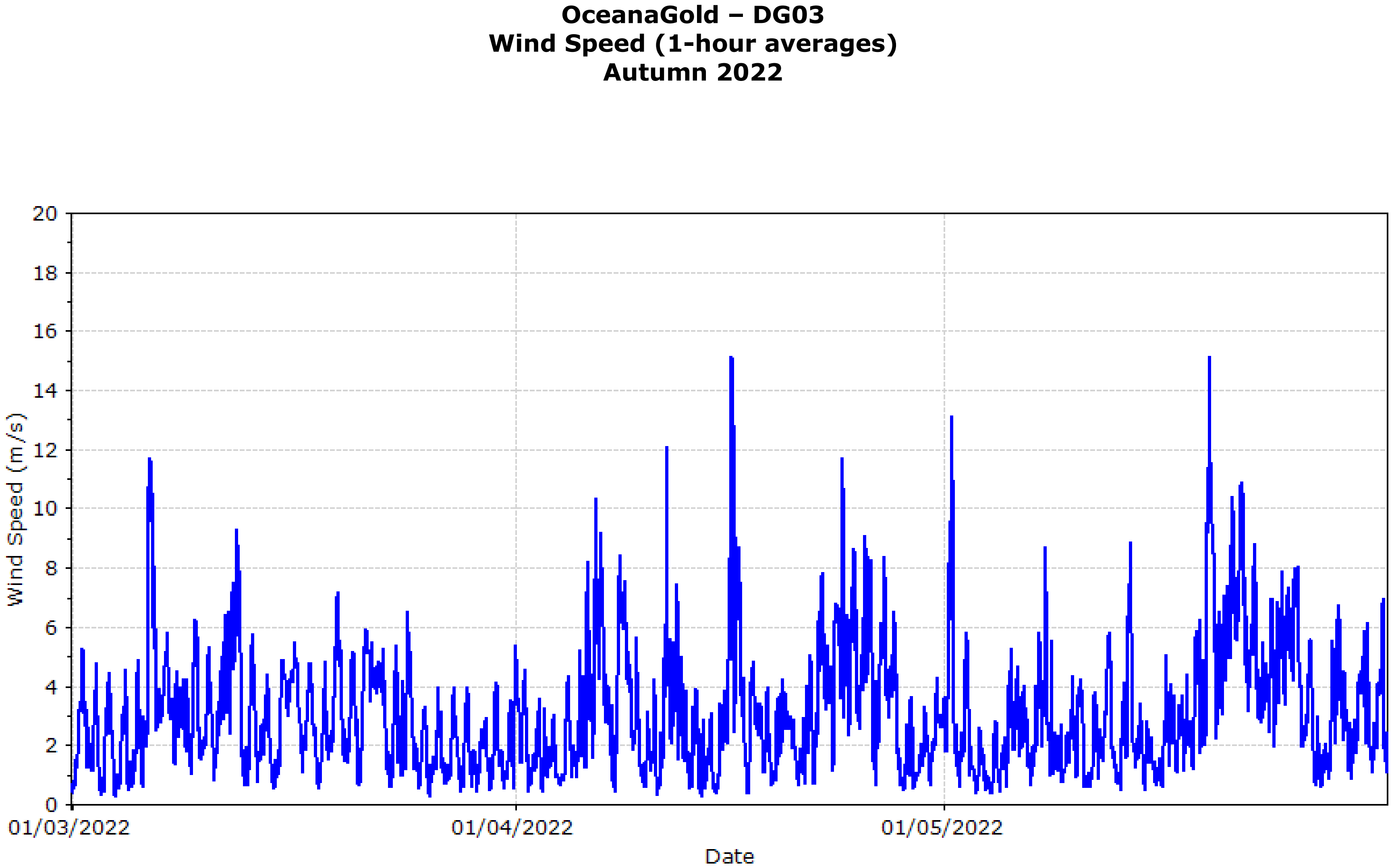

Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

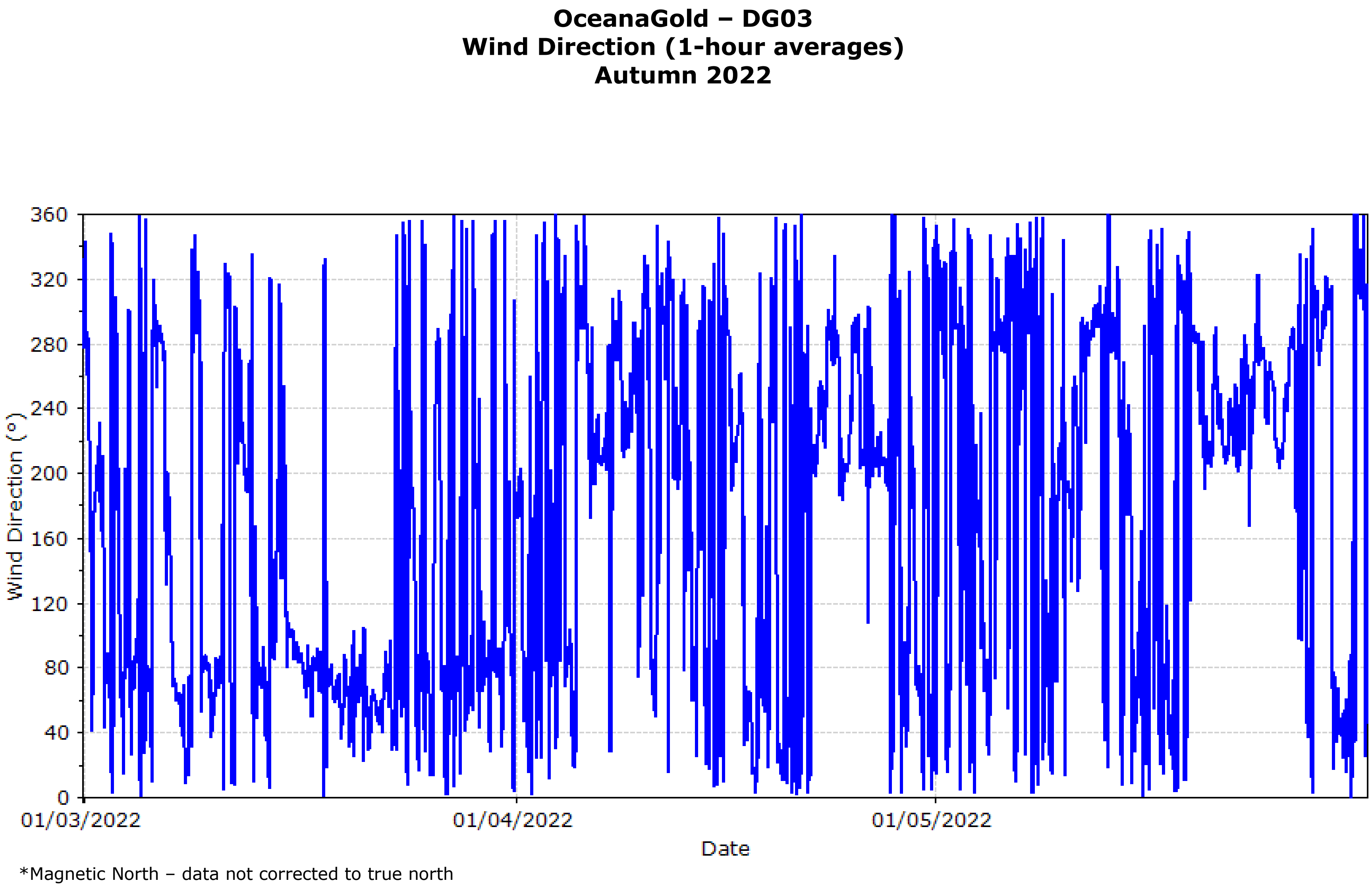

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

OceanaGold – DG03
Wind Rose (1-hour averages)
Autumn 2022

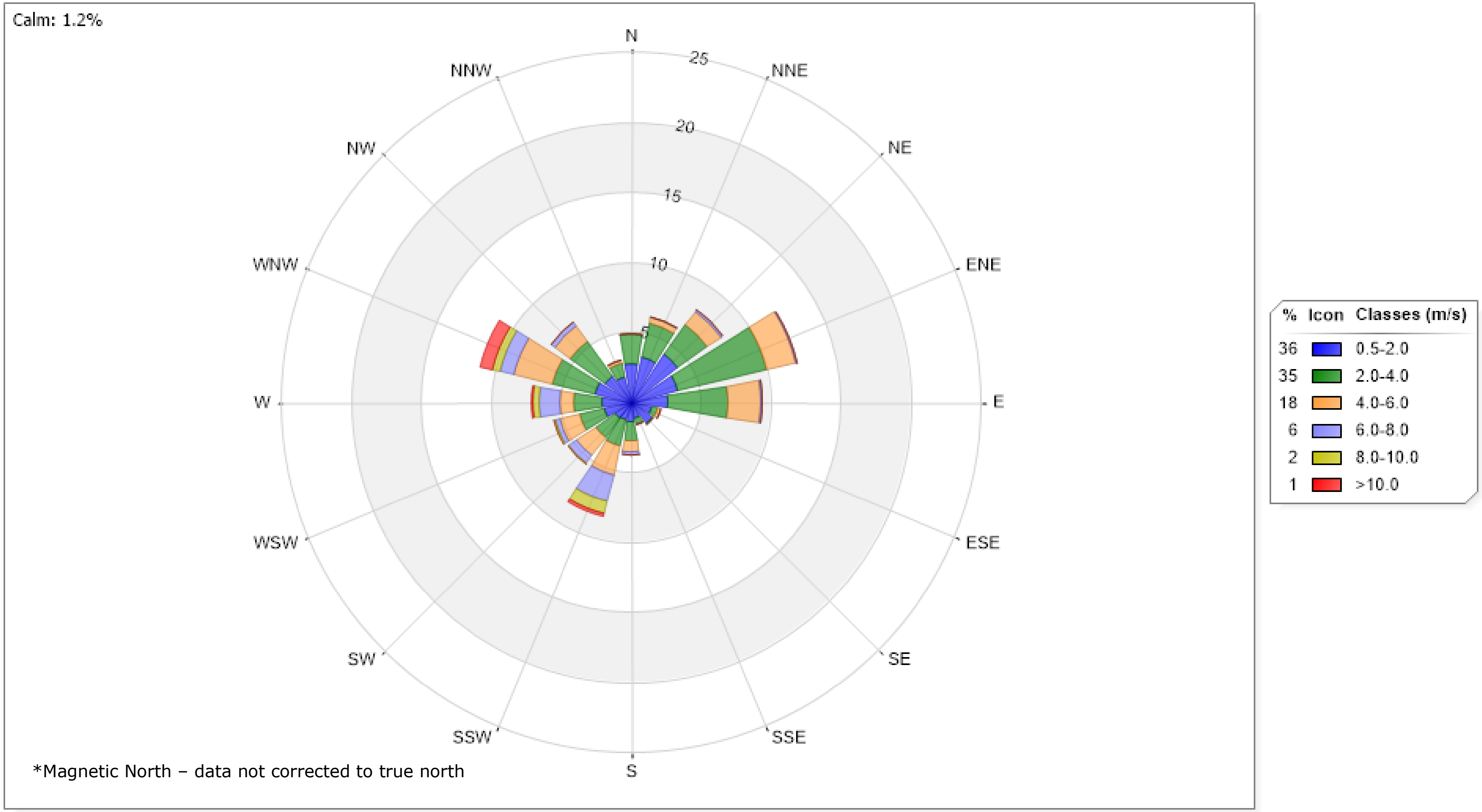

Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

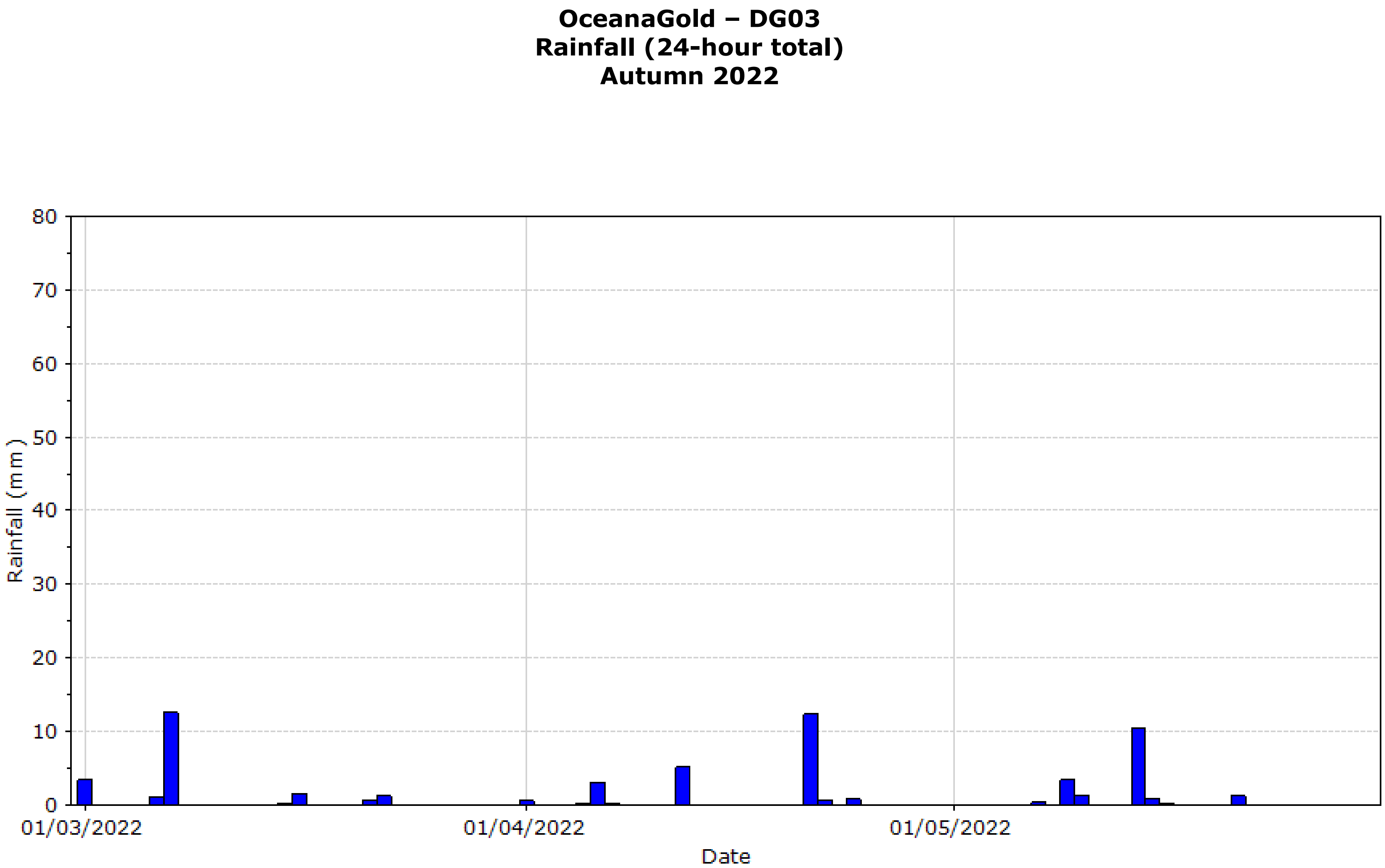

Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

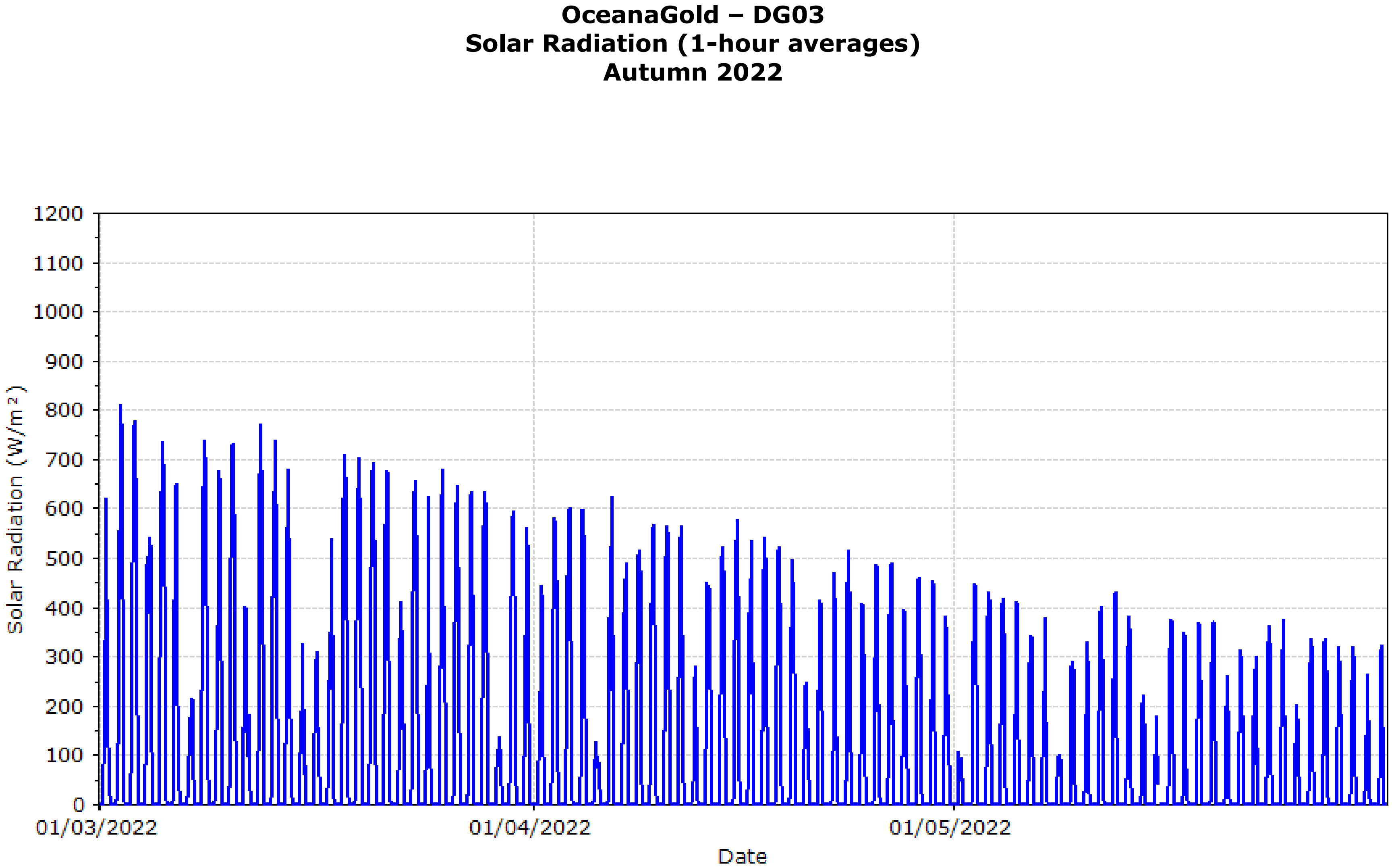

Figure 17: **OceanaGold – DG03: Solar Radiation (1-hour averages)**

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Ministry for the Environment (2002). *2002a. Ambient Air Quality Guidelines*. MfE, Wellington, New Zealand.

Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	09-06-21	2415	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2415	Callout	Installed	H MdAli
	19-04-22	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
Temperature sensor – Campbell Scientific 107					
	09-06-21	2418	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
Anemometer – Vector A101M					
	09-06-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
Wind vane – Vector W200P					
	09-06-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
Rain gauge – TB3-0.2/P					
	09-06-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2419	Six-Monthly Maintenance	Parameter Check	J Abraham

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Winter 2022

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2022-181

Ambient Air Quality Monitoring
Quarterly Summary Report
Winter 2022

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

28 September 2022

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

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Author	Peer Reviewer & Authoriser
Kath McLeod	Vilani Abeyratne
Senior Air Quality Technician	Ambient Data - Team Leader
Data Management Team	Data Management Team
Watercare Services Ltd	Watercare Services Ltd

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Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Winter 2022 (June 2022 to August 2022) showed:

At DG15:

- There was one exceedence of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 100%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 215 µg/m³ was on 29 August 2022.
- There were higher (>250 µg/m³) TSP E-Sampler hourly concentrations from all directions direction except north-northeast, south-southwest and west-northwest.
- Elevated (>14 µg/m³) diurnal TSP hourly concentrations occurred from 23:00 to 04:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 99%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the west-southwest and northwest.

At DG03:

- Valid data captured for ambient temperature at 1.5 m, relative humidity, rainfall and solar radiation were 100%. Ambient temperature at 6 m was 77%. Wind speed and wind direction valid data were also 100%
- The predominant wind direction was from the west-northwest.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Winter 2022
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Winter 2022.

Table 2: Site performance Winter 2022

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	100	-
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	99	-
Wind Direction	10-minute	99	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	77	Intermittent no data gaps.
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Winter 2022. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there was one exceedence of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration of 215 µg/m³ was on 29 August 2022. The 1-hour TSP concentrations greater than 250 µg/m³ (Figure 3) came from all direction except north-northeast, south-southwest and west-northwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred from 22:00 to 07:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
June 2022	0	2	9
July 2022	0	8	106
August 2022	0	14	215
Winter 2022	**0**	**8**	**215 29/08/2022**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		One	
Wind direction (DG15)			
Hourly TSP >250 µg/m³		all except NNE, SSW-SW &WNW	
Diurnal variation			
Hourly Diurnal TSP >14 µg/m³		23:00 – 04:00	

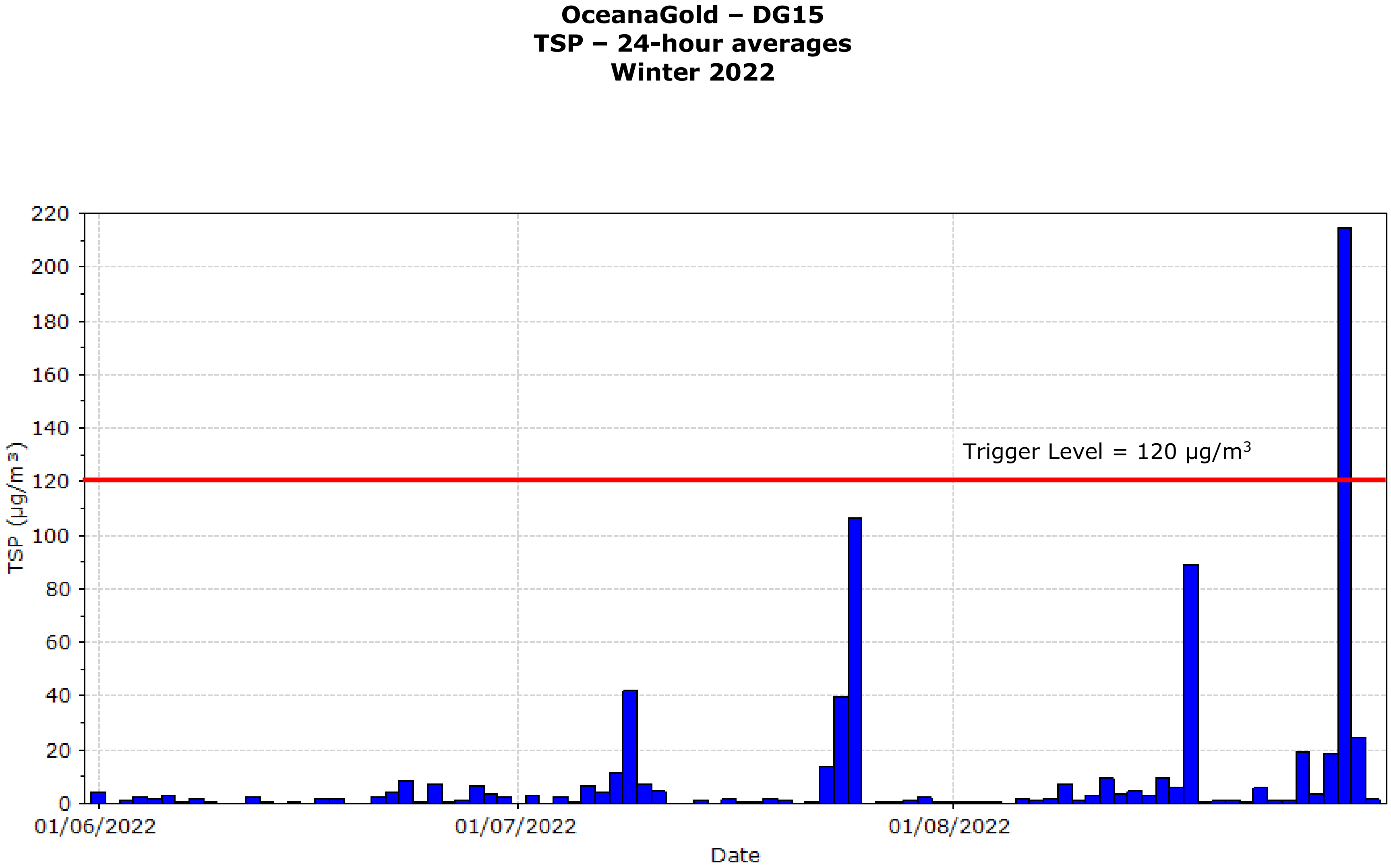


Figure 2: **OceanaGold – DG15: TSP E-Sampler (24-hour averages)**

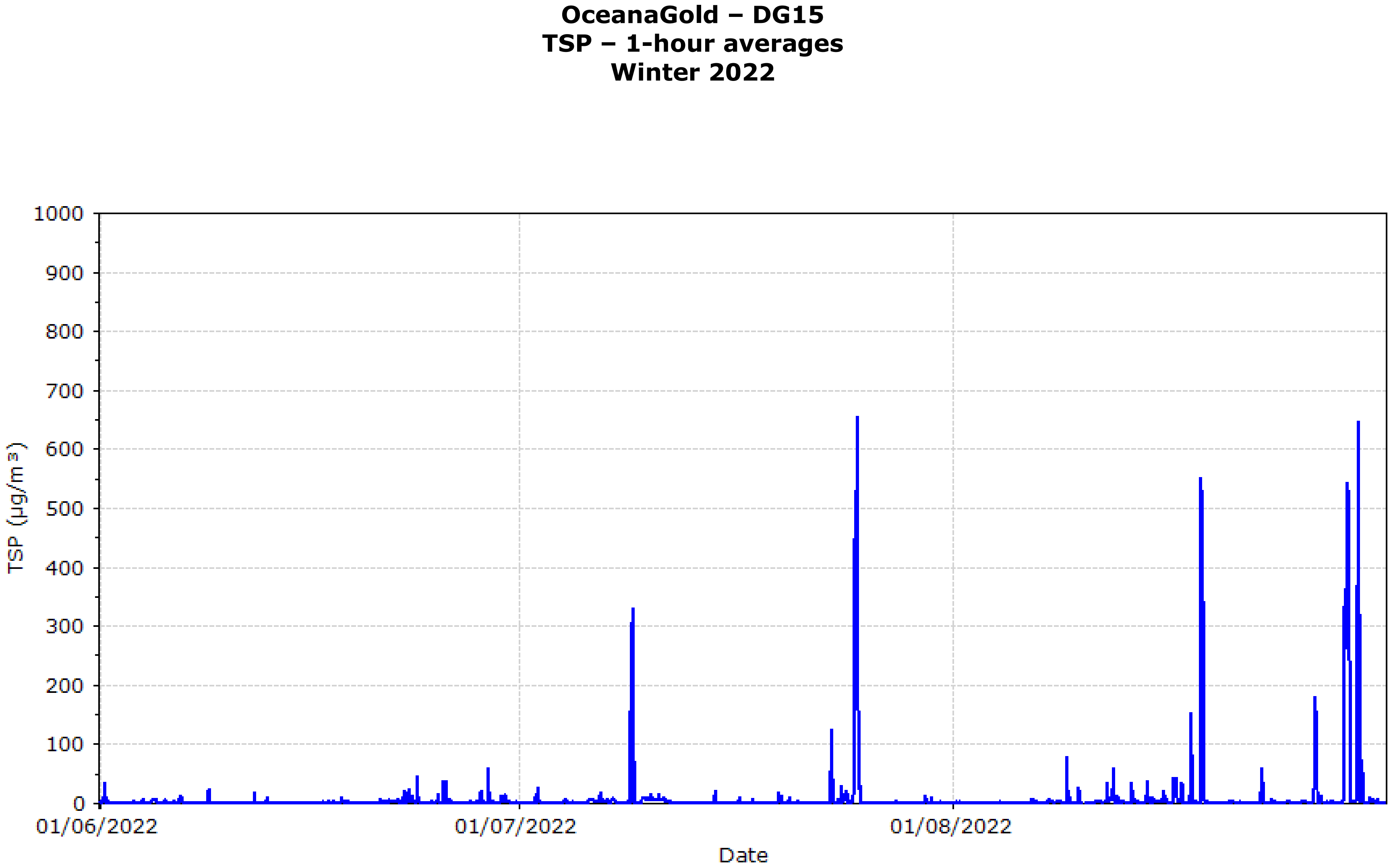


Figure 3: OceanaGold – DG15: TSP E-Sampler (1-hour averages)

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Winter 2022

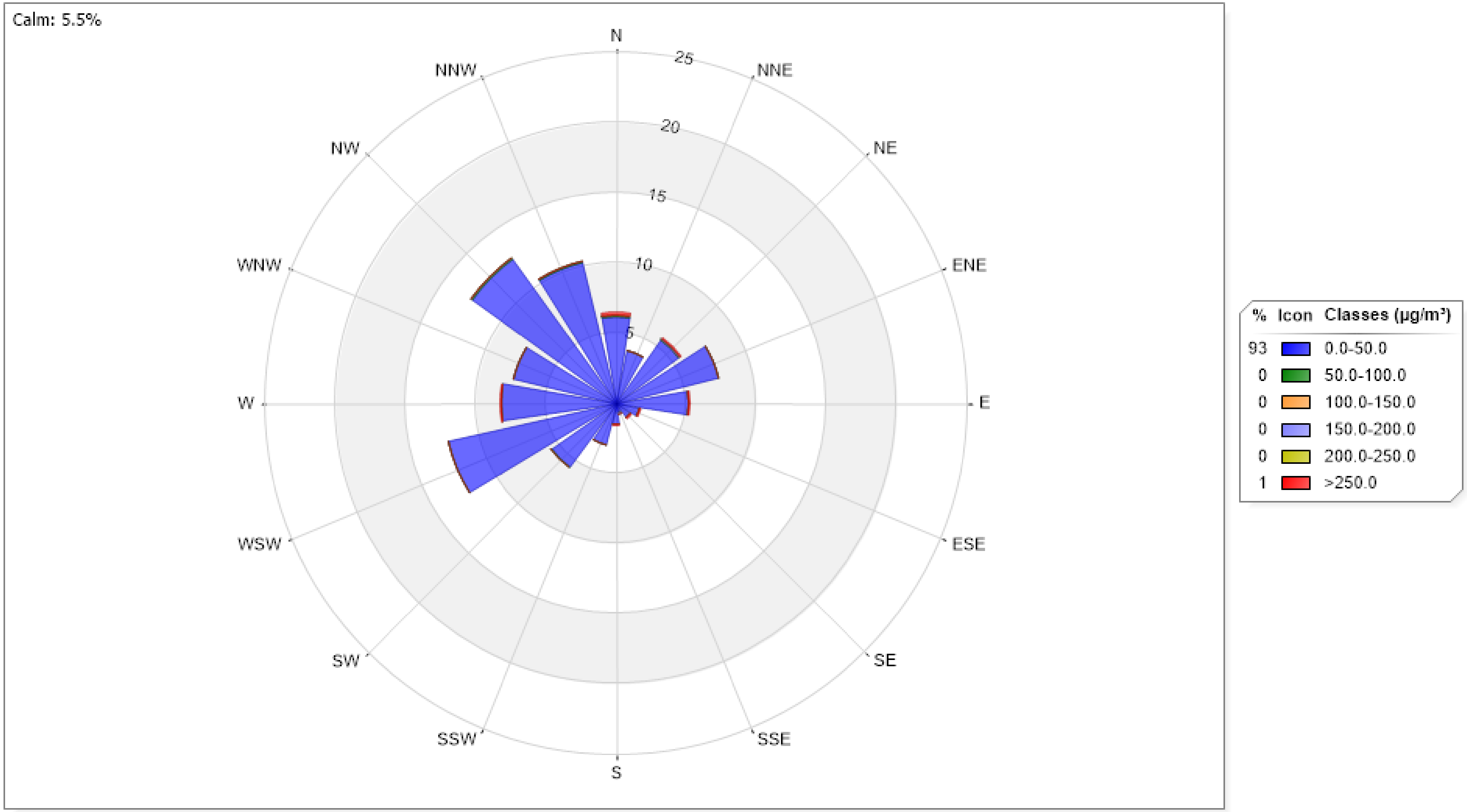


Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

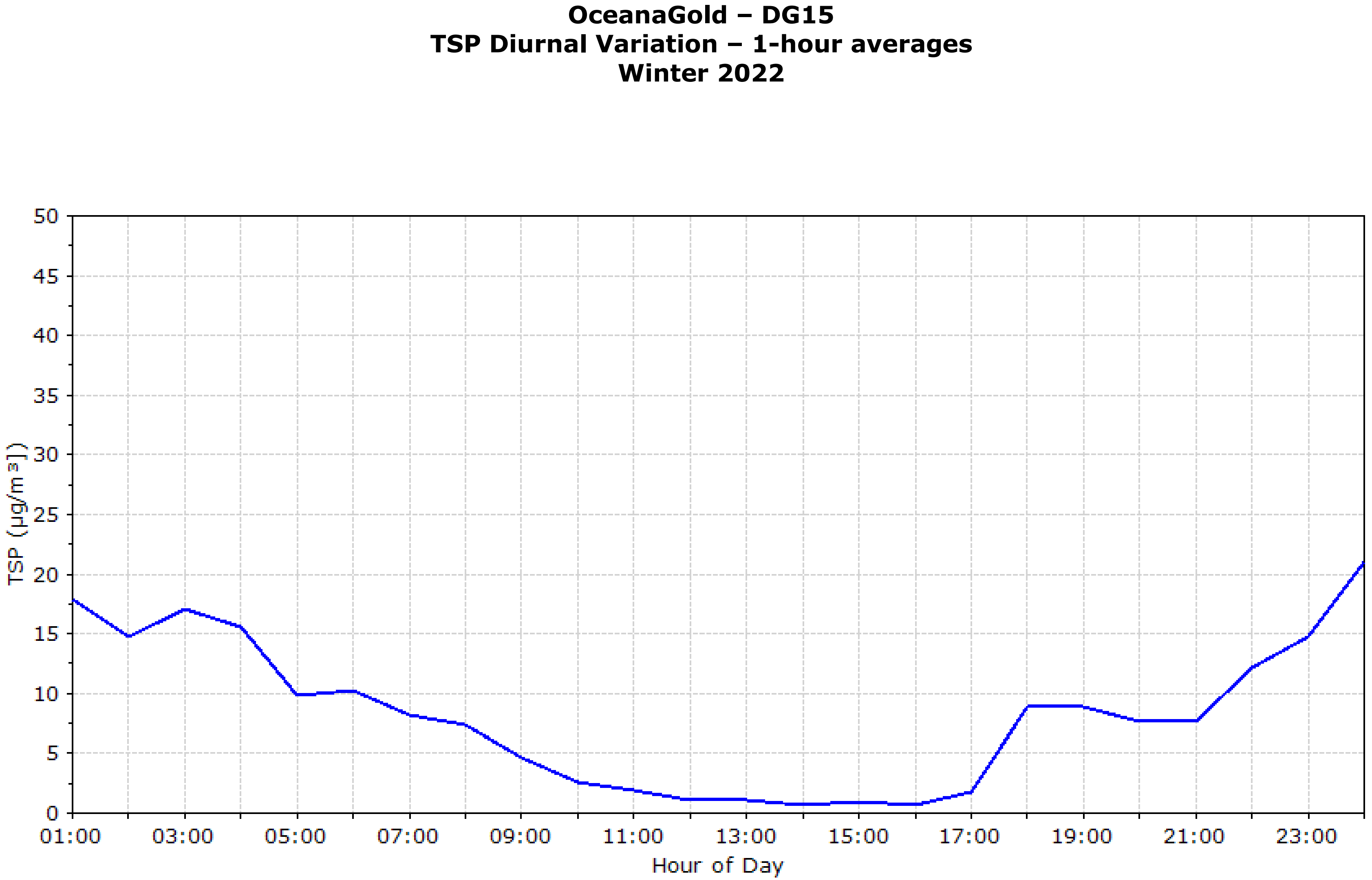


Figure 5: **OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)**

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Winter 2022 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	-6.1	5.1	16.0
July 2022	-6.5	3.9	13.0
August 2022	-6.9	6.2	17.2
Winter 2022	**-6.9 10/08/2022 04:00**	**5.1**	**17.2 16/08/2022 16:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	0.0	5.1	12.0
July 2022	-1.3	3.9	9.7
August 2022	-1.1	6.2	13.5
Winter 2022	**-1.3 10/07/2022**	**5.0**	**13.5 05/08/2022**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
June 2022	WSW	3.7	2.7	11.5
July 2022	WSW	4.7	3.4	10.2
August 2022	NW	8.0	2.4	10.7
Winter 2022	**WSW & NW**	**5.5**	**2.8**	**11.5**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
June 2022	0.8	8.8	23.8	11
July 2022	4.7	37.0	144.6	18
August 2022	0.8	6.8	24.0	11
Winter 2022	**2.1**	**37.0**	**192.4**	**40**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Winter 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	109	29	5	1	0	0	144	6.5
NNE	48	33	2	0	0	0	84	3.8
NE	64	60	3	0	0	0	126	5.7
ENE	55	87	15	4	6	0	167	7.6
E	30	40	19	17	9	1	117	5.3
ESE	11	11	11	7	0	0	40	1.8
SE	13	17	1	0	0	0	31	1.4
SSE	15	4	1	0	0	0	20	0.9
S	20	16	0	0	0	0	36	1.6
SSW	37	12	8	10	0	0	68	3.1
SW	27	35	36	20	4	2	125	5.7
WSW	62	82	62	44	19	1	270	12.3
W	85	69	21	7	1	0	183	8.3
WNW	71	57	28	8	2	0	166	7.5
NW	86	108	57	23	4	2	280	12.7
NNW	89	85	33	11	6	5	229	10.4
All	**822**	**745**	**305**	**153**	**51**	**11**	**2087**	**95**
Calm	121						121	5.5

Table 8 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from the east, southwest to west-southwest and northwest to north-northwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the northwest.

OceanaGold – DG15
Ambient Temperature (1-hour averages)
Winter 2022

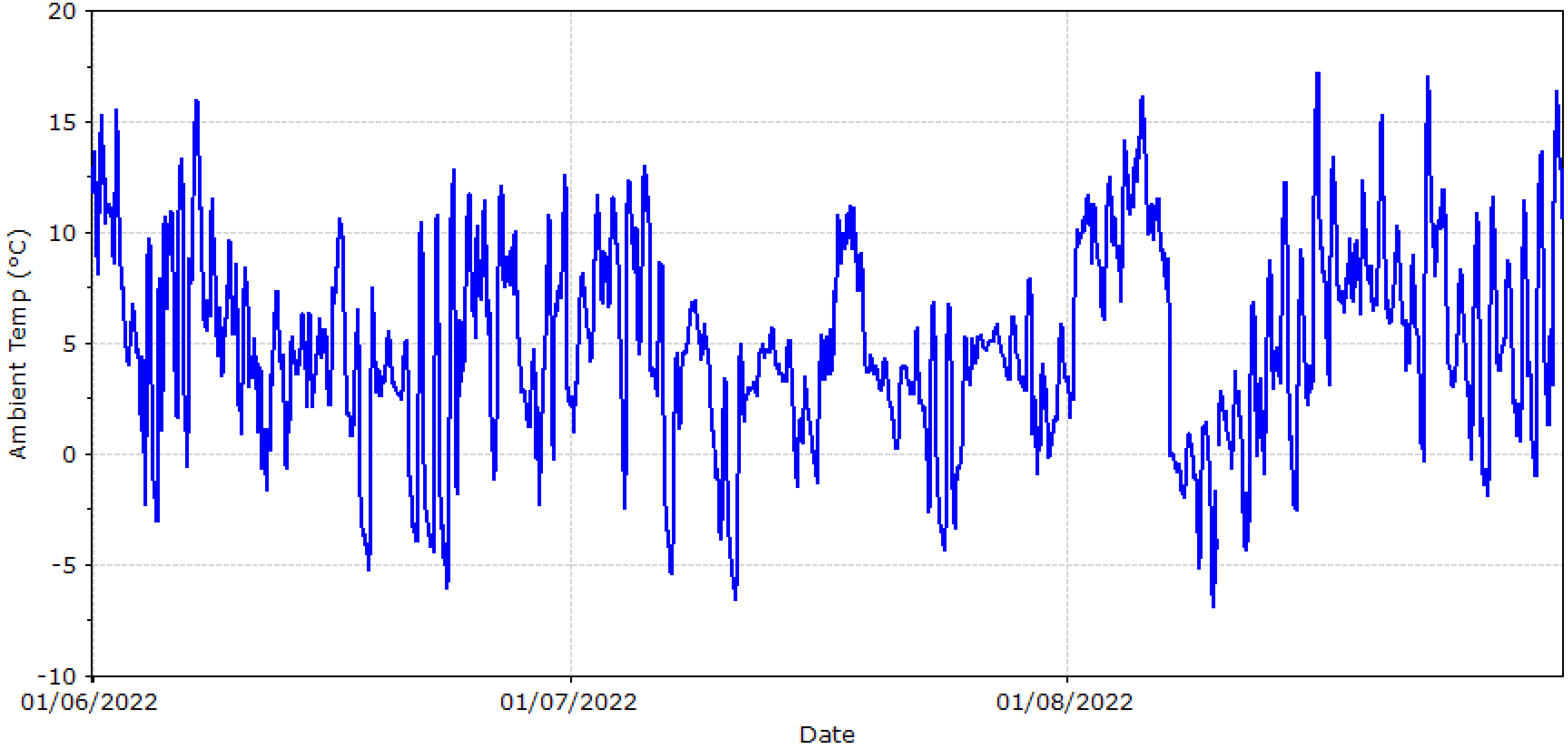


Figure 6: OceanaGold – DG15: Ambient Temperature (1-hour averages)

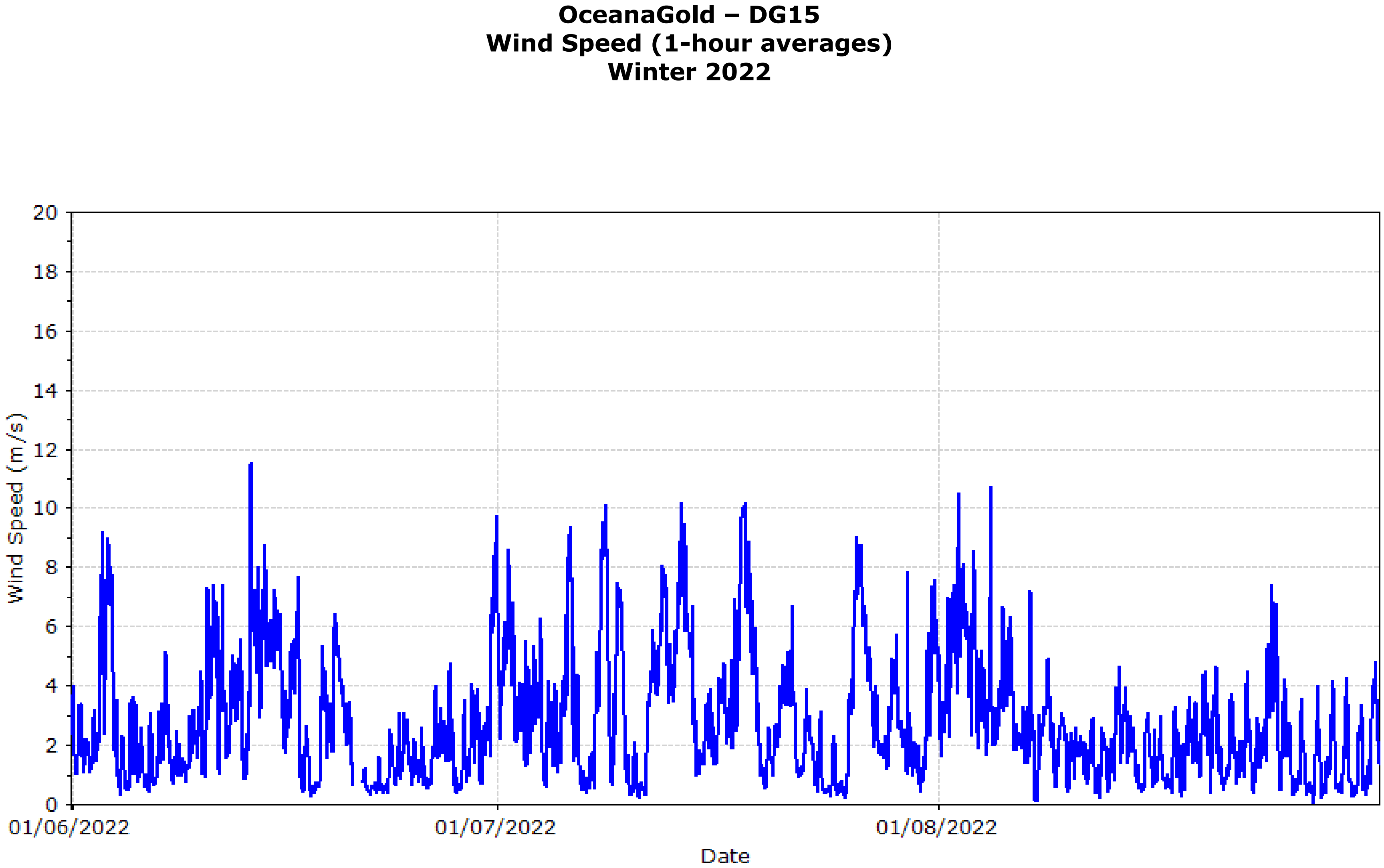


Figure 7: OceanaGold – DG15: Wind Speed (1-hour averages)

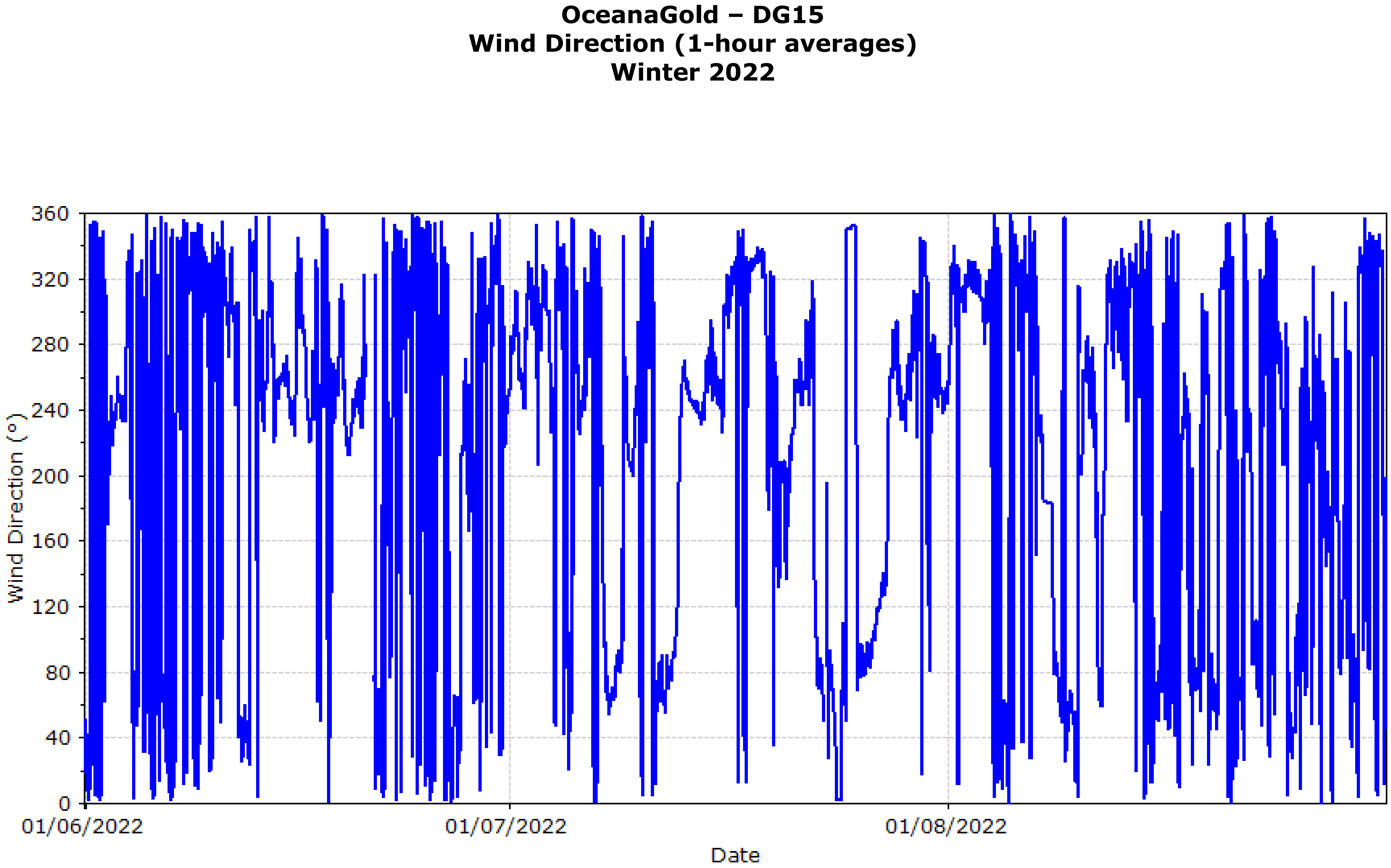


Figure 8: OceanaGold – DG15: Wind Direction (1-hour averages)

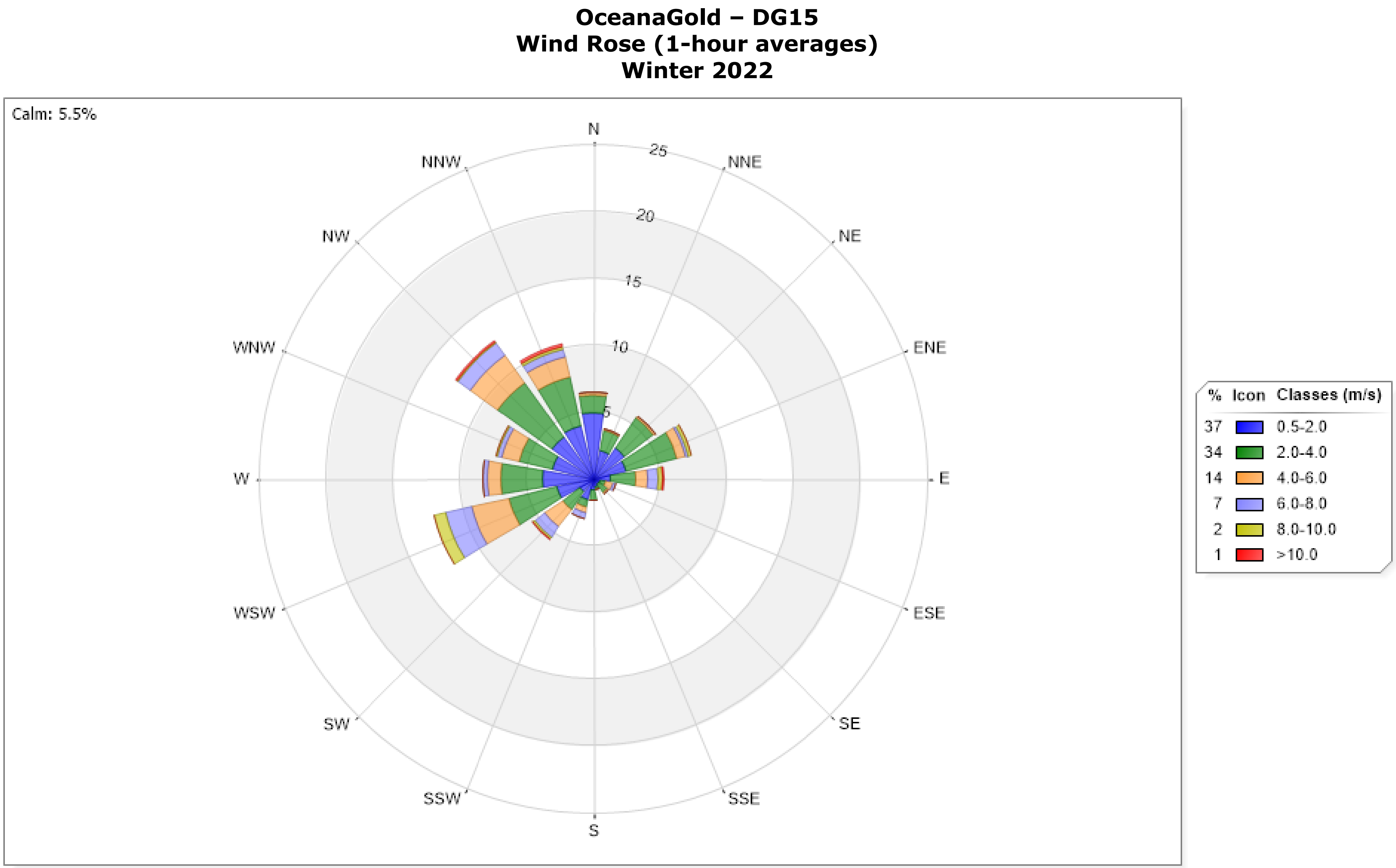


Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

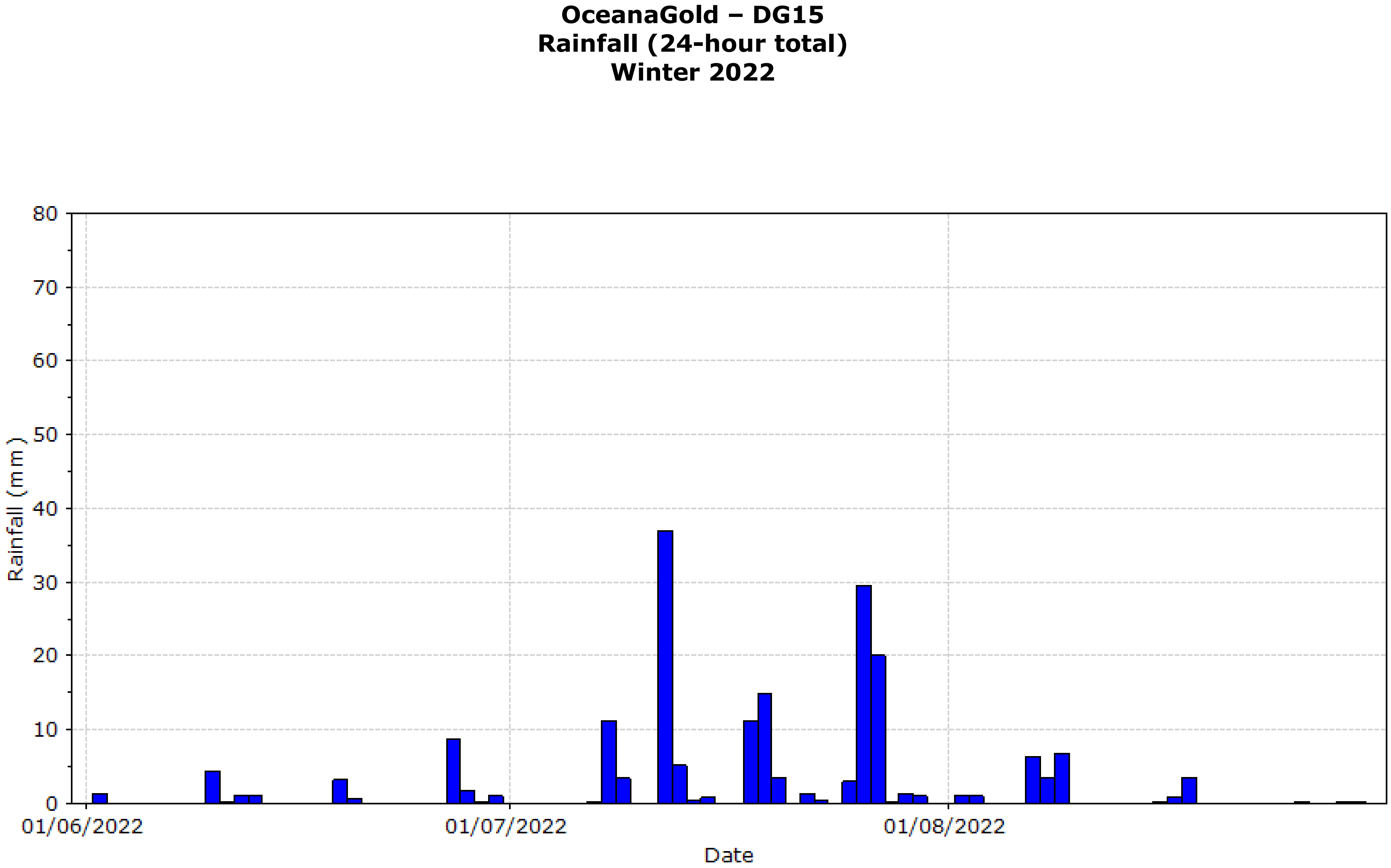


Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Winter 2022 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	-2.1	5.5	15.8
July 2022	-3.9	3.7	12.8
August 2022	-3.6	6.1	17.2
Winter 2022	**-3.9** **11/07/2022 06:00**	**5.1**	**17.2** **16/08/2022 16:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	-0.9	6.2	15.2
July 2022	-2.3	4.6	12.7
August 2022	0.1	7.0	16.7
Winter 2022	**-2.3** **11/07/2022 07:00**	**5.8**	**16.7** **16/08/2022 16:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
June 2022	24.0	72.2	100.0
July 2022	34.3	84.4	100.0
August 2022	26.5	77.2	100.0
Winter 2022	**24.0**	**78.0**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	1.9	5.5	12.2
July 2022	-0.6	3.7	9.0
August 2022	-1.1	6.2	12.9
Winter 2022	**-1.1 08/08/2022**	**5.1**	**12.9 05/08/2022**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	2.3	6.2	12.9
July 2022	0.3	4.6	9.3
August 2022	1.4	7.2	11.2
Winter 2022	**0.3 10/07/2022**	**5.9**	**12.9 01/06/2022**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2022	45.7	72.2	98.7
July 2022	49.8	84.4	100.0
August 2022	48.1	77.2	100.0
Winter 2022	**45.7**	**78.0**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
June 2022	WNW	0.7	3.7	15.1
July 2022	WNW	1.5	4.1	19.2
August 2022	WNW	1.5	3.6	18.5
Winter 2022	WNW	**1.2**	**3.8**	**19.2**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
June 2022	0.2	3.2	6.2	5
July 2022	6.0	45.4	184.6	18
August 2022	0.8	6.0	24.8	9
Winter 2022	**2.3**	**45.4**	**215.6**	**32**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
June 2022	14.3	49.4	76.6
July 2022	7.2	50.0	92.4
August 2022	26.4	93.4	150.4
Winter 2022	**7.2 12/07/2022**	**64.4**	**150.4 29/08/2022**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Winter 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	52	56	7	1	0	0	116	5.3
NNE	44	71	21	1	0	0	137	6.2
NE	43	76	12	9	4	1	145	6.6
ENE	53	81	22	19	5	0	180	8.2
E	37	30	14	7	0	0	88	4.0
ESE	23	11	7	1	0	0	42	1.9
SE	29	7	2	0	0	0	38	1.7
SSE	27	12	0	0	0	0	39	1.8
S	27	17	9	15	0	0	68	3.1
SSW	27	50	55	41	5	2	180	8.2
SW	56	67	33	8	0	0	164	7.4
WSW	65	83	15	13	9	0	185	8.4
W	45	70	31	20	21	12	199	9.0
WNW	26	101	84	47	42	55	355	16.1
NW	19	64	31	15	15	16	160	7.2
NNW	28	43	8	4	2	0	85	3.9
All	**601**	**839**	**351**	**202**	**103**	**86**	**2181**	**99**
Calm	27						27	1.2

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from northeast, south-southwest and west to northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the west-northwest.

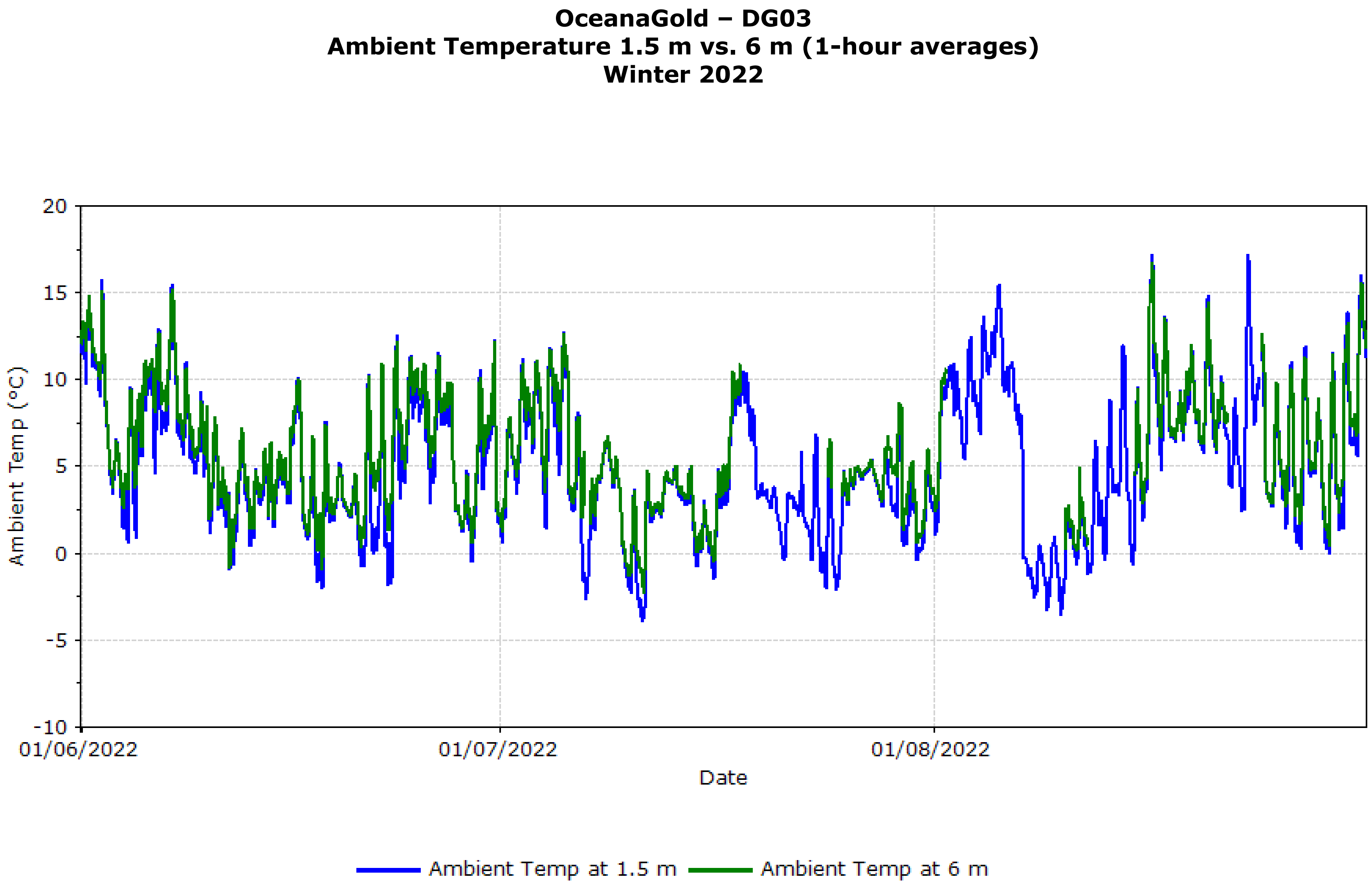


Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

OceanaGold – DG03
Ambient Temperature and Relative Humidity at 6 m (1-hour averages)
Winter 2022

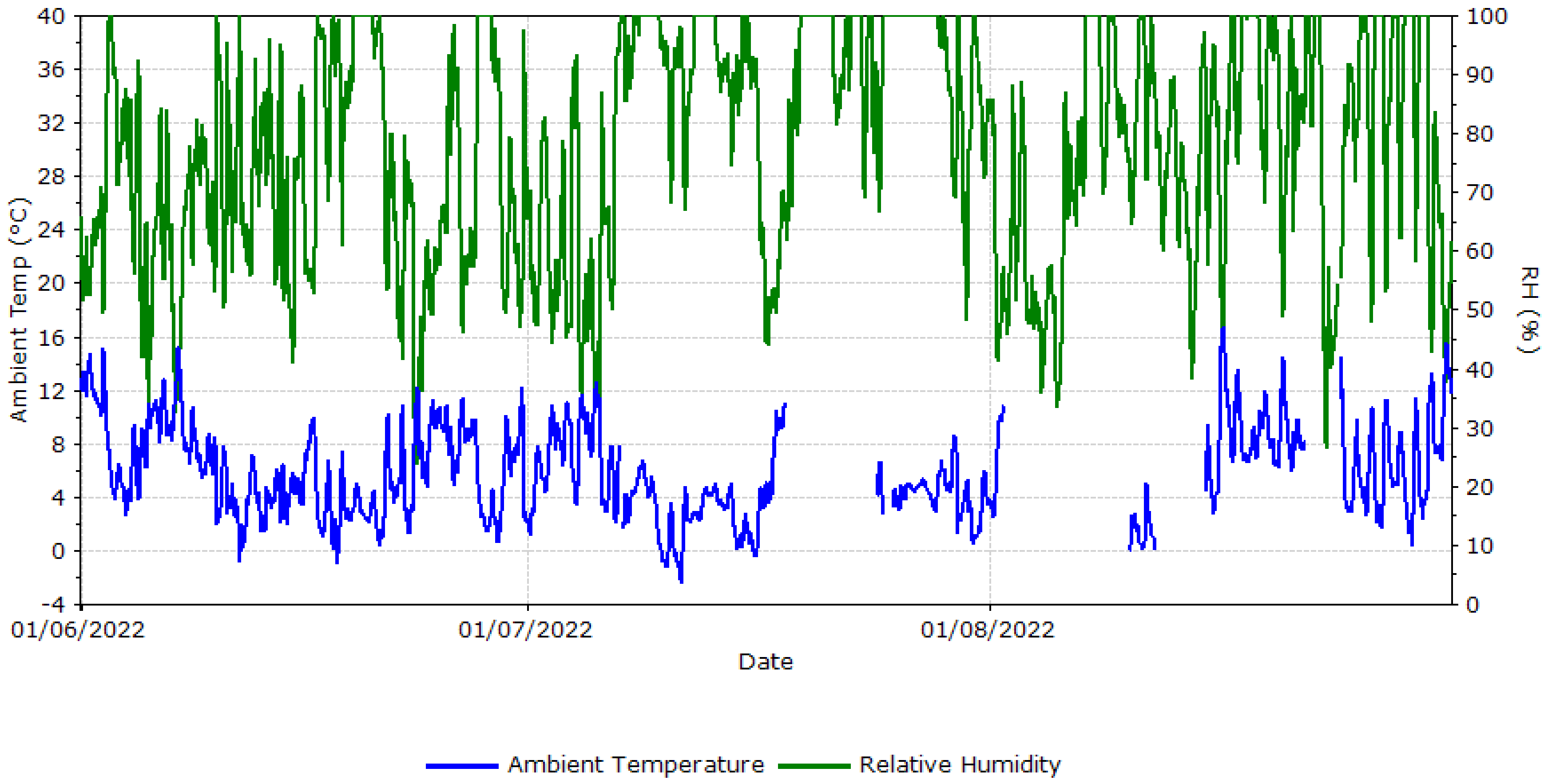


Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

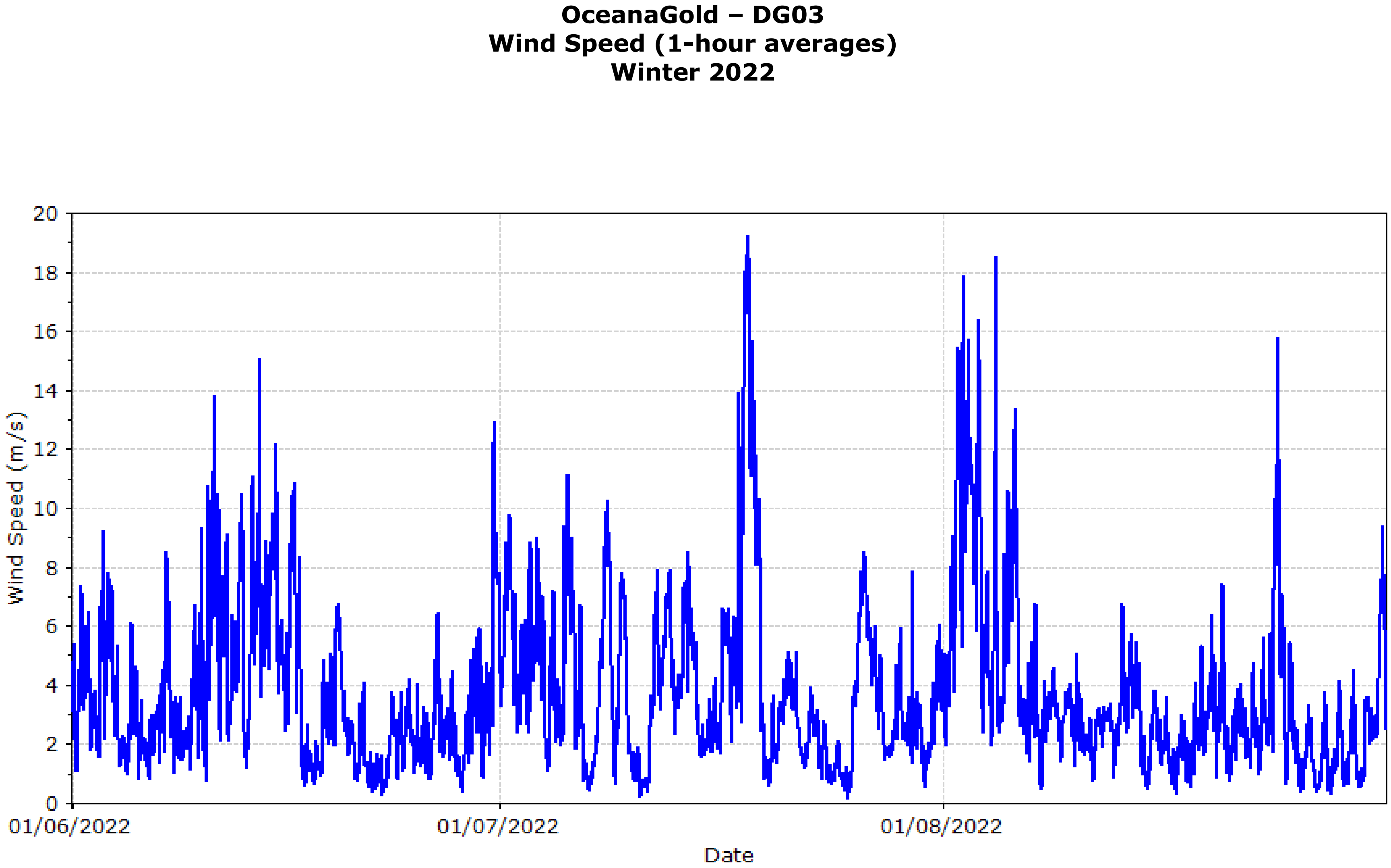
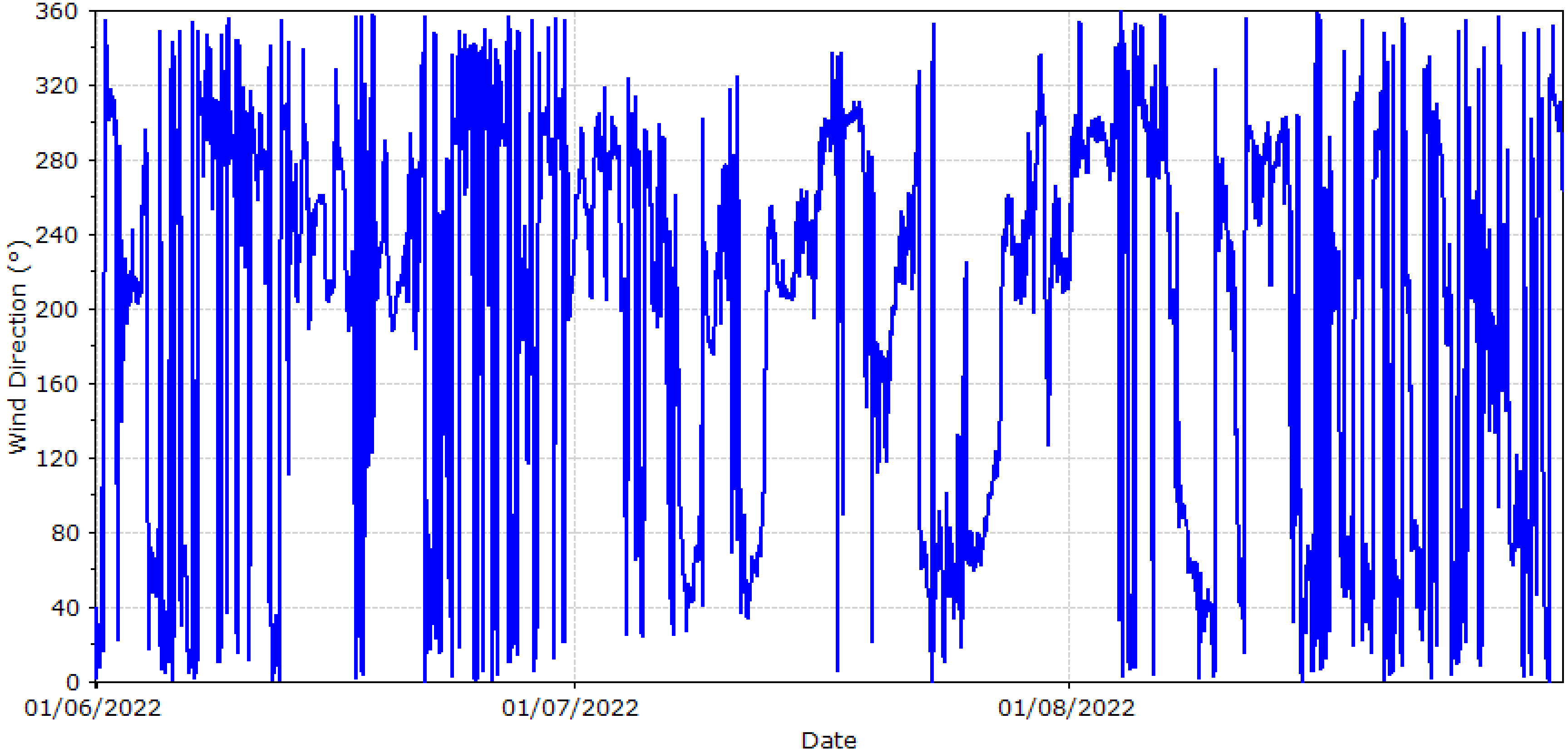


Figure 13: **OceanaGold – DG03: Wind Speed (1-hour averages)**

OceanaGold – DG03
Wind Direction (1-hour averages)
Winter 2022



*Magnetic North – data not corrected to true north

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

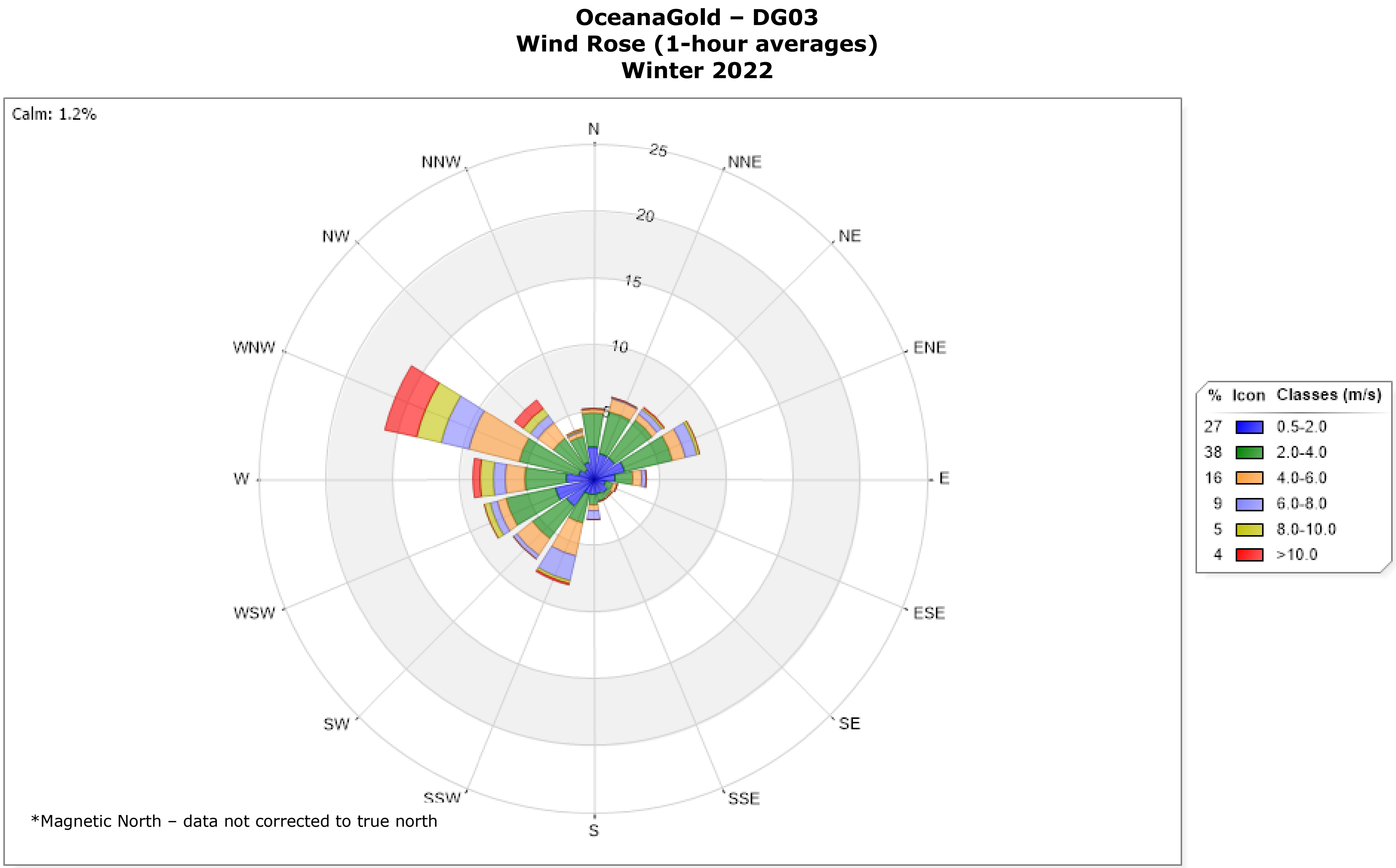


Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

OceanaGold – DG03
Rainfall (24-hour total)
Winter 2022

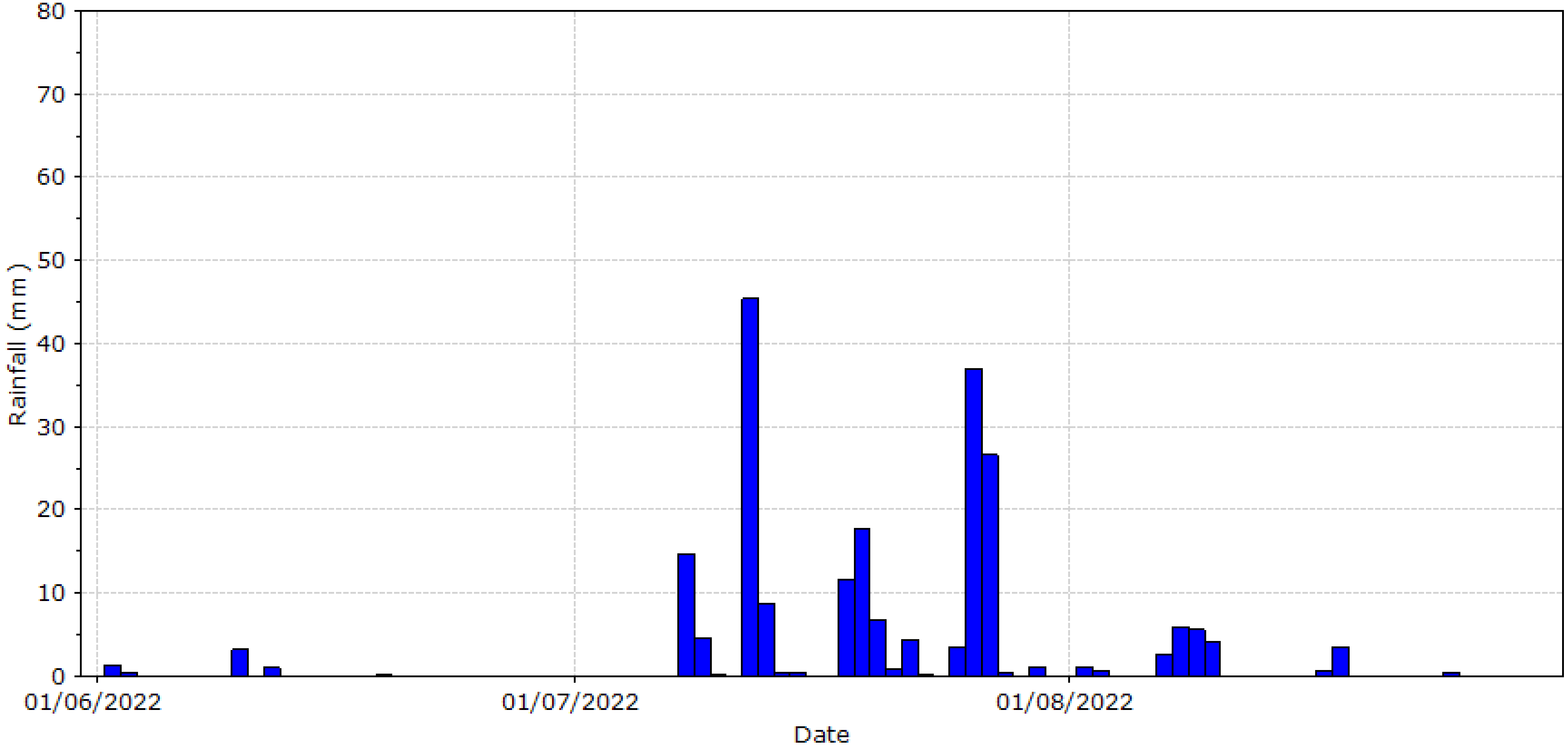


Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

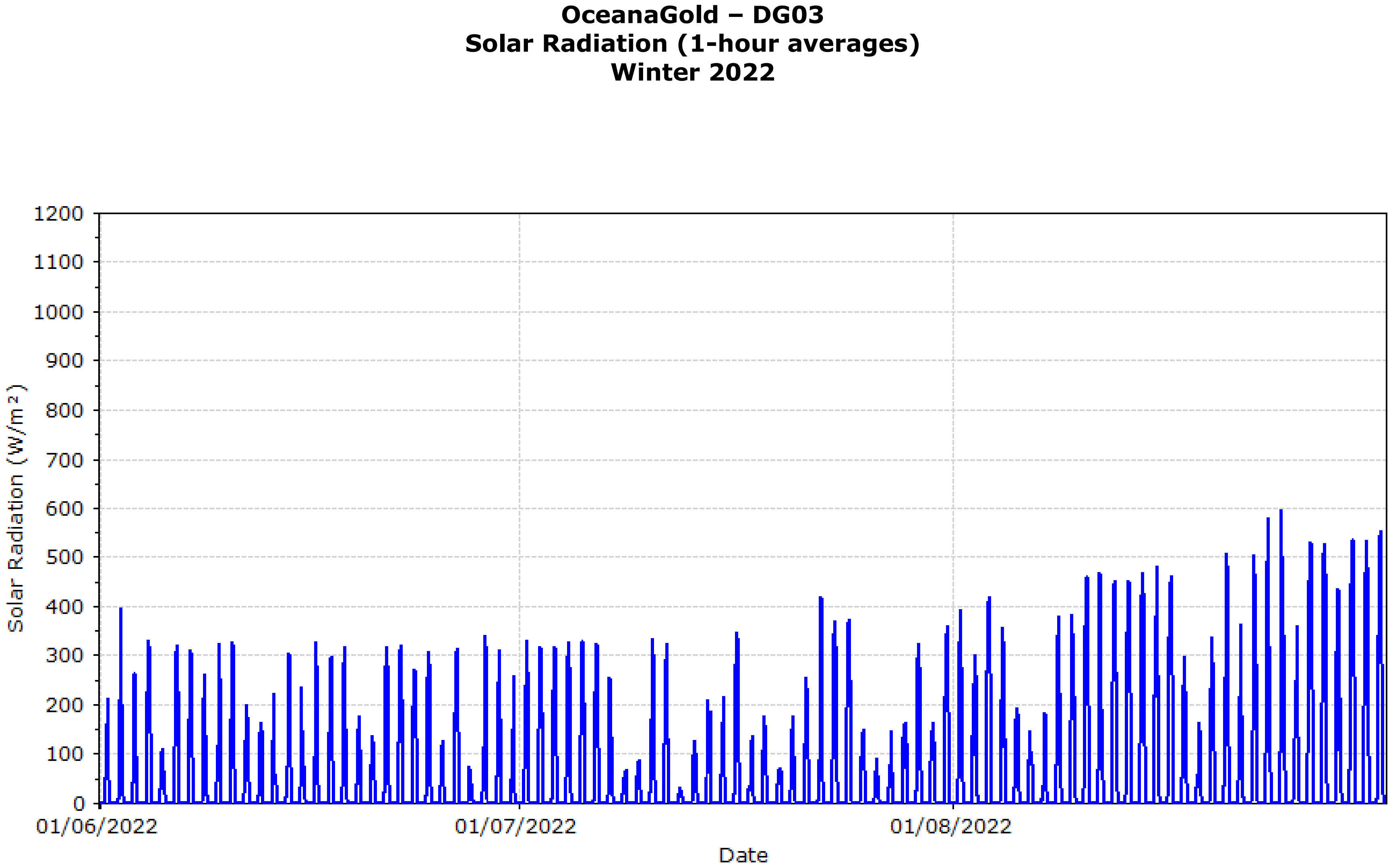


Figure 17: OceanaGold – DG03: Solar Radiation (1-hour averages)

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Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	*Date*	*AQG*	*Planned Maintenance*	*Service Information*	*Technician*
OceanaGold DG15:					
TSP – Met One E-Sampler					
	09-06-21	2415	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2415	Callout	Installed	H MdAli
	19-04-22	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
	16-06-22	2415	Six-Monthly Maintenance	Parameter Check	B Kaushal
Temperature sensor – Campbell Scientific 107					
	09-06-21	2418	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
Anemometer – Vector A101M					
	09-06-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
Wind vane – Vector W200P					
	09-06-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
Rain gauge – TB3-0.2/P					
	09-06-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	15-12-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2419	Six-Monthly Maintenance	Parameter Check	J Abraham

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Spring 2022

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2022-224

Ambient Air Quality Monitoring
Quarterly Summary Report
Spring 2022

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

22 December 2022

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

Watercare report number: AQ-2022-224
Watercare reference: 15-54681

Author

Kath McLeod
Senior Air Quality data Analyst
Data Management Team
Watercare Services Ltd

Peer Reviewer & Authoriser

Vilani Abeyratne
Ambient Data - Team Leader
Data Management Team
Watercare Services Ltd

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Table of Contents

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Spring 2022 (September 2022 to November 2022) showed:

At DG15:

- There were two exceedences of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 100%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 147 µg/m³ on 10 September 2022. The second highest TSP 24-hour concentration was 133 µg/m³ on 22 September 2022.
- There were higher (>250 µg/m³) TSP E-Sampler hourly concentrations from all directions direction except, south-southeast and west-northwest to north-northwest.
- Elevated (>15 µg/m³) diurnal TSP hourly concentrations occurred from 22:00 to 07:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the east.

At DG03:

- Valid data captured for ambient temperature at 6 m, ambient temperature at 1.5 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%.
- The predominant wind direction was from the east-northeast.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Spring 2022
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Spring 2022.

Table 2: Site performance Spring 2022

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	100	-
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Spring 2022. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there were two exceedences of the TSP trigger level measured by the E-Sampler. The two highest TSP 24-hour concentrations were 147 µg/m³ on 10 September 2022 and 133 µg/m³ on 22 September 2022. The 1-hour TSP concentrations greater than 250 µg/m³ (Figure 3) came from all direction except south-southeast and west-northwest to north-northwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred from 22:00 to 07:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
September 2022	0	23	147
October 2022	0	8	58
November 2022	0	9	70
Spring 2022	**0**	**13**	**147** **10/09/2022**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		10/09/2022 – 147 µg/m³	
		22/09/2022 – 133 µg/m³	
Wind direction (DG15)			
Hourly TSP >250 µg/m³		all except SSE & WNW-NNW	
Diurnal variation			
Hourly Diurnal TSP >15 µg/m³		22:00 – 07:00	

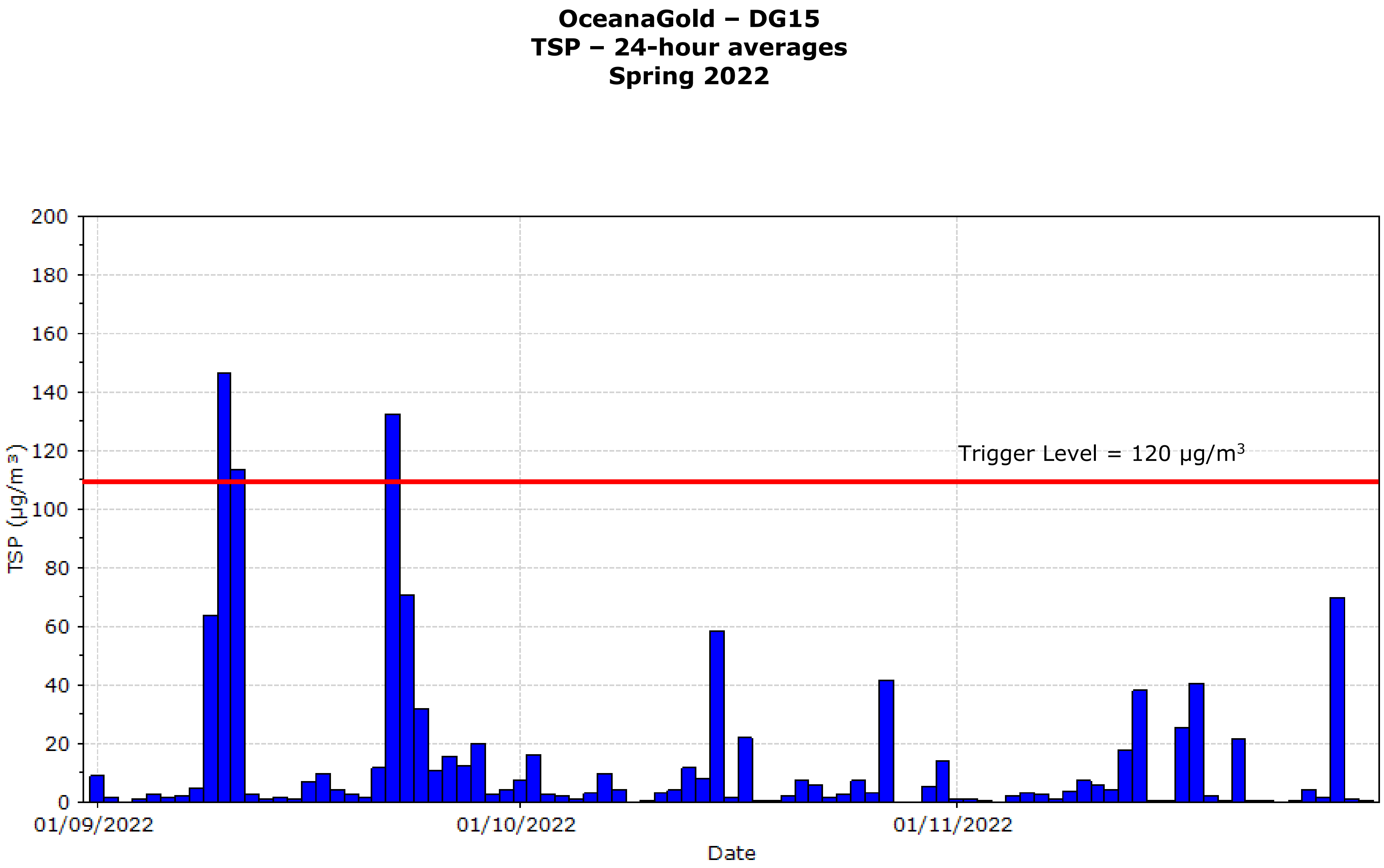

Figure 2: **OceanaGold – DG15: TSP E-Sampler (24-hour averages)**

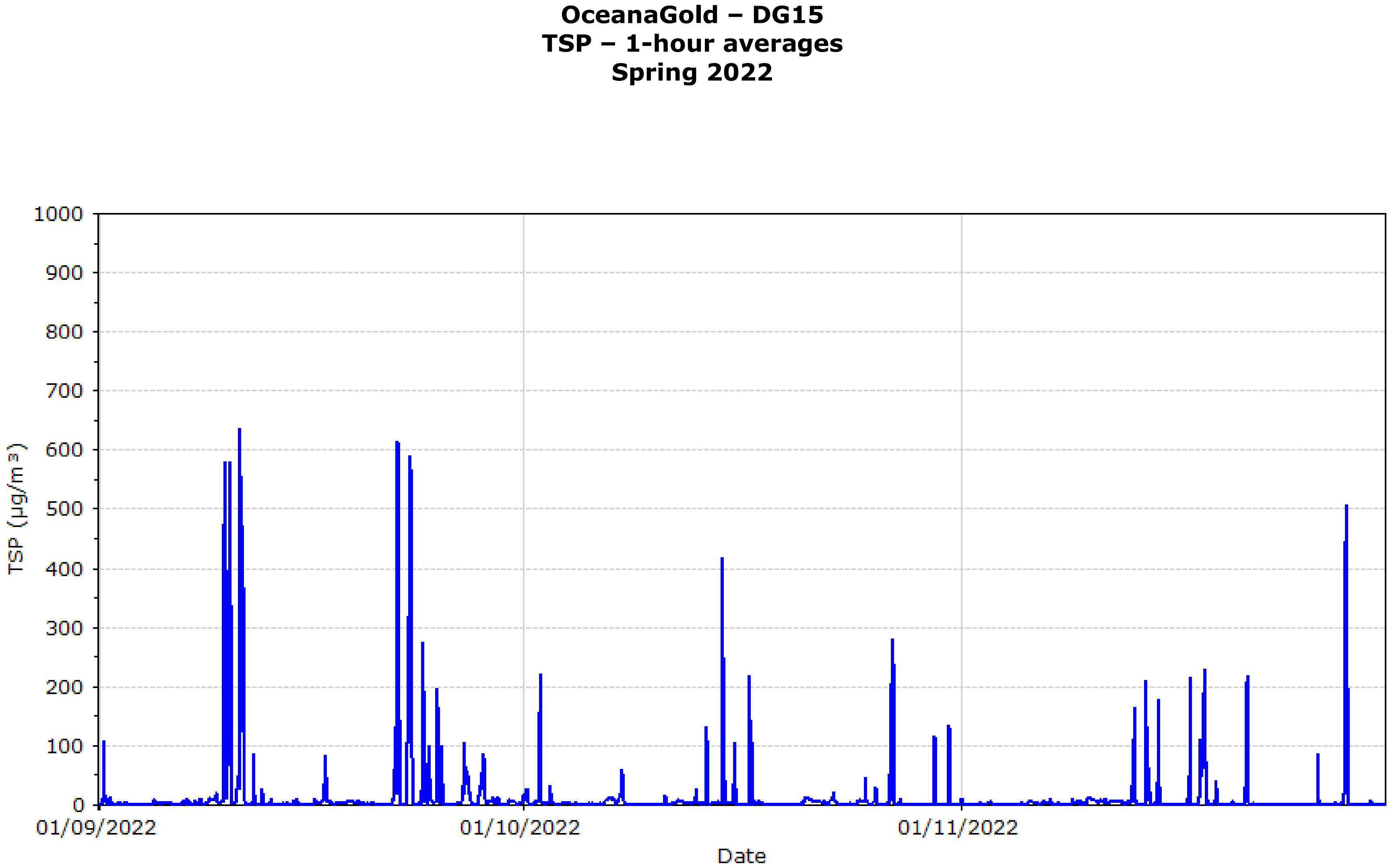

Figure 3: **OceanaGold – DG15: TSP E-Sampler (1-hour averages)**

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Spring 2022

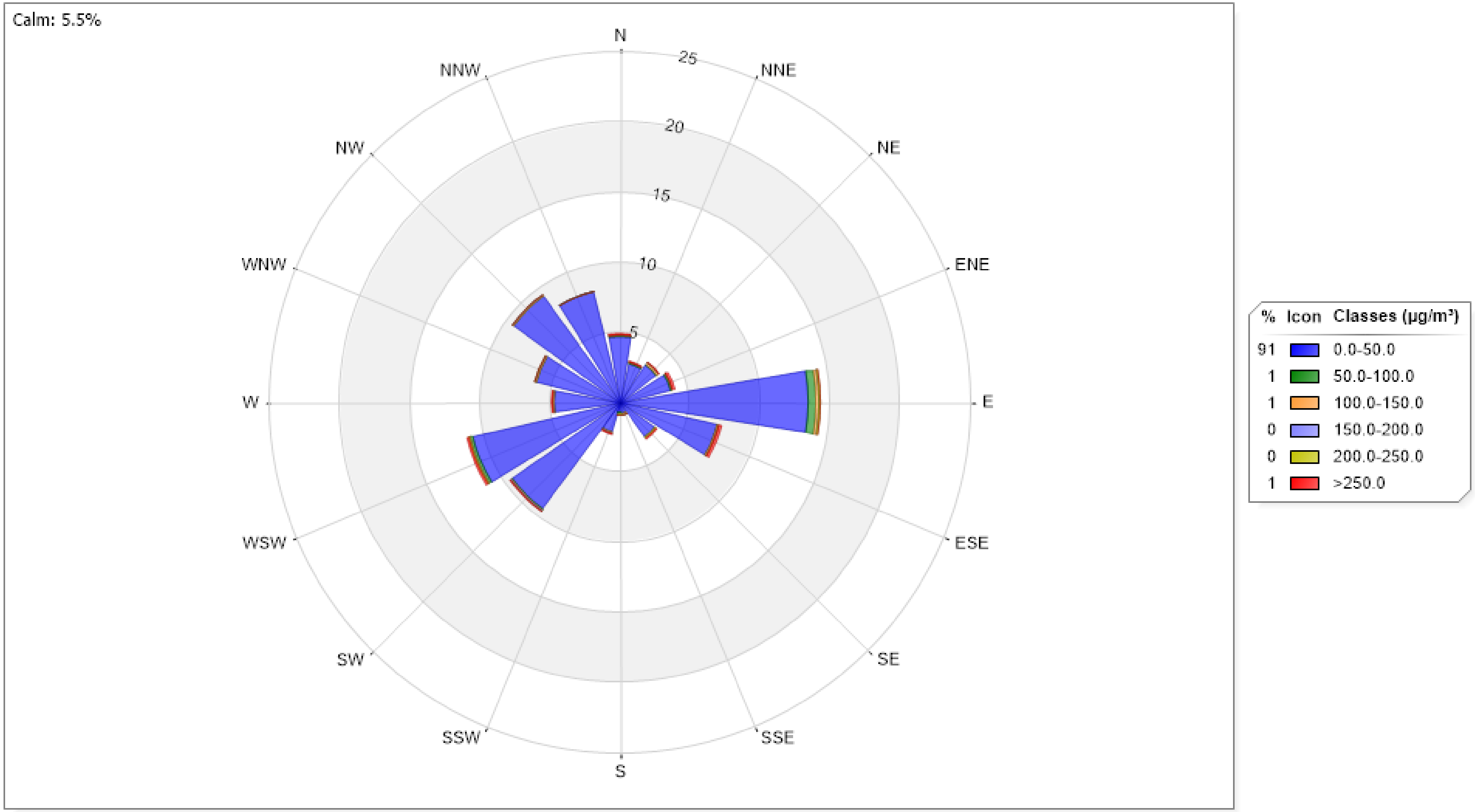

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

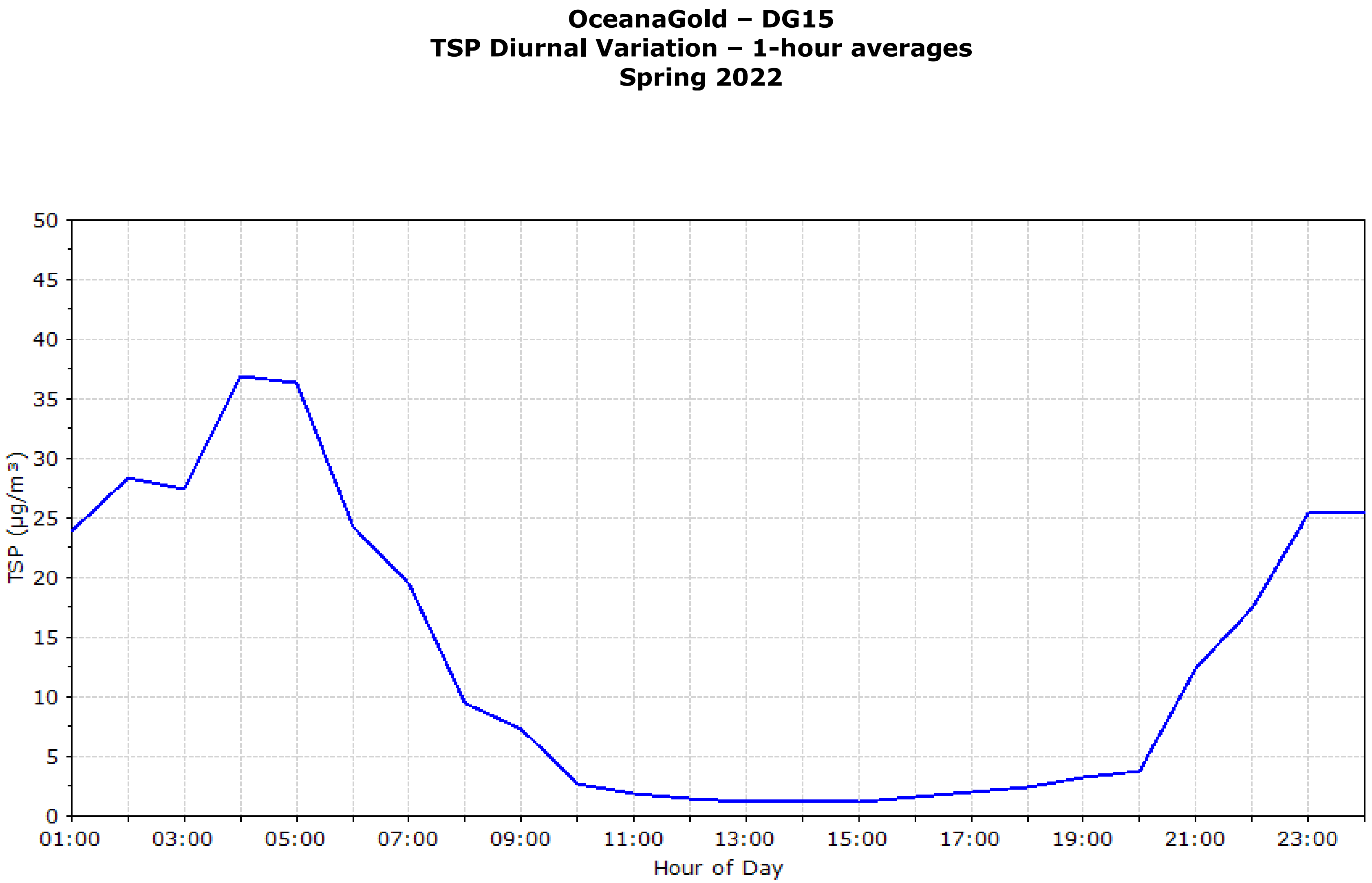

Figure 5: OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Spring 2022 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	-5.3	6.4	18.7
October 2022	-4.0	7.9	22.4
November 2022	1.3	11.4	23.9
Spring 2022	**-5.3 06/09/2022 02:00**	**8.6**	**23.9 15/11/2022 13:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	0.5	6.4	12.3
October 2022	-0.3	7.9	15.2
November 2022	6.0	11.4	17.3
Spring 2022	**-0.3 05/10/2022**	**8.6**	**17.3 15/11/2022**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
September 2022	WSW	7.08	2.7	12.1
October 2022	E	5.9	3.4	12.9
November 2022	E	3.5	3.0	9.0
Spring 2022	**E**	**5.5**	**3.0**	**12.9**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
September 2022	0.7	5.4	19.8	11
October 2022	1.4	14.6	42.8	11
November 2022	0.9	13.6	28.2	14
Spring 2022	**1.0**	**14.6**	**90.8**	**36**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Spring 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	85	19	3	0	0	0	107	4.9
NNE	52	14	0	0	0	0	66	3.0
NE	63	7	7	1	0	0	78	3.5
ENE	42	33	13	0	0	0	89	4.0
E	61	159	77	21	0	0	318	**14.4**
ESE	31	78	53	4	0	0	166	7.5
SE	31	31	11	0	0	0	74	3.3
SSE	15	6	0	0	0	0	21	1.0
S	19	2	1	0	0	0	22	1.0
SSW	23	13	14	1	1	0	53	2.4
SW	49	55	40	42	25	2	212	9.6
WSW	47	49	42	44	45	20	248	11.2
W	47	22	31	6	1	0	107	4.9
WNW	60	45	28	4	0	0	137	6.2
NW	47	91	62	7	1	1	209	9.5
NNW	88	78	14	0	0	0	180	8.2
All	**760**	**703**	**396**	**130**	**74**	**23**	**2087**	**95**
Calm	121						121	5.5

Table 8 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from the southwest to west-southwest and northwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the east.

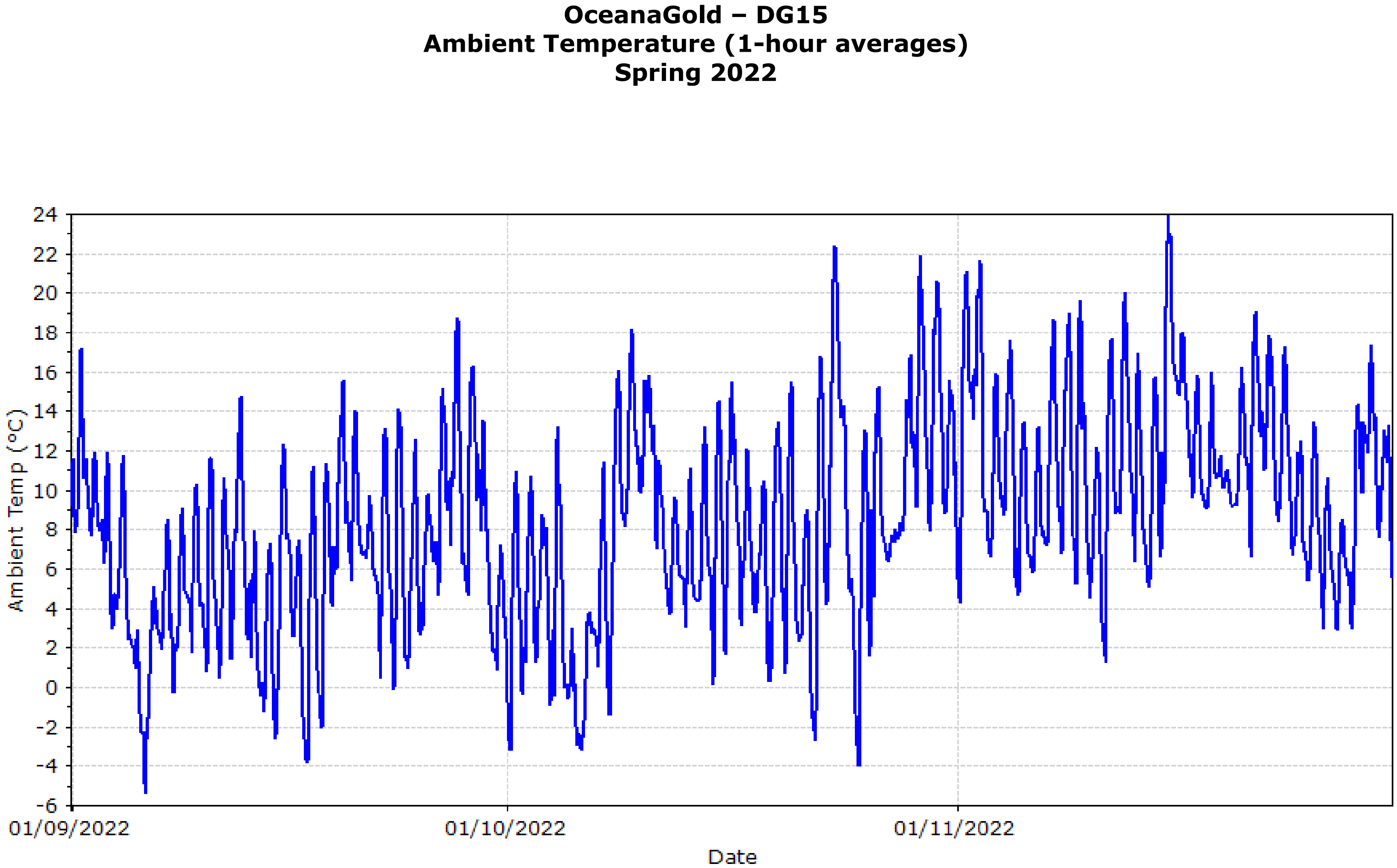

Figure 6: OceanaGold – DG15: Ambient Temperature (1-hour averages)

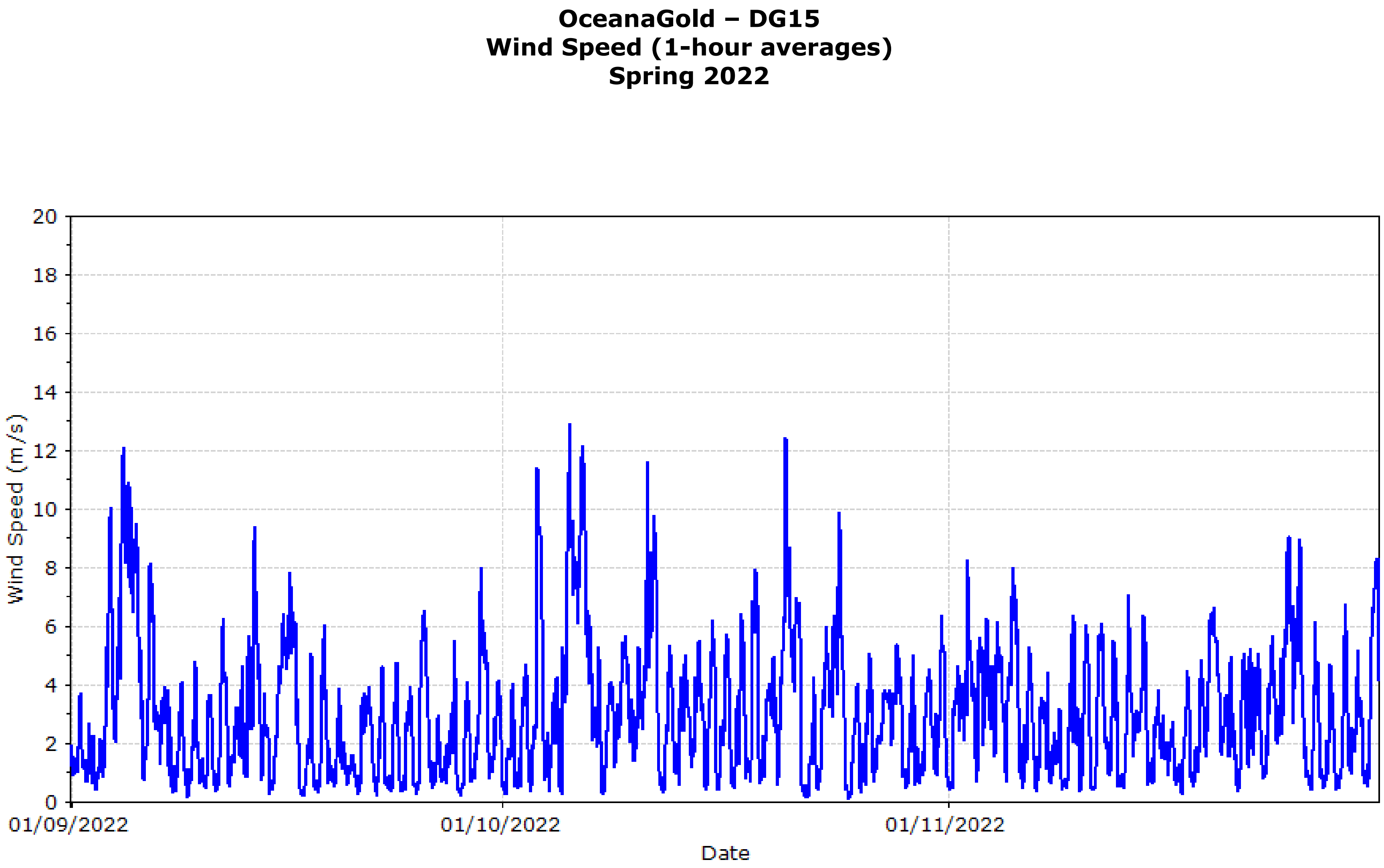

Figure 7: OceanaGold – DG15: Wind Speed (1-hour averages)

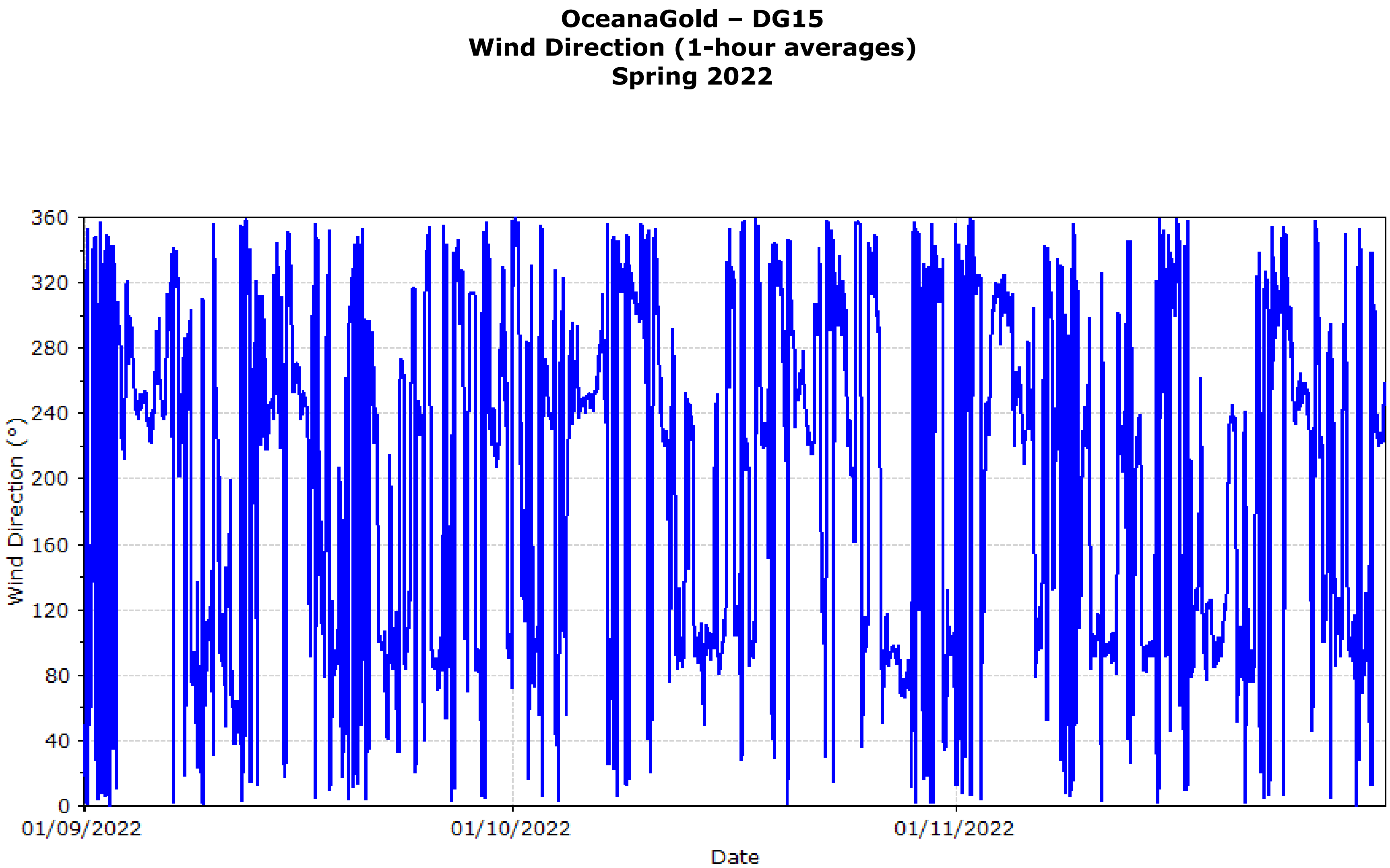

Figure 8: OceanaGold – DG15: Wind Direction (1-hour averages)

OceanaGold – DG15
Wind Rose (1-hour averages)
Spring 2022

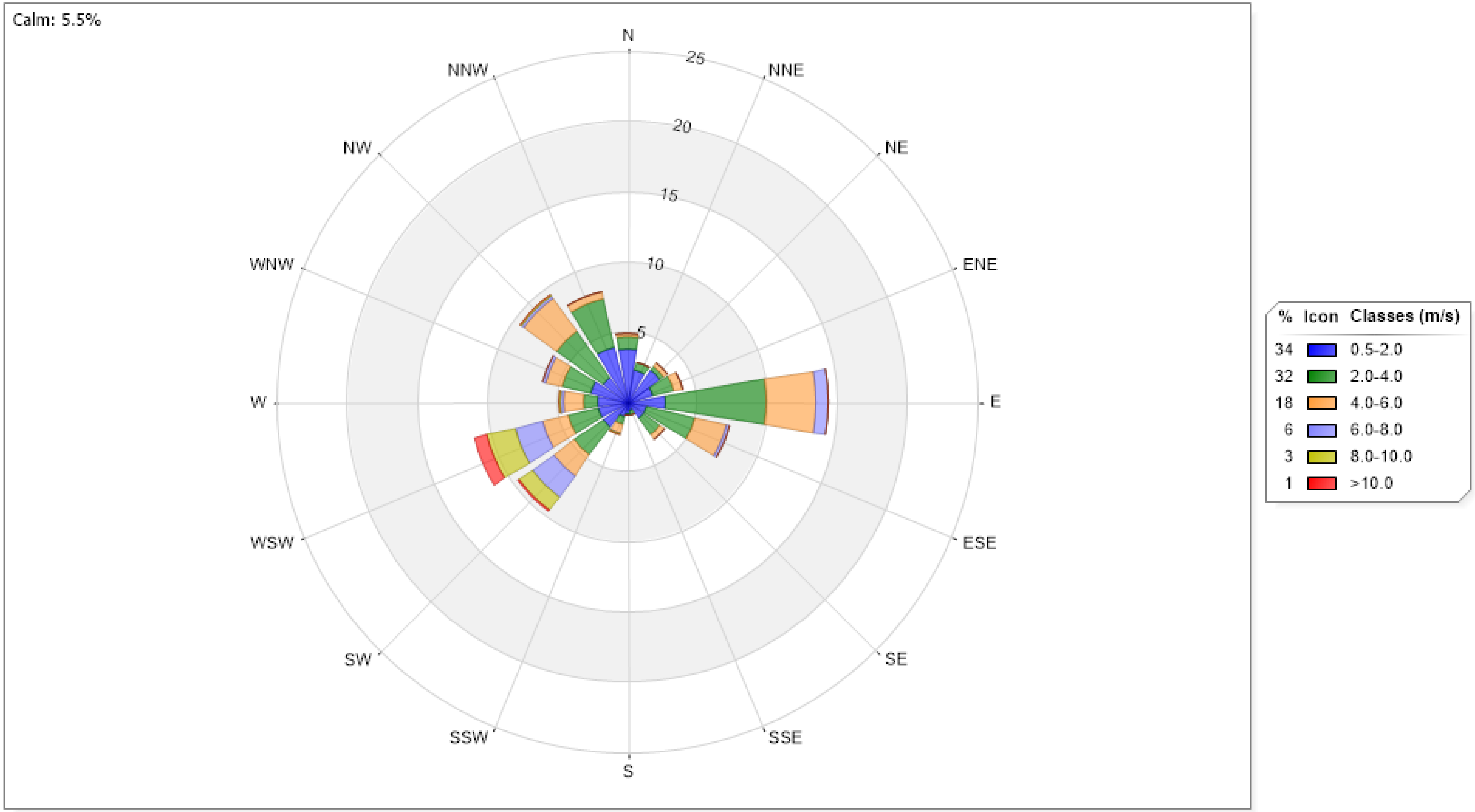

Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

OceanaGold – DG15
Rainfall (24-hour total)
Spring 2022

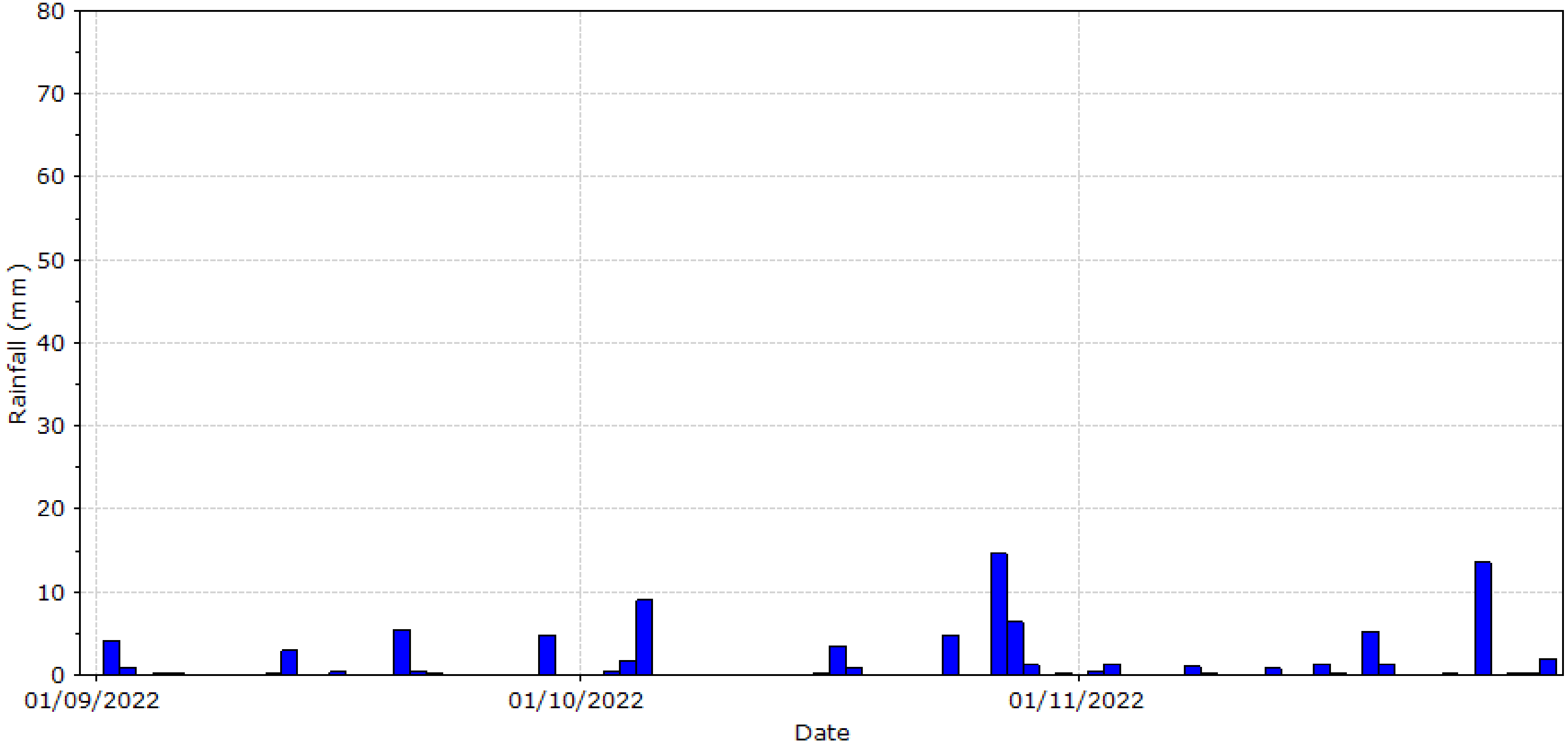

Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Spring 2022 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	-3.8	6.6	18.9
October 2022	-3.7	8.0	22.7
November 2022	2.9	11.3	24.4
Spring 2022	**-3.8 06/09/2022 03:00**	**8.6**	**24.4 15/11/2022 13:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	-3.1	6.9	18.6
October 2022	-3.3	8.3	21.8
November 2022	3.8	11.4	23.3
Spring 2022	**-3.3 06/10/2022 03:00**	**8.9**	**23.3 15/11/2022 13:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
September 2022	30.0	80.7	100.0
October 2022	18.0	75.3	100.0
November 2022	32.3	78.3	100.0
Spring 2022	**18.0**	**78.1**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	0.1	6.6	12.6
October 2022	-1.0	8.0	15.5
November 2022	5.7	11.3	18.0
Spring 2022	**-1.0 05/10/2022**	**8.6**	**18.0 15/11/2022**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	0.2	6.9	12.9
October 2022	-0.7	8.3	16.1
November 2022	5.8	11.4	18.1
Spring 2022	**-0.7 05/10/2022 24:00**	**8.9**	**18.1 15/11/2022 24:00**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2022	55.7	80.7	98.4
October 2022	40.3	75.3	100.0
November 2022	50.2	78.3	100.0
Spring 2022	**40.3**	**78.1**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
September 2022	SSW	2.9	3.2	13.8
October 2022	WNW	1.6	4.1	15.7
November 2022	ENE-E	0.8	3.8	14.4
Spring 2022	ENE	**1.8**	**3.7**	**15.7**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
September 2022	1.2	9.6	36.0	10
October 2022	2.6	27.2	81.0	10
November 2022	1.8	27.0	54.6	15
Spring 2022	**1.9**	**27.2**	**171.6**	**35**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
September 2022	37.5	129.6	214.2
October 2022	59.1	196.5	302.1
November 2022	94.9	215.6	323.1
Spring 2022	**37.5 02/09/2022**	**180.8**	**323.1 11/11/2022**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Spring 2022)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	30	31	3	0	0	0	64	2.9
NNE	51	37	4	5	1	0	98	4.5
NE	56	54	20	3	0	0	133	6.1
ENE	62	132	72	12	0	0	279	**12.8**
E	50	96	91	9	0	0	247	11.3
ESE	18	12	3	0	0	0	33	1.5
SE	27	6	0	0	0	0	33	1.5
SSE	24	13	6	2	0	0	45	2.1
S	34	41	29	18	5	0	127	5.8
SSW	30	57	53	60	41	12	254	11.6
SW	32	36	28	11	3	0	111	5.1
WSW	42	33	15	4	0	3	97	4.5
W	43	37	27	31	30	18	187	8.5
WNW	33	54	75	44	21	19	247	11.3
NW	37	41	29	8	5	0	120	5.5
NNW	35	29	5	1	0	0	70	3.2
All	**606**	**711**	**461**	**209**	**106**	**52**	**2146**	**98**
Calm	38						38	1.8

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from south-southwest and west- southwest to west-northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the east-northeast.

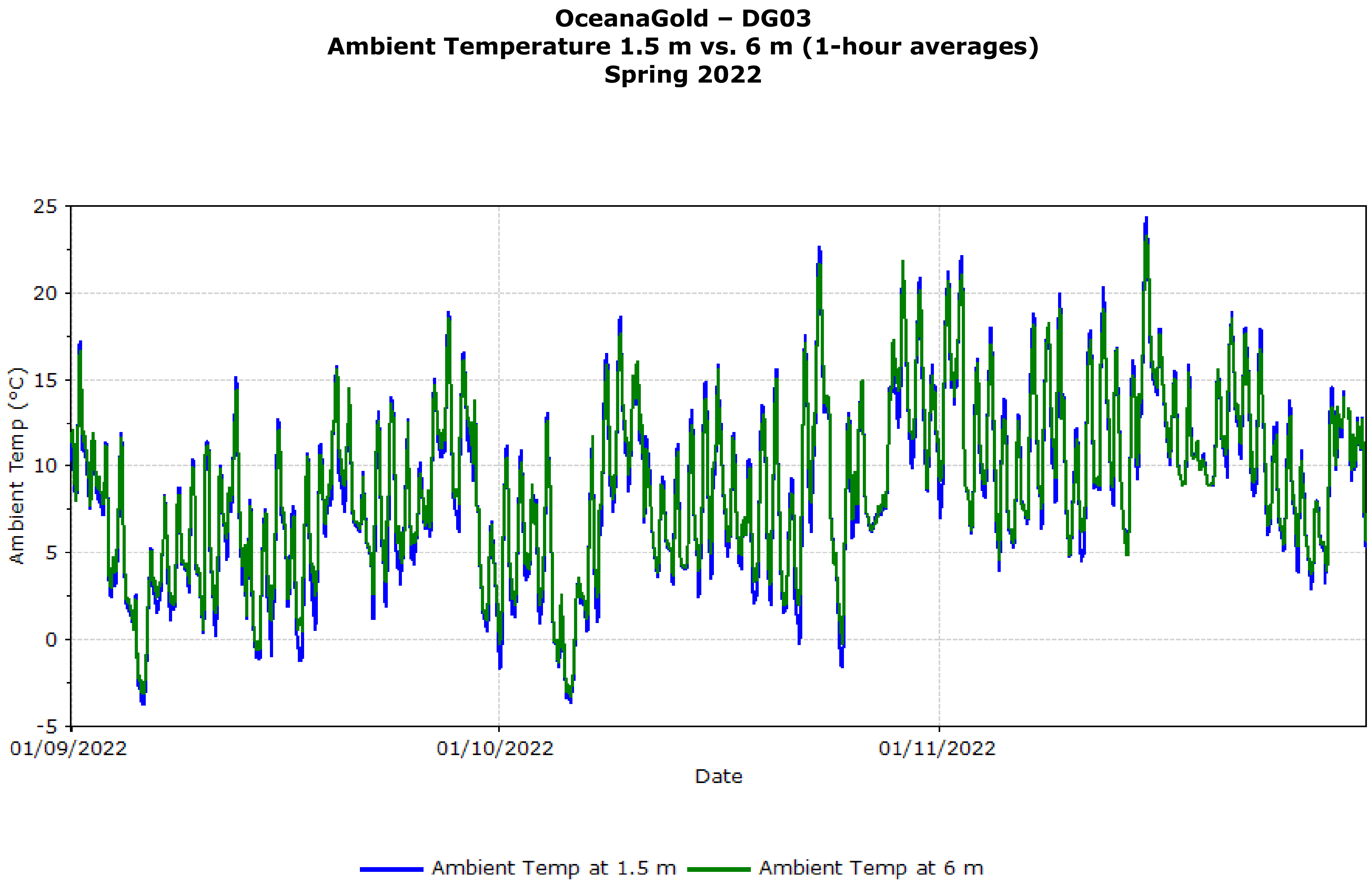

Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

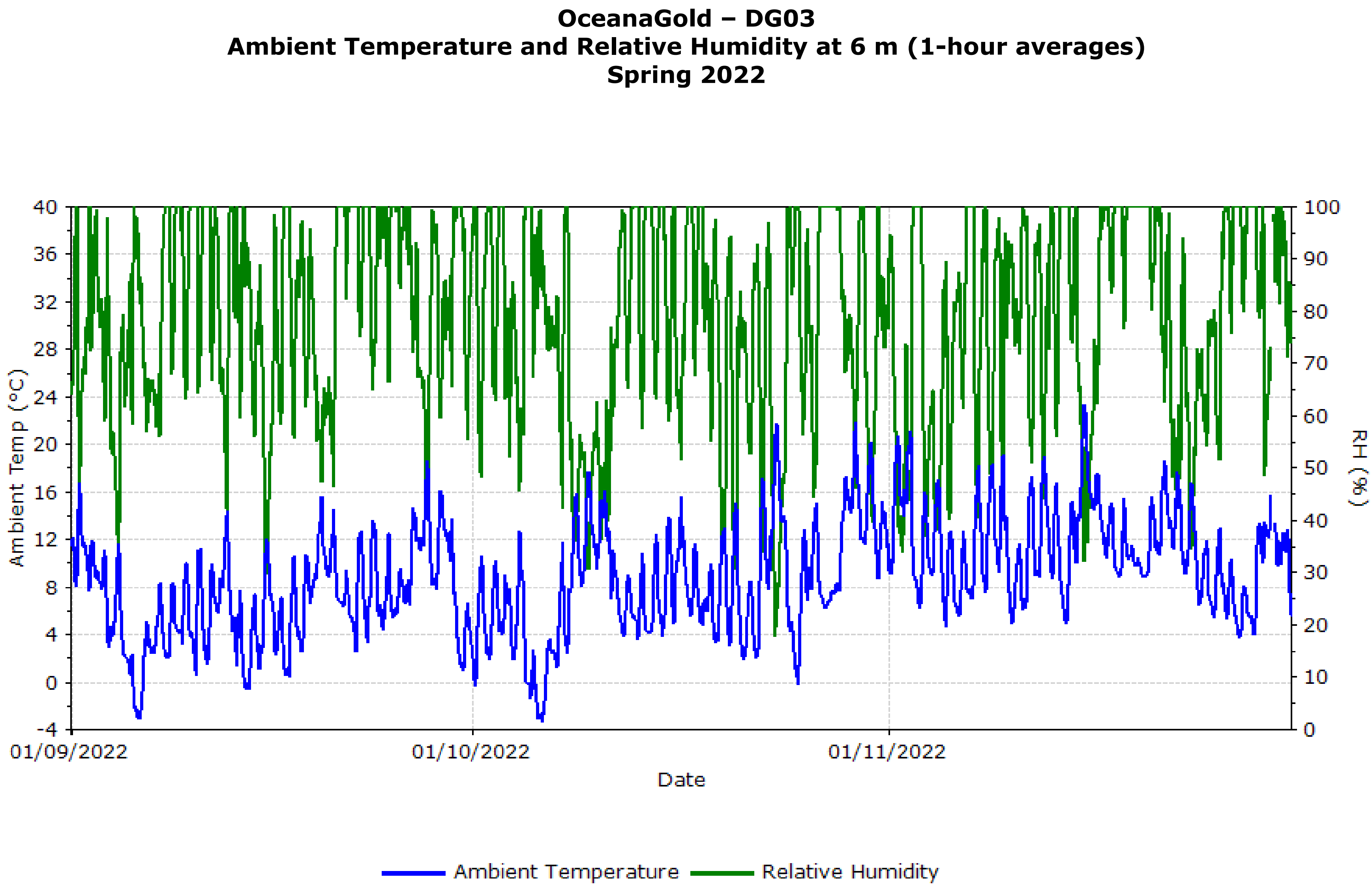

Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

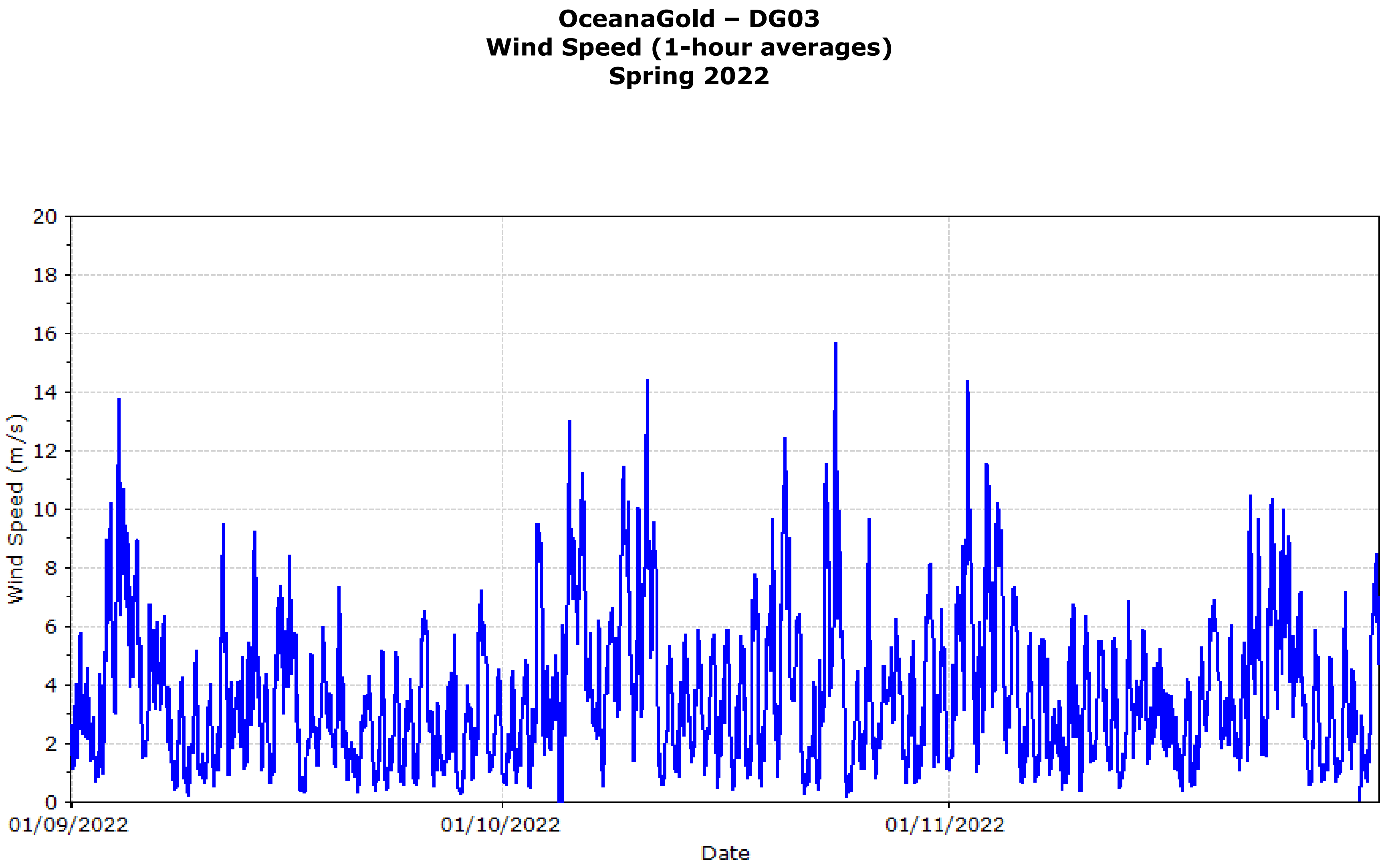

Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

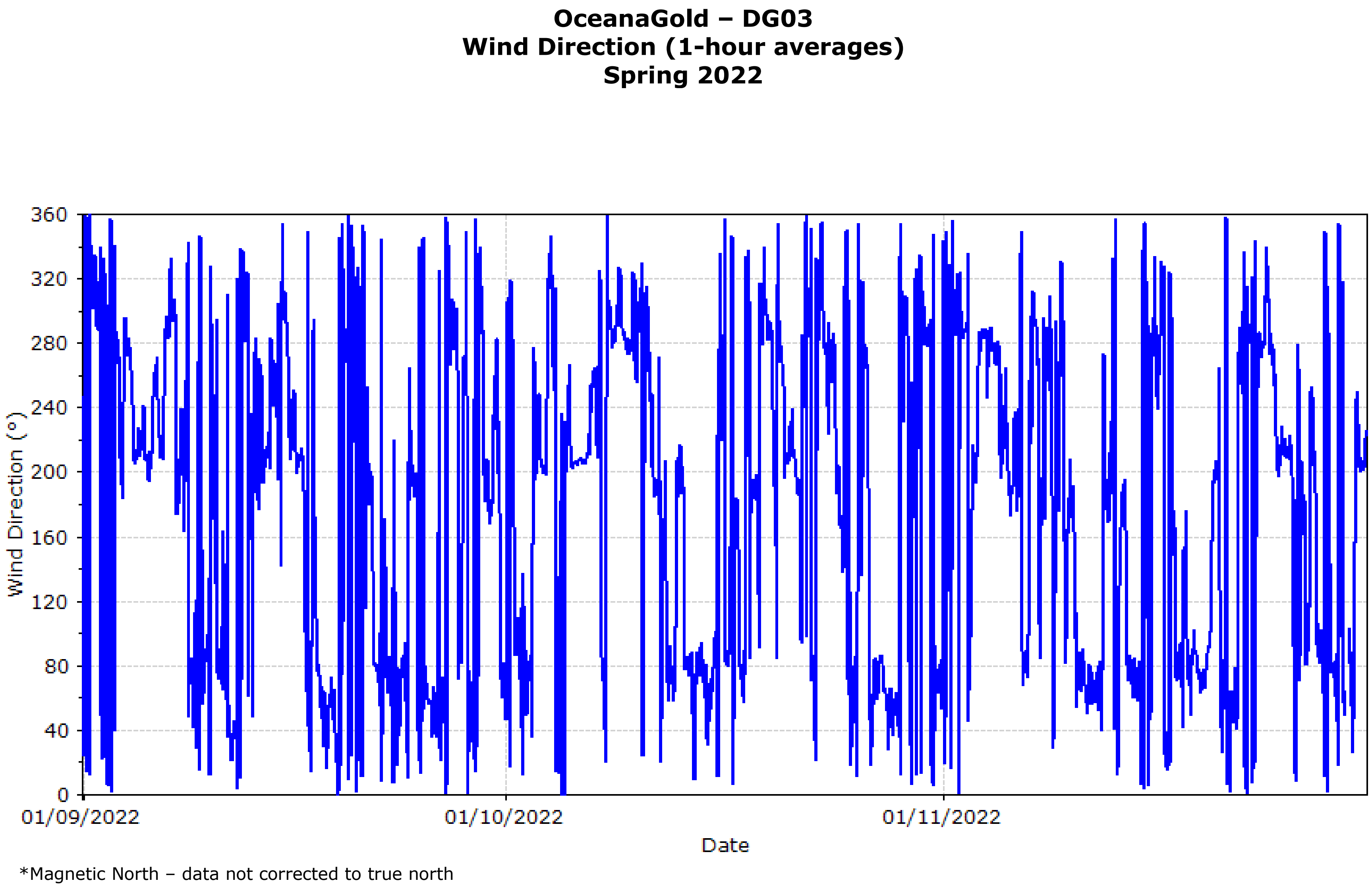

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

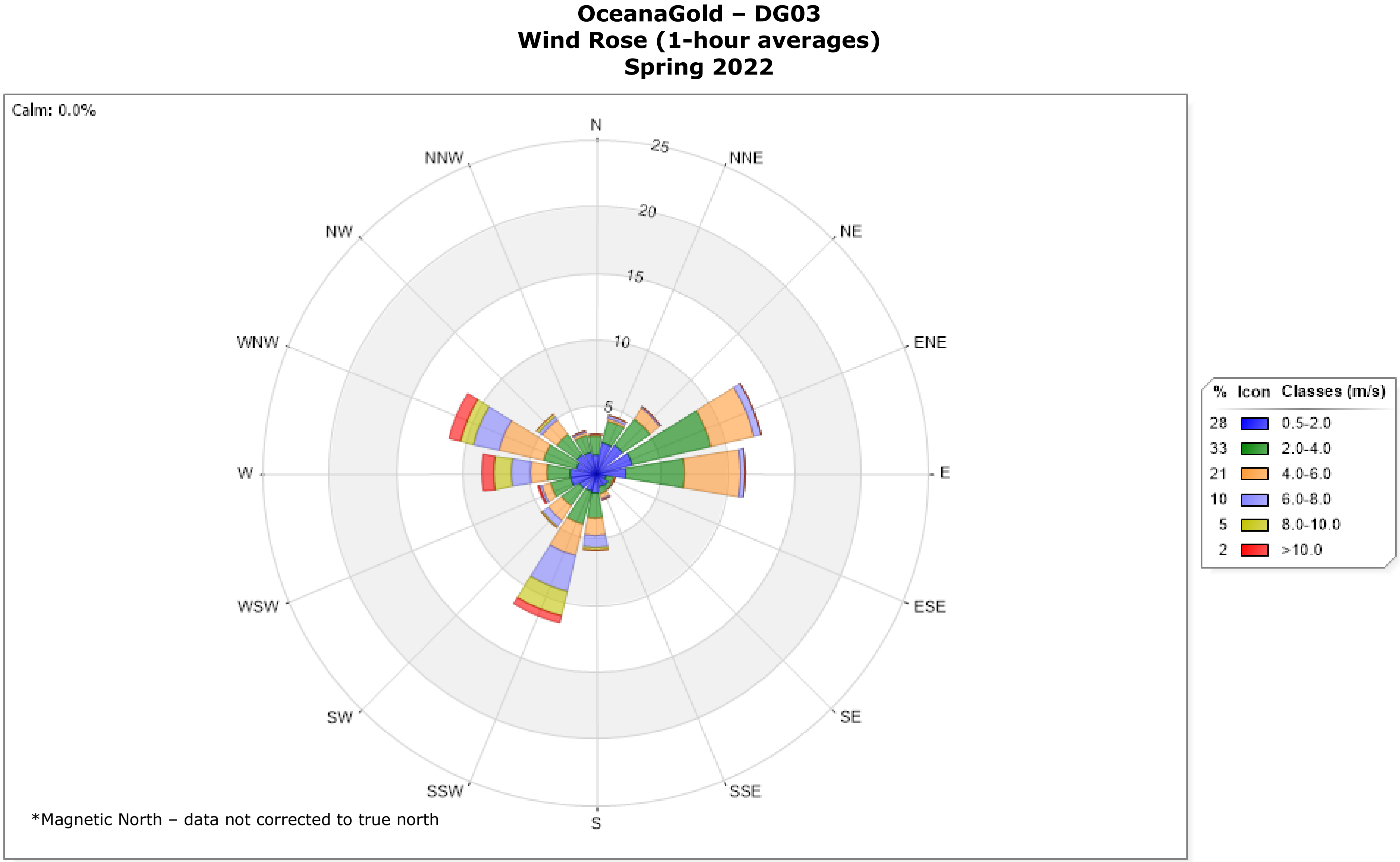

Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

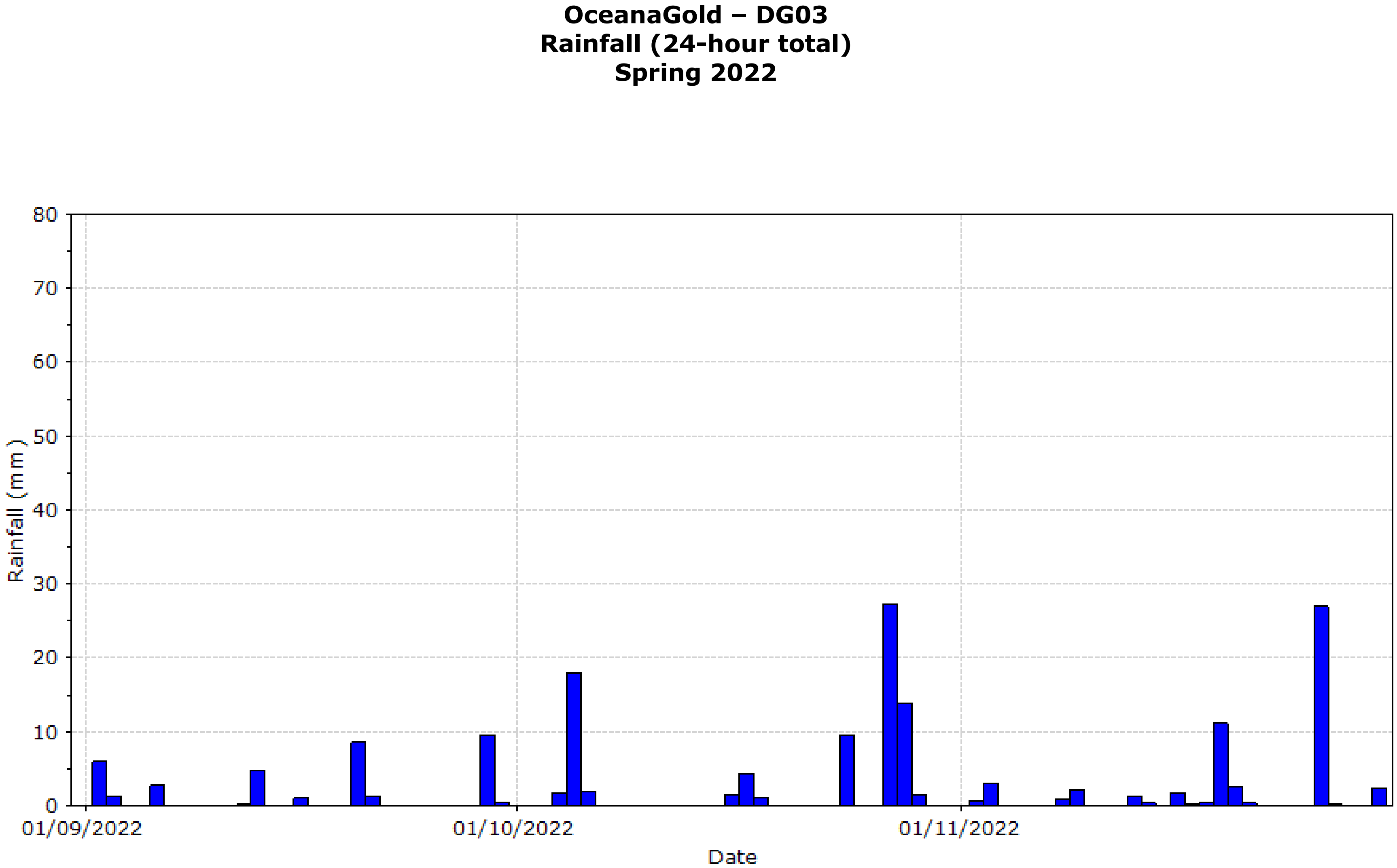

Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

OceanaGold – DG03
Solar Radiation (1-hour averages)
Spring 2022

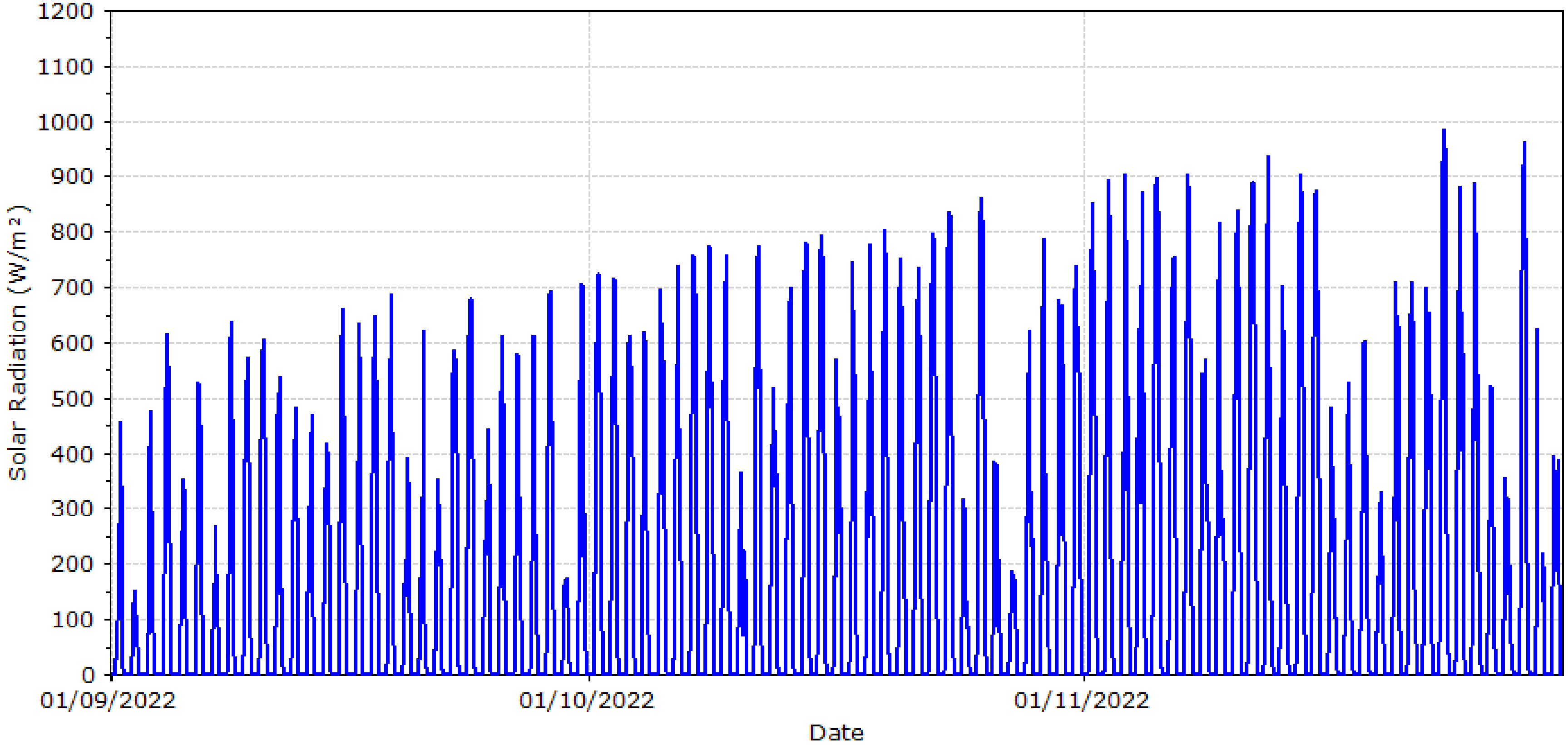

Figure 17: **OceanaGold – DG03: Solar Radiation (1-hour averages)**

References

Ministry for the Environment (2002). *2002a. Ambient Air Quality Guidelines*. MfE, Wellington, New Zealand.

Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	15-12-21	2415	Callout	Installed	H MdAli
	19-04-22	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
	16-06-22	2415	Six-Monthly Maintenance	Parameter Check	B Kaushal
	14-09-22	2415	Quarterly Maintenance	Parameter Check	R Hodgkinson
	13-12-22	2415	Annual Maintenance	Audit Calibrations	R Hodgkinson
Temperature sensor – Campbell Scientific 107					
	19-04-22	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2418	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
Anemometer – Vector A101M					
	15-12-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2417	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
Wind vane – Vector W200P					
	15-12-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2416	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
Rain gauge – TB3-0.2/P					
	15-12-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2419	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2419	Six-Monthly Maintenance	Parameter Check	R Hodgkinson

D

Appendix D – Monitoring Instrumentation

Monitoring Instrumentation

The Ministry for the Environment Good Practice Guide for Monitoring and Data 2009 recommends the following specifications for meteorological instruments. Both the DG03 and DG15 sites are maintained by Scott Technical instruments company. The equipment used at both sites is compared to the MfE recommendations in Table D1.

Table D1. Meteorological Monitoring Equipment Specifications

Monitoring Parameter	Monitoring Requirement
Meteorological Mast GPG	6 m minimum 10 m preferable
Scott tech Comment	Historically, there was a 5m climbable mast at the Mine Site. Due to H&S issues associated with the climbable nature of the mast, OGNZL requested a replacement mast. It was recently replaced with a 6m tiltable mast. The option of installing a 10m mast was offered at this time but not taken up. The village site (DG15) is a 6m tiltable mast as supplied to Watercare around 2012.
Wind speed	Resolution 0.1 m/s, accuracy ± 0.2 m/s, start-up speed 0.2 m/s
Scott tech Comment	Both the mine and village sites have a Vector A101M anemometers installed. The resolution and start-up specifications meet the above requirements. The accuracy is 1% of the full-range of 10-55 m/s or 0.1 m/s to 0.55 m/s (at full range).
Wind direction	Resolution 1°, accuracy ± 2°, referenced to true north
Scott tech Comment	Both the mine and village sites have a Vector W200P wind vane installed. The wind direction resolution is better than 1° and it has an accuracy of +/-3° in steady winds over 5 m/s with +/- 2% accuracy if calibrated. Our standard policy is to align wind vanes to True North. For the mine site (DG03), when the new 6 m mast was installed, the wind vane alignment was matched to the old 5 m mast to maintain consistency in the data. The alignment of the boom on the old 5 m mast is noted as being magnetic North in the most recent service report. It is no problems for us to update the datalogger program to apply an offset to correct the wind direction data to True North, or we could re-align the boom on the next site visit. The wind vane boom at the village site (DG15) has been recorded as aligned to True North in the most recent service report (2020) and site check report (2021).
Air temperature	MfE state the resolution should be 0.1°C and accuracy 0.2°C. The Guide to Instruments and Methods of Observation Volume I – Measurement of Meteorological Variables, World Meteorological Organization, 2021 states “For general meteorological work, the observed air temperature should be representative of the free air conditions surrounding the station over as large an area as possible, at a height of between 1.25 and 2 m above ground level”
Scott tech Comment	Both sites meet the above specification. Mine Site (DG03) – Temperature sensor is an EE181 Village Site (DG15) – Temperature sensor is a Campbell 107

Monitoring Parameter	Monitoring Requirement
Automated logging system	Reliable power with battery back-up.
Scott tech Comment	Both sites meet the above specification
Coordinate system	The use of the Cartesian coordinate system is recommended whereby data is converted to its x and y components. This data can then be accumulated in a vector form. This solves averaging and unweighted direction problems. Results may subsequently be converted to polar coordinates if required.
Scott tech Comment	Both the Mine Site and Village Sites are currently programmed to calculate wind speed and direction using the Wind Vector calculation with Output Option 0 on the logger used. This setting uses mean windspeed and unit vector wind direction averaging.
Desirable measurements are:	
Humidity (or dew point)	Resolution 1% relative humidity (rh), accuracy ± 5% rh
Scott tech Comment	Humidity is measured at the Mine Site using the EE181 sensor which meets the above specification. Humidity monitoring is not required at the Village Site.
Solar radiation (for stability estimates)	Resolution 1 W/m^2, accuracy 10 W/m^2
Scott tech Comment	The Mine Site has an Apogee SP-110 pyranometer sensor installed which meets the above specification. Solar radiation monitoring is not required at the Village Site.
Rainfall	Resolution 1 mm
Scott tech Comment	Both sites have 0.2 mm resolution rain gauges installed.
Temperature profile	Temperature at two heights, 1.5 m and 10 m, needs 0.1°C accuracy using identical sensors at both heights.
Scott tech Comment	The lower sensor is the EE181 temp/RH sensor (accuracy ±0.2ºC at 23ºC), and the upper sensor is a Campbell 107 thermistor (accuracy ±0.2ºC from 0 - 50ºC). Only one height is required for temperature monitoring at the Village Site.
Specific siting requirements	The site must be free of influence of trees buildings structures, should be at least two times the height away from the obstacle and for wind sensors it should be at least 10 times the height away from obstacles. (Refer to Part I sections 5.9.2 and 6.2 of the Guide to Meteorological Instruments and Methods of Observation (World Meteorological Organization 1996 Oke TR 2006)).
Comment	The Village site is in an open paddock away from obstructions. The mine site monitor (DG03) is beside the large mixed tailings dam which will shelter some winds from northerly directions.
Required time resolution	Data should be collected at the same minimum time resolution as air quality data resolution should be at least hourly.
Comment	Continuous TSP dust monitoring data is recorded on the same frequency as this data.
Period of monitoring	For atmospheric modelling and trend analysis a minimum of one year's data is recommended.
Comment	The monitoring programme has been in place for many years.

E

Appendix E – Additional Wind Roses

DG03 Windroses

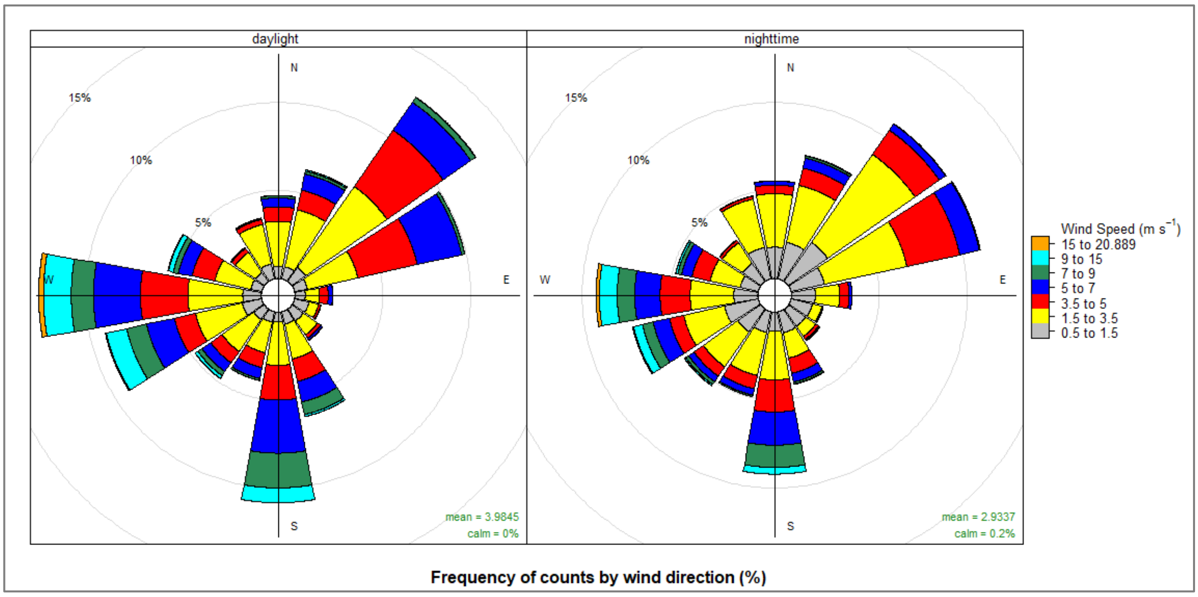

Figure E7-2. Diurnal Windrose (hourly average) for DG03 from 01 January 2022 to 31 December 2022

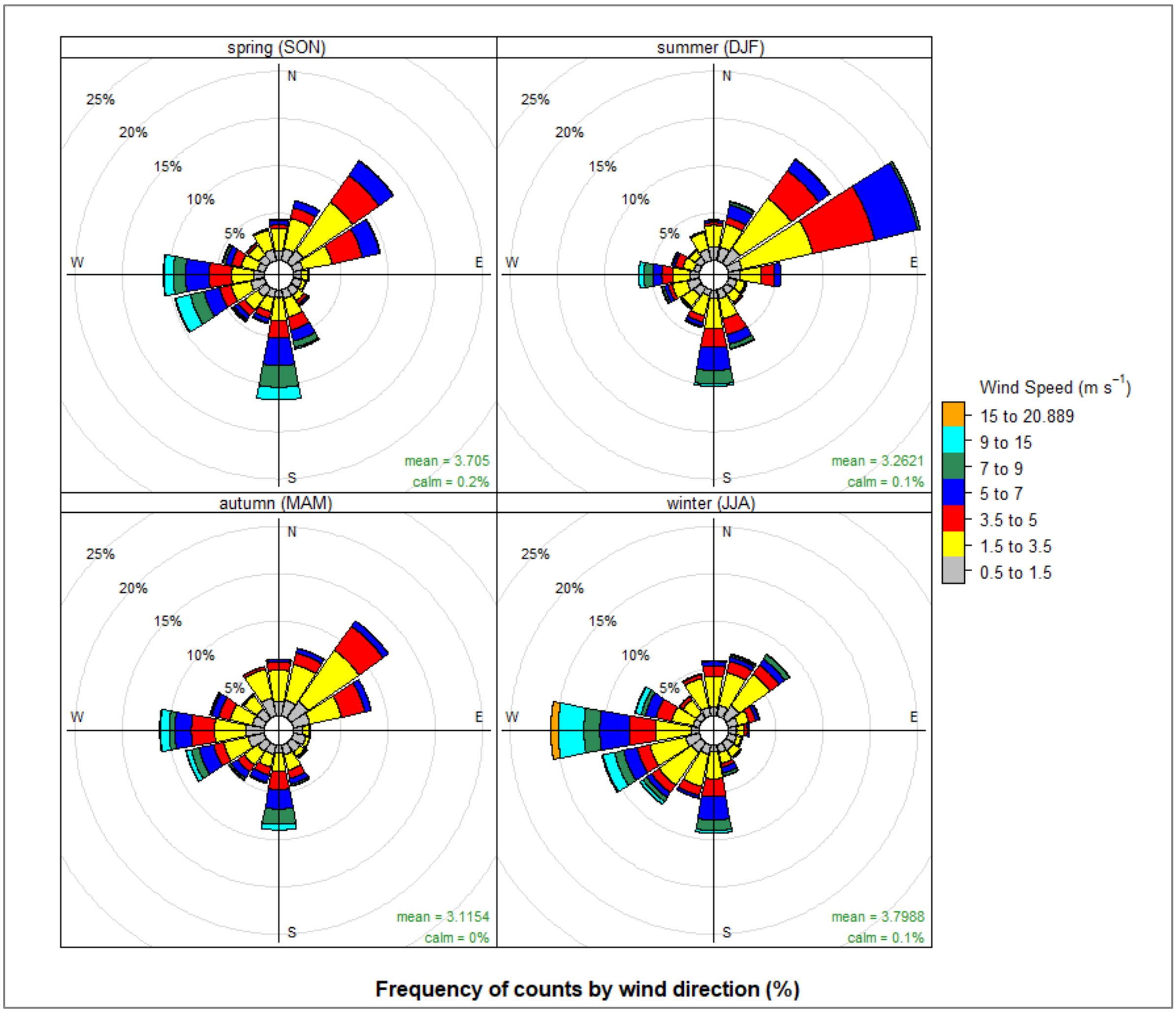

Figure E7-3. Seasonal Windrose (hourly average) for DG03 from 01 January 2022 to 31 December 2022

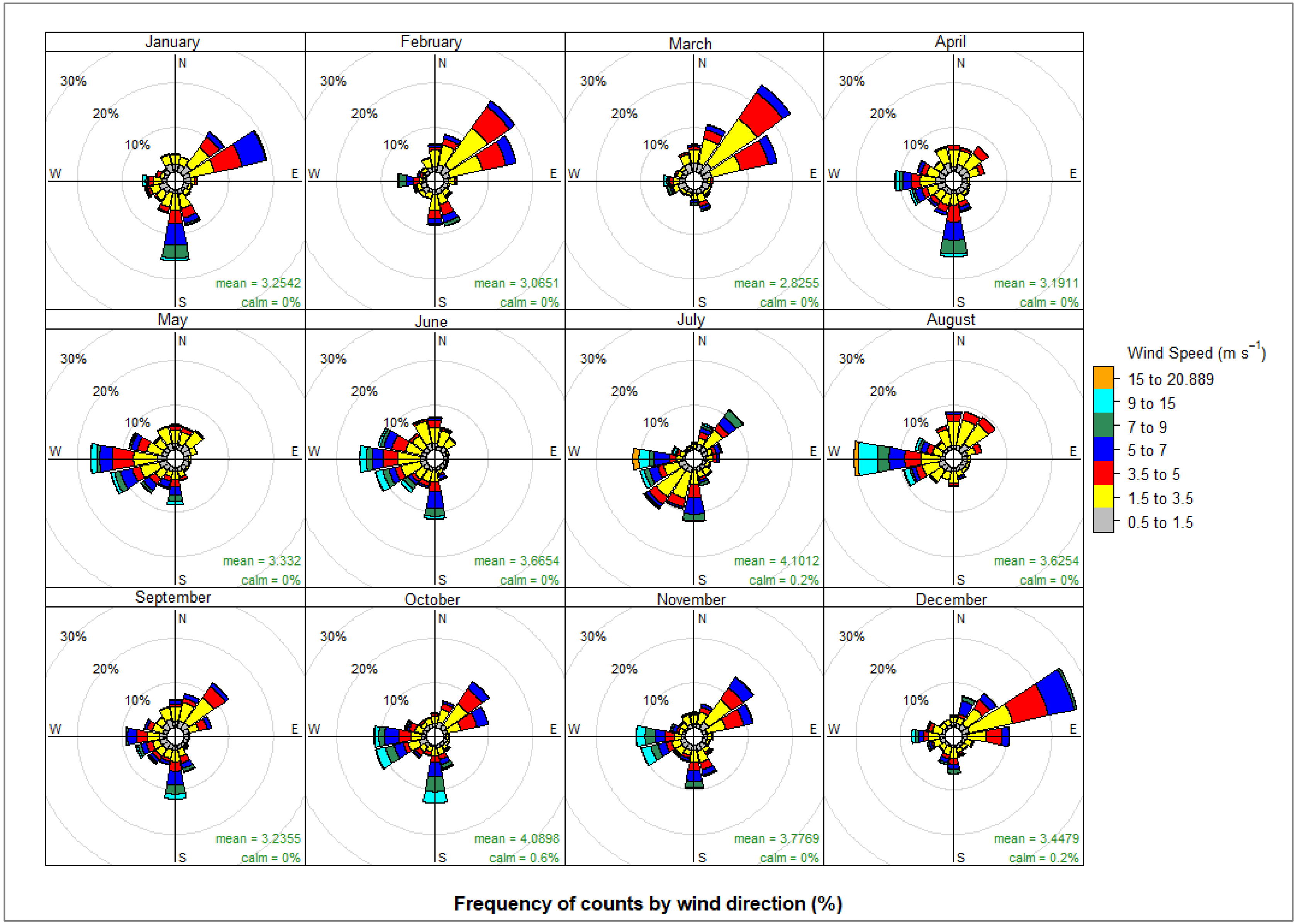

Figure E7-4. Monthly Windrose (hourly average) for DG03 from 01 January 2022 to 31 December 2022

DG15 Windroses

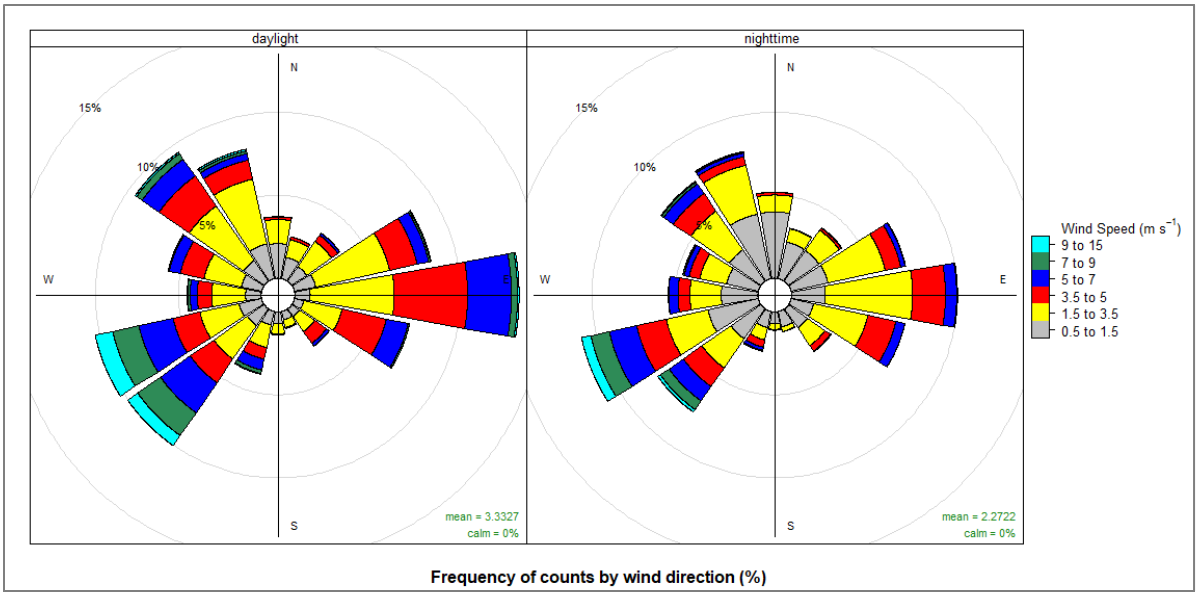

Figure E7-5. Diurnal Windrose (hourly average) for DG15 from 01 January 2022 to 31 December 2022

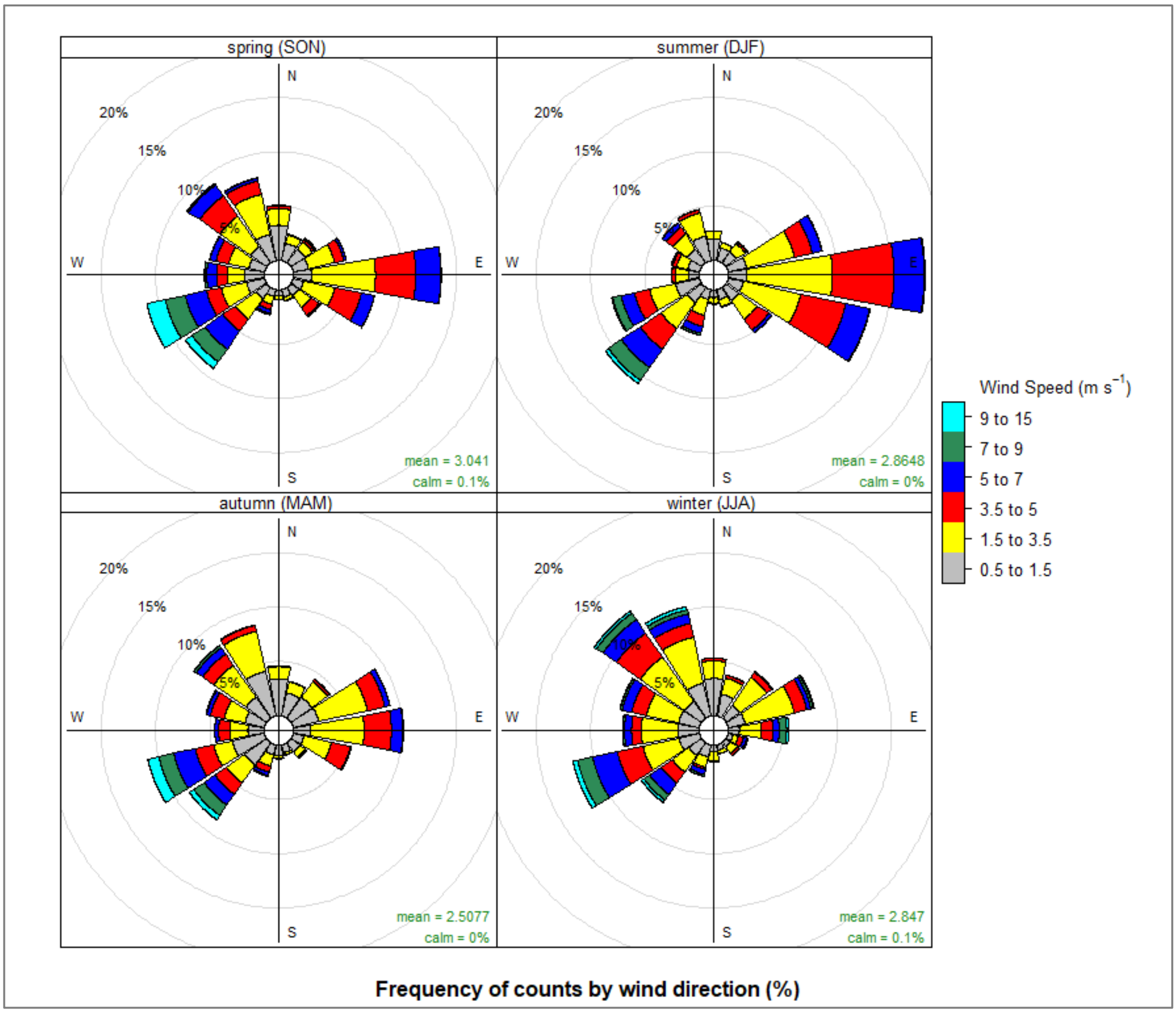

Figure F-7-6. Seasonal Windrose (hourly average) for DG15 from 01 January 2022 to 31 December 2022

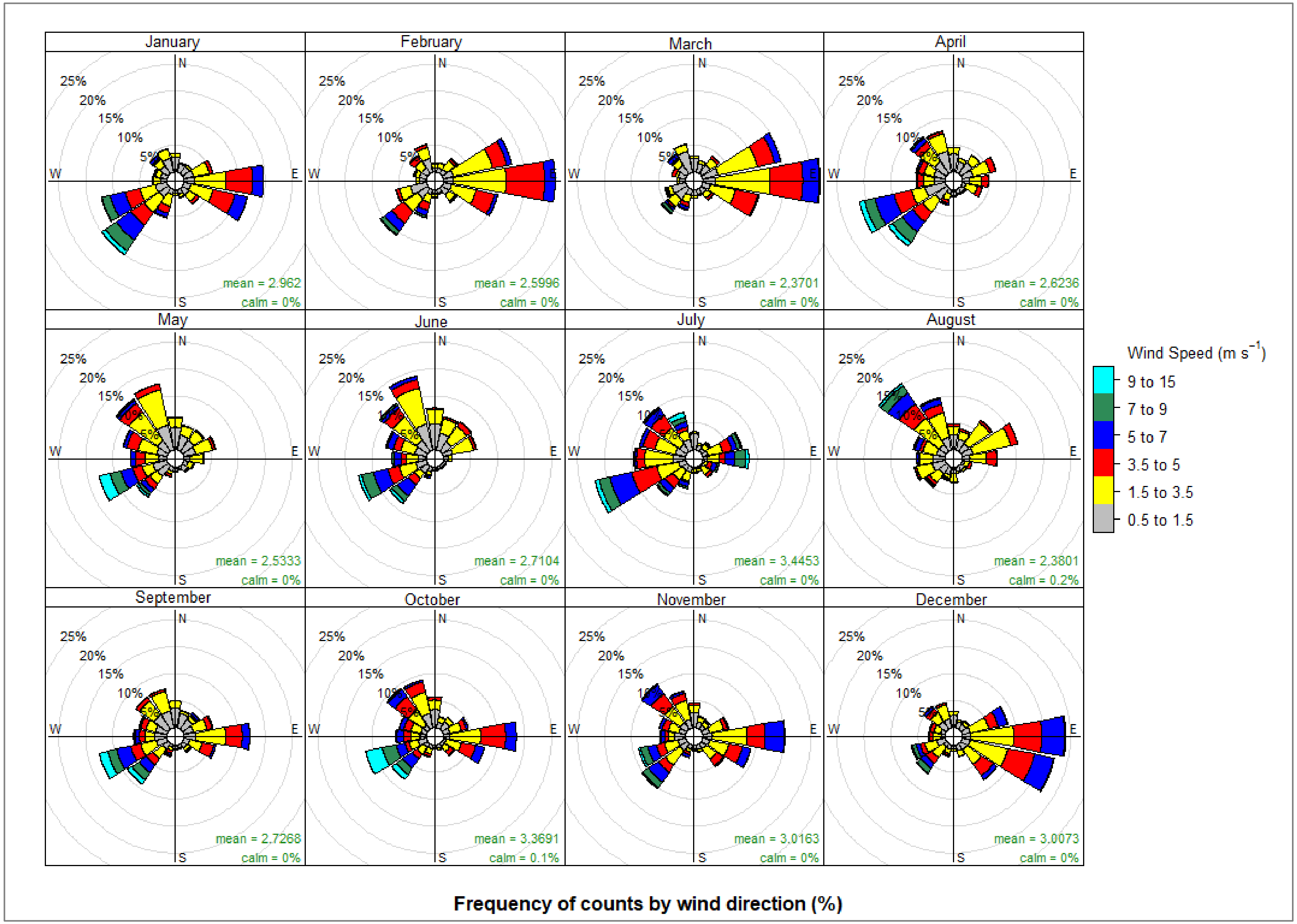

Figure E7-7. Monthly Windrose (hourly average) for DG15 from 01 January 2022 to 31 December 2022

F

Appendix F – TSP Exceedances

Table F-1. TSP exceedance of the hourly consent limit at DG07 compared to DG03 relative humidity

Date and Time	DG07 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
25/01/2022 1:00	446.8	100
25/01/2022 2:00	360.9	100
25/01/2022 3:00	463	100
25/01/2022 4:00	459.7	100
25/01/2022 5:00	399.5	100
25/01/2022 6:00	549	100
25/01/2022 7:00	318.8	100
31/01/2022 23:00	295.5	100
1/02/2022 4:00	280.4	100
3/02/2022 4:00	285.2	100
8/02/2022 22:00	414.5	100
9/02/2022 19:00	259.4	100
11/02/2022 21:00	481.1	100
11/02/2022 22:00	282.9	100
15/02/2022 22:00	403.8	100
25/02/2022 1:00	412	100
25/02/2022 2:00	552.3	100
25/02/2022 3:00	380.9	100
25/02/2022 4:00	452.6	100
25/02/2022 5:00	302.5	100
5/03/2022 3:00	395.3	100
5/03/2022 4:00	572	100
5/03/2022 5:00	690.9	100
10/03/2022 1:00	269.1	100
10/03/2022 2:00	254.7	100
10/03/2022 3:00	558.2	100
10/03/2022 4:00	390	100
10/03/2022 5:00	926.1	100
10/03/2022 6:00	666.1	100
10/03/2022 7:00	694.8	100
11/03/2022 0:00	562	100
11/03/2022 1:00	769	100
11/03/2022 2:00	374	96.5
13/03/2022 23:00	349	100
21/03/2022 0:00	332	100
21/03/2022 2:00	299.4	100
26/03/2022 22:00	383.6	100
27/03/2022 19:00	598.8	100
27/03/2022 20:00	425.2	100
27/03/2022 23:00	561.7	100
28/03/2022 3:00	660.7	100
28/03/2022 4:00	461.1	100
28/03/2022 5:00	340.2	100
28/03/2022 6:00	333.9	100
28/03/2022 21:00	331.2	100
28/03/2022 22:00	599.9	100
28/03/2022 23:00	250.3	100
29/03/2022 3:00	270.1	100
29/03/2022 4:00	281.6	100
29/03/2022 7:00	801.8	100
31/03/2022 2:00	415.1	100
31/03/2022 3:00	591.5	100
31/03/2022 4:00	429.3	100
31/03/2022 6:00	253.5	100
3/04/2022 6:00	279.6	100
13/04/2022 23:00	313.7	100
14/04/2022 4:00	281.2	100
14/04/2022 5:00	373.2	100

Date and Time	DG07 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
21/04/2022 23:00	295.3	100
27/04/2022 21:00	258.7	100
27/04/2022 22:00	277.5	100
27/04/2022 23:00	323	100
30/04/2022 2:00	296.2	100
30/04/2022 3:00	277.1	100
9/05/2022 5:00	446.9	100
9/05/2022 7:00	400.4	100
15/05/2022 3:00	264.6	100
15/05/2022 22:00	259.4	100
16/05/2022 5:00	253.2	100
16/05/2022 6:00	587.7	100
16/05/2022 7:00	275.5	100
17/05/2022 8:00	325.7	99.9
17/05/2022 19:00	620.6	100
17/05/2022 21:00	267.1	99.9
9/07/2022 0:00	369	100
17/08/2022 3:00	276.7	99.1
18/08/2022 13:00	787.3	100
18/08/2022 14:00	1176.1	100
18/08/2022 17:00	807	100
18/08/2022 18:00	1218.7	100
18/08/2022 19:00	1513.7	100
18/08/2022 20:00	1528.4	100
18/08/2022 21:00	353.5	100
21/08/2022 6:00	708.2	92.8
22/09/2022 2:00	327.8	100
22/09/2022 21:00	374.6	100
22/09/2022 22:00	639.8	100
22/09/2022 23:00	382.4	100
23/09/2022 0:00	715.9	100
23/09/2022 1:00	770.2	100
23/09/2022 2:00	1095.4	100
23/09/2022 3:00	340.4	100
25/09/2022 7:00	280	100
15/10/2022 2:00	371.6	100
26/10/2022 22:00	749.6	100
26/10/2022 23:00	1126.4	100
27/10/2022 1:00	826.9	100
27/10/2022 2:00	791.4	100
27/10/2022 3:00	982.1	100
27/10/2022 4:00	1030.7	100
27/10/2022 5:00	710.5	100
21/11/2022 1:00	331.6	99.8

Table F-2. TSP exceedance of the hourly consent limit at DG11 compared to the DG03 relative humidity

Date and Time	DG11 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
11/01/2022 12:00	328.835	100.0
11/01/2022 17:00	281.16	100.0
11/01/2022 18:00	624.585	100.0
11/01/2022 20:00	593.4767	100.0
15/01/2022 0:00	389.4667	100.0
15/01/2022 1:00	452.9633	100.0
15/01/2022 4:00	372.4983	100.0
16/01/2022 2:00	315.8083	100.0
16/01/2022 3:00	453.1183	100.0
22/01/2022 20:00	308.2667	100.0
25/01/2022 1:00	257.095	100.0

Date and Time	DG11 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
26/01/2022 0:00	257.7367	100.0
26/01/2022 1:00	482.8417	100.0
3/02/2022 4:00	428.3117	100.0
9/02/2022 7:00	295.5417	100.0
9/02/2022 16:00	612.55	100.0
9/02/2022 17:00	468.5083	100.0
11/02/2022 20:00	300.1617	100.0
25/02/2022 2:00	522.25	100.0
25/02/2022 3:00	292.2183	100.0
25/02/2022 5:00	336.9917	100.0
26/02/2022 1:00	401.7883	100.0
5/03/2022 3:00	355.7317	100.0
10/03/2022 0:00	351.25	100.0
10/03/2022 3:00	621.3683	100.0
10/03/2022 4:00	577.815	100.0
10/03/2022 5:00	504.9183	100.0
10/03/2022 6:00	671.9667	100.0
10/03/2022 7:00	333.2683	100.0
10/03/2022 21:00	325.6683	100.0
14/03/2022 0:00	319.5367	100.0
14/03/2022 3:00	285.3867	100.0
14/03/2022 4:00	280.78	99.8
23/03/2022 0:00	263.08	100.0
26/03/2022 2:00	265.6267	100.0
27/03/2022 19:00	452.235	100.0
27/03/2022 22:00	579.0767	100.0
27/03/2022 23:00	531.55	100.0
28/03/2022 0:00	389.95	100.0
28/03/2022 2:00	687.0133	100.0
28/03/2022 3:00	692.305	100.0
28/03/2022 22:00	492.1633	100.0
28/03/2022 23:00	267.28	100.0
29/03/2022 0:00	280.1733	100.0
29/03/2022 2:00	531.0933	100.0
29/03/2022 3:00	573.98	100.0
29/03/2022 4:00	329.9883	100.0
30/03/2022 22:00	276.905	100.0
3/04/2022 6:00	264.3267	100.0
3/04/2022 7:00	284.6267	100.0
4/04/2022 18:00	365.6517	100.0
4/04/2022 19:00	862.485	100.0
4/04/2022 20:00	667.1	100.0
4/04/2022 21:00	374.4333	100.0
14/04/2022 3:00	331.8233	100.0
14/04/2022 4:00	262.2383	100.0
30/04/2022 0:00	567.7517	100.0
30/04/2022 2:00	293.3217	100.0
9/05/2022 0:00	485.0733	100.0
9/05/2022 1:00	306.58	100.0
17/05/2022 9:00	272.0717	100.0
9/07/2022 1:00	530.7933	100.0
25/07/2022 1:00	403.3983	100.0
25/07/2022 2:00	360.825	100.0
25/07/2022 3:00	401.2833	100.0
28/08/2022 23:00	363.165	100.0
29/08/2022 1:00	317.2517	100.0
29/08/2022 3:00	458.6067	100.0
29/08/2022 4:00	599.88	100.0
29/08/2022 5:00	552.08	100.0

Date and Time	DG11 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
29/08/2022 6:00	368.4417	100.0
29/08/2022 7:00	269.8067	100.0
29/08/2022 21:00	329.8617	100.0
29/08/2022 22:00	671.1917	100.0
29/08/2022 23:00	1317.955	100.0
30/08/2022 0:00	342.0017	100.0
9/09/2022 20:00	349.7933	100.0
9/09/2022 21:00	602.3783	100.0
10/09/2022 3:00	521.5383	100.0
10/09/2022 5:00	433.55	100.0
10/09/2022 6:00	484.0033	100.0
10/09/2022 7:00	293.0083	100.0
10/09/2022 22:00	529.33	100.0
10/09/2022 23:00	454.2083	100.0
11/09/2022 0:00	551.9967	100.0
11/09/2022 1:00	587.1083	100.0
11/09/2022 2:00	409.1333	100.0
11/09/2022 3:00	281.1717	100.0
11/09/2022 6:00	251.9267	100.0
22/09/2022 3:00	401.3817	100.0
22/09/2022 21:00	324.415	100.0
22/09/2022 22:00	646.7783	100.0
22/09/2022 23:00	368.1317	100.0
23/09/2022 0:00	252.5733	100.0
23/09/2022 1:00	476.5333	100.0
23/09/2022 2:00	329.8583	100.0
23/09/2022 22:00	312.51	100.0
18/11/2022 3:00	291.255	100.0
18/11/2022 4:00	331.0333	100.0
15/12/2022 5:00	261.9133	100.0
15/12/2022 23:00	334.5817	100.0
16/12/2022 21:00	256.945	100.0
17/12/2022 21:00	273.4517	100.0

Sensitivity: General

Oceana Macraes - Ambient Air Monitoring Report for 2023

Prepared for OceanaGold New Zealand
Prepared by Beca Limited

24 April 2024

Contents

Appendices

Revision History

Revision N°	Prepared By	Description	Date
1	Nicole Rubio	Draft for Client Review	22 April 2024
2	Nicole Rubio	Final	24 April 2024

Document Acceptance

Action	Name	Signed	Date
Prepared by	Nicole Rubio		24 April 2024
Reviewed by	Rhys Kevern	Rhys Kevern	24 April 2024
Approved by	Graeme Jenner		24 April 2024
on behalf of	Beca Limited		

Executive Summary

Background

OGNZL currently holds air discharge permits associated with different aspects of the Macraes Gold Project site. Some of these conditions require ambient monitoring to be undertaken, as well as an external review of the monitoring results.

The following monitoring is currently undertaken around the mine sites as required by OGNZL air discharge consent numbers 96785_V5, RM10.351.52.V1, RM12.378.15, RM16.138.19 and RM20.24.12:

- Dust deposition rates at monthly intervals at 16 sites,
- Real time total suspended particulate (**TSP**) concentrations at Sites DG07 Horse Flat Road and DG15 Macraes Township,
- Continuous meteorological monitoring at two representative locations (Sites DG03 outside the main office, next to the mixed tailings dam, and DG15 in Macraes township)
- Daily record kept of water used for dust suppression.

Results

Data Capture

Meteorological monitoring at DG03 and DG15 for 2023 had a data capture rate of 100% for 2023.

The TSP monitoring for 2023 data capture was quite low at DG07, ranging from 14–100% capture with an annual average of 70.1%. The TSP monitoring data capture at DG11 ranged from 30-98%. TSP Monitoring at DG11 ceased in August 2023 upon agreement with ORC. DG07 malfunctioned in August and has not yet been replaced. At DG15, the data capture rate ranged between 89-100%.

Windspeed and Direction

The DG03 windrose shows that winds experienced are predominantly from the west to west-northwest, east-northeast, and south-southwest directions. The strongest winds come from the west. However, the DG15 windrose shows that the winds experienced at DG15 are predominantly from the east, west-southwest and north-northwest directions. The strongest winds come from the west-southwest direction.

Temperature and Solar Radiation

Temperature and solar radiation were, on average, lowest in winter months (June – August) and highest during the summer months (December, January, and February). There is no significant difference with the temperatures recorded at DG03 (at a mast height of 1.75 m) and DG15 with approximately 95% of the temperature data within a 5ºC difference.

Humidity

Relative humidity at DG03 ranged from 13.8% to 100% with an annual average of 77.7% for 2023.

Rainfall

The data shows that the wettest month was March with approximately 17% of the annual rainfall recorded at DG03 and DG15, with a total rainfall of 118 and 104.4 mm for the month, respectively.

The driest month measured at DG03 and DG15 for 2023 was in August, with only 18.2 and 18.6 mm of rain measured for the month respectively.

Deposited Dust

The dust monitoring results did not exceed the consent limit for the year 2023. High deposition rates were measured at DG03 as the site is beside the high-use OGNZL gravel road entrance to their offices. The adjacent Golden Point Road is sealed at this point.

TSP

The maximum TSP 1-hour average concentration at DG07 for 2023 was 1,907 µg/m^3. There was a total of 61 exceedances of the 250 µg/m^3 1-hour average consent limit throughout the year. The maximum 24-hour average concentration at DG07 for 2023 was 371 µg/m^3, while the annual average 24-hour concentration for 2023 was 18.5 µg/m^3. There were 7 exceedances of the 24-hour consent limit, the majority recorded in April.

The maximum TSP 1-hour average concentration measured at DG11 for 2023 was 836.0 µg/m^3. There was a total of 25 exceedances of the 250 µg/m^3 consent limit through the year, with most of these exceedances occurring in January. The maximum 24-hour average concentration at DG11 was 121 µg/m^3. There was a total of 3 exceedances of the 24-hour consent limit (of 80 µg/m^3).

Table F 1 and Table F 2 in **Appendix F** present the exceedances of the hourly consent limit recorded for DG07 and DG11 alongside the hourly relative humidity measurements at DG03. For all the exceedances, the relative humidity measured at the monitoring station was 99.9% or above. The correlation between a TSP exceedance and the relative humidity would suggest that during these periods, the instrument was reporting water aerosol (fog) concentrations, rather than dust from mining activities.

There is no 1-hour TSP consent limit in any of the resource consents regarding DG15. The results show the annual 1-hour average TSP concentration for 2023 was 9.2 µg/m^3. However, the maximum 1-hour average TSP concentration was 816 µg/m^3. The results indicate that, in the winter months (June – August), the TSP measurements decreased, which would coincide with higher rainfall during this period.

Ongoing TSP Monitoring at DG07 and DG11

Condition 5(e) of Consent RM20.24.12 allows for review of the need for ongoing monitoring at DG07. Similarly, Condition 6(a)(e) of Consent RM10.351.52.V1 allows for review of the need for ongoing monitoring at DG11. In both cases, the total suspended particulate monitoring may be amended or suspended if such agreement is provided in writing by the Consent Authority. Upon recommendation from Beca in the 2022 dust review report, ORC approved the decommissioning of DG11 in August.

TSP monitoring at DG07 was only undertaken from January to August 2023 due to malfunctioning of the monitor unit. DG07 is in a separate valley to DG11 and DG15 and therefore, provides monitoring data representative of that separate location. It is recommended that this site continues to be used in the monitoring and management of mine dust in that area. In addition, a local meteorological station should be installed at DG07 to allow for determination of windy conditions (>5 m/s) to aid in dust management in that valley. OGNZL is working with the landowner to allow for installation of a meteorological monitor at DG07.

Observations

- The meteorological monitoring masts installed at the OGNZL site are 6 m above ground level. Several standards require the anemometer height to be 10 m above ground level, however the Ministry for the Environment Monitoring Good Practice Guide (Monitoring GPG[1]) does allow for the monitoring height to be between 6 and 10 m high. To maintain consistency with historic data it is preferable to keep the current met masts at 6 m but any new installation should be at 10 m high.

[1] Good Practice Guide for Air Quality Monitoring and Data Management 2009

- The Monitoring GPG recommends monitors recording temperature at two different heights are the same model. The two monitors at DG03 have the same accuracy but are not the same model, the 1.75 m temperature probe is a combined humidity and temperature probe. This deviation is unlikely to make a material difference to the data recorded.
- The anemometer at DG03 is currently aligned to magnetic north rather than true north. Any new meteorological installations should be aligned to true north. To maintain the integrity of the wind direction data at site DG03 with historic data, the current monitoring configuration should be maintained. However, the data that is presented in this report has been corrected to true north.
- Watercare's averaging of site recorded 10-minute data to produce hourly averages has used linear averaging rather than vector averaging, which is incorrect. Section 2.8.4.4 of AS/NZS 3580.14:2014 states that vector averaging is the preferred method of averaging data. Section 2.8.2 of the USEPA Quality Assurance Handbook recommends a unit-vector algorithm should be used for calculating scalar wind speed and wind direction.
- Dust monitoring data for 2023 shows that there have been 18 occurrences of bird droppings noted during data collection. OGNZL has utilised bird repellent paste as recommended in the 2022 monitoring review report however birds are still fouling the deposition gauges. Another method to deter birds from roosting on the gauges and fouling the deposition gauges may be the installation of spikes on the upper ring of the dust gauge. Implementation of these methods will help increase validity of data collected at the sites. Some improvements were made by the latter part of the year as bird repellent methods were improved through trial and error. In addition, there were two instances (DG17 and DG25) where access to the monitoring site was not permitted. Arrangements need to be made to ensure OGNZL has ongoing access to the monitoring site.
- Condition 5d of Consent RM20.24.12 requires meteorological monitoring to be undertaken at Horse Flat Road (DG07) but this monitoring has not occurred. As discussed above, OGNZL is working on implementing a meteorological monitoring site at DG07.

Conclusion

Dust is being managed effectively at the site as:

- The dust monitoring results have not exceeded the consent limit of 3 g/m^2/30 days over 2023.
- Although several TSP exceedances were recorded at each of the monitoring sites DG07, DG11 and DG15, they can be attributed to the monitoring instrument being affected by fog during high relative humidity conditions as they occurred when relative humidity was >99.9%.
- The monthly average of 24-hourly average TSP ranges from 8.3 – 38.4 µg/m^3 for DG07, 18.9 – 34.4 µg/m^3 for DG11 and 1.3 – 19.6 µg/m^3 for DG15, indicating that for much of the time TSP concentrations are low compared to the consented limits.
- There are a number of recommendations provided in regard to the improvement of meteorological and dust monitoring at the site.

1 Introduction

1.1 Overview

Oceana Gold (New Zealand) Limited (**OGNZL**) operates a large open cast and underground gold mine in Otago, northwest of Palmerston and northeast of Middlemarch. The predominant discharge to air from the mining activity is dust (or particulate matter), from the handling and transportation of waste rock and ore.

OGNZL currently holds Otago Regional Council (ORC) air discharge permits associated with different aspects of the Macraes Gold Project site as listed in **Table 1-1**. Some of these conditions require ambient monitoring to be undertaken, as well as an external review of the monitoring results.

Table 1-1. Existing air discharge consents currently held by OGNZL.

Consent Number	Details
Discharge Permit 96785_V5	To discharge contaminants from mining operations and post-mining rehabilitation to air in the vicinity of Macraes Flat (all of the mine site except features associated with Macraes Phase III and Coronation).
Discharge Permit 2006.689	To discharge contaminants to air for the purpose of ventilating Frasers Underground Mine.
Discharge Permit 2007.511	To discharge contaminants to air for the purpose of carrying out mining activities and post mining rehabilitation (Golden Bar Pit, Rock Stack, Silt Ponds and Infrastructure).
Discharge Permit RM10.351.52.V1	To discharge contaminants from mining operations and post mining rehabilitation to air for the purpose of undertaking mining operations (Macraes Phase III expansion and Frasers West).
Discharge Permit RM12.378.15	To discharge contaminants from mining operations and post-mining rehabilitation to air for the purpose of undertaking mining operations (Coronation Waste Rock Stack, Coronation Pit and associated haul roads, utility areas and stockpiles).
Discharge Permit RM16.138.19.V1	To discharge contaminants from mining operations and post-mining rehabilitation to air for the purpose of undertaking mining operations (Coronation North).
Discharge Permit RM20.024.12	To discharge contaminants from mining operations and post-mining rehabilitation to air for the purpose of undertaking mining operations (Deepdell North Stage III).
Discharge Permit RM20.130.01	To discharge contaminants to air for the purpose of ventilating the Golden Point Underground Mine (Golden Point Underground Mine – Macraes).

1.2 Monitoring Overview

The following monitoring is currently undertaken around the mine sites (shown in **Figure 1-1)** as required by OGNZL air discharge Consents 96785_V5, RM10.351.52.V1, RM12.378.15, RM16.138.19.V1 and RM20.24.12:

- Dust deposition rates at monthly intervals at 16 sites,
  Real time total suspended particulate (**TSP**) concentrations at Sites DG07 Horse Flat Road and DG15 Macraes Township (note previously TSP monitoring was required at DG11 but this has been discontinued as approved by ORC.),

- Continuous meteorological monitoring at two representative locations (Sites DG03 outside the main office, next to the mixed tailings dam, and DG15 in Macraes township) noting meteorological monitoring is required at DG07 under consent RM20.24.12 but has not been undertaken,
- Daily record kept of water used for dust suppression.

All of the consents mentioned above include essentially the same condition which requires an annual review of dust and meteorological monitoring results based on a calendar year.

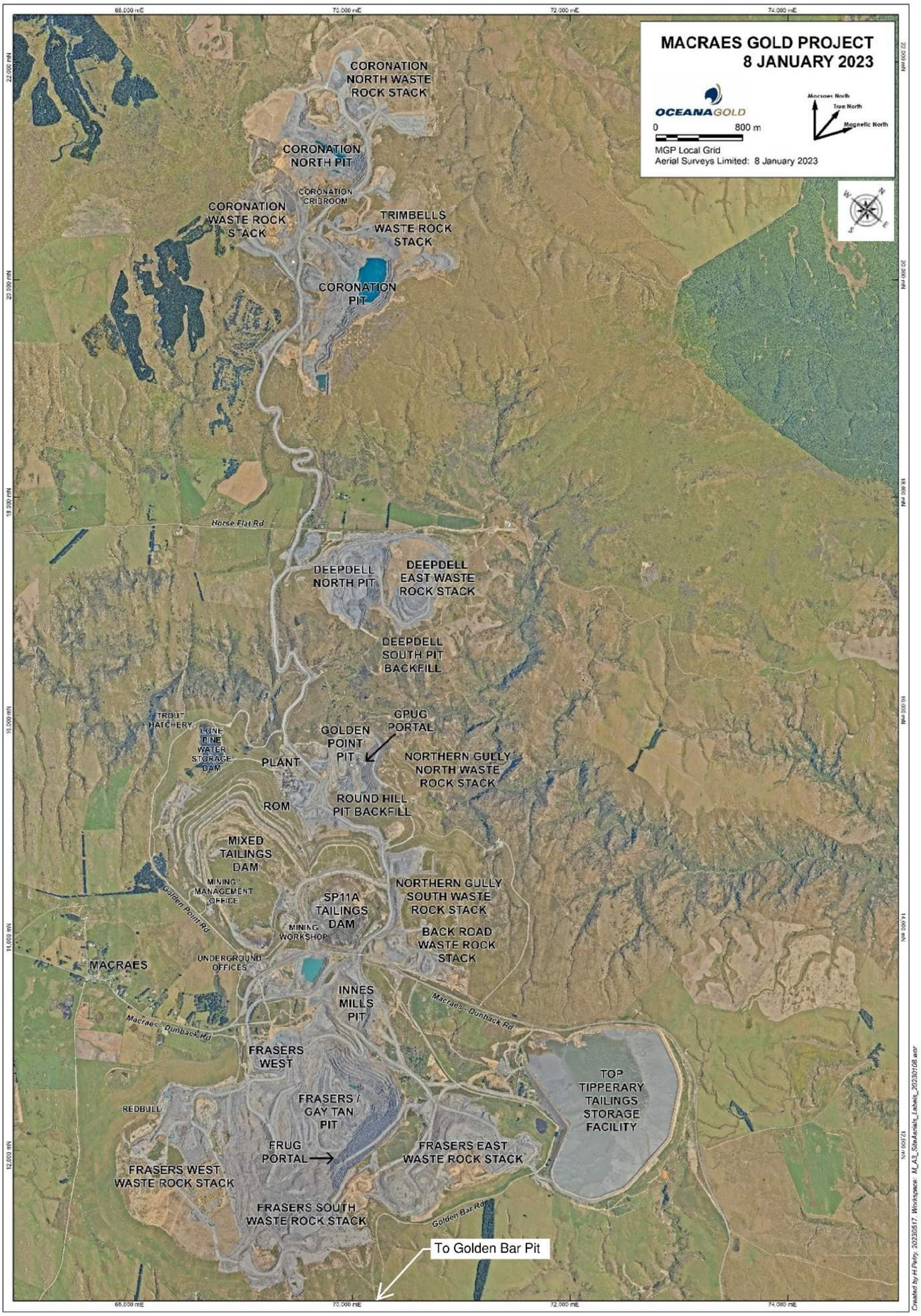

Figure 1-1. Site mining locations

1.3 Purpose of Report

Beca Ltd (Beca) has been commissioned to provide an assessment of the ambient air monitoring results against the conditions of all five consents based on information provided by OGNZL. A summary of the relevant conditions of each of these consents that require monitoring is provided in **Appendix A.** The general text of the consent conditions which relate to the preparation of the annual monitoring review report is provided in Section 1.4.

The review of specific monitoring results is as follows:

- Analysis of insoluble deposited dust monitoring results from OGNZL for all monitoring sites for 2023, calculation of background dust deposition rates and comparison of the results with consent limits.
- Analysis of continuous nephelometer TSP monitoring data collected by Watercare during 2023 and comparison of the results with consent limits.
- Analysis of continuous meteorological data (wind speed, wind direction temperature and humidity) collected by Watercare at two sites during 2023.
- Review of information from OGNZL on mining activities during 2023 as they related to the emissions to air and ambient air quality levels outside of the site boundary.
- Review of the quality of the monitoring data and the adequacy of the ambient monitoring programme and describe any improvements that are recommended.
- Review the adequacy of the dust mitigation measures used by OGNZL and describe any changes that are recommended.
- Recommend any changes to the monitoring conditions that might be necessary.

1.4 Summary of Consent Conditions

A summary of the resource consent conditions[2] as they relate to the preparation of an annual air quality monitoring report are as follows:

Note specific Conditions:

An independent consultant, engaged by the Consent Holder in consultation with the Consent Authority, shall [must] undertake an annual review and assessment of all dust monitoring data. The reviewer's report shall [must] include:

(a) The name, qualifications, and experience of the reviewer;

(b) The methods used and the investigations undertaken for the review;

(c) Interpretation of the monitoring data reviewed;

(d) An assessment of the quality of the monitoring data;

(e) An assessment of the monitoring regime;

(f) A description and evaluation of each of the dust mitigation measures used by the consent holder;

(g) Recommendations on whether:

> *i) The monitoring of dust is adequate or should be changed, and if changed the changes that are recommended;*

[2] Consent numbers 96785_V5 (Cnd 17), RM10.351.52.V1 (Cnd 18), RM12.378.15 (Cnd 16), RM16.138.19.V1 (Cnd 16) and RM20.24.12 (Cnd 18)

ii) The dust mitigation measures used by the consent holder are adequate, or should be changed, and the changes that are recommended; and

iii) Any changes should be made to the conditions of this consent; and

(h) Any other matters that the reviewer considers should be drawn to the attention of the consent holder or the Consent Authority.

The Annual Report shall be provided to the consent authority by 30 April each year.

1.5 Reviewers Qualifications

A summary of the reviewer's qualifications is included in **Appendix B**.

1.6 Limitations

This report has been prepared by Beca for OGNZL. Beca has relied upon the information provided by OGNZL, in completing this document. OGNZL in turn rely on contractors for data management, including WaterCare and Environmental Standards Limited. Unless otherwise stated, Beca has not sought to independently verify this information as provided. This report is therefore based upon the accuracy and completeness of the information provided and Beca cannot be held responsible for any misrepresentations, incompleteness, or inaccuracies provided within that information. Should any new or additional information become available, this report will need to be reviewed accordingly.

2 Review and Analysis of Methodology

Beca has undertaken a review of the monitoring data using the following methods:

- Auditing of the data supplied by OGNZL for gaps and anomalous results,
- Statistically analysing the ambient air quality and meteorological data to produce monthly and annual values including windroses which are also presented for quarterly periods, and
- Comparing deposited dust and total suspended particulate (**TSP**) concentration data against consent limits.

Unit vector averaging of wind direction and scalar averaging of wind speed has been used to produce summary data in comparison to the linear averaging undertaken in the data provided by Watercare. The wind directions of site DG03 near the mixed tailings dam have been corrected from magnetic north to true north by subtraction of 25º.

In instances when the recorded monthly dust deposition at the background deposition gauge rate was higher than the deposition rate recorded at a specific monitoring site, the result has been reported as a nominal value of 0 $g/m^2/30$ days.

3 Site Monitoring

3.1 Monitoring Operations

Watercare Laboratory Services Limited (Watercare) carries out the meteorological and continuous TSP monitoring (on behalf of OGNZL), and OGNZL carries out the deposited dust monitoring, with the deposition gauges analysed by Environmental Standards Ltd. Scott Technical Instruments calibrates and maintains both meteorological sites. A full description of the climate, dust deposition and TSP stations is included in the quarterly monitoring reports prepared by Watercare Laboratory Services (Watercare Reports). Copies of these reports are included in **Appendix C.** The details of the monitoring instruments and comparison with the Ministry for the Environment *Good Practice Guide for Monitoring and Data* 2009 (GPG monitoring) requirements is provided in **Appendix D**.

3.2 OGNZL Air Quality Monitoring Programme

OGNZL currently operates two meteorological monitoring stations, 16 dust deposition stations and two (formerly three) continuous TSP monitoring stations. **Table 3-1** provides a summary of the monitoring sites and the locations of the sites are shown in **Figure 3-1**.

TSP monitoring at DG11 is no longer a requirement under Consent RM10.351.52.V1 Condition 6(e). It was considered that the TSP monitoring at DG15 is near the DG11 site and is representative of TSP concentrations in the Macraes Village locality. Otago Regional Council (ORC) has permitted OGNZL to discontinue TSP monitoring at the DG11, with the last monitoring results recorded in July 2023.

Table 3-1. Summary of Macraes Mine monitoring programme.

Site Num	Location of Monitor	Monitor Purpose	Parameters Recorded	Limit
DG02	Back of Macraes	Consent compliance 96785_V5, RM16.138.19.V1 and RM12.378.15. RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17	≤3 g/m²/30 days above background
DG03	South of Mixed Tailings Dam beside a gravel section of Golden Point Road	Meteorological Monitoring	The consent requires monitoring of wind speed, wind direction, air temperature at 2 heights, rainfall and solar radiation. Relative humidity is also monitored. Dust deposition is monitored in addition to consent requirements	-
DG07	Howard's farm	Consent compliance 96785_V5, RM20.24.12, RM16.138.19.V1 and RM12.378.15 RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17	≤3 g/m²/30 days above background except for twice per year.

Site Num	Location of Monitor	Monitor Purpose	Parameters Recorded	Limit
			TSP	80 µg/m^3 24hr average, 250 µg/m^3 1hr average
DG09	Control 7 km ex H/W 85	Background levels – control site for DG02, DG07, DG15, DG20, DG21	Dust deposition	-
DG10	Control 3.25 km ex Macraes	Background levels – control site for DG02, DG07, DG15, DG20, DG21	Dust deposition	-
DG11	Expansion drilling site, across from 1,700 Macraes Rd	Consent compliance for consent RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG17.	≤3 g/m^2/30 days above background except for twice per year.
DG13	Red Bank Rd	Monitoring Only	Dust deposition	-
DG15	Behind 1757 Macraes - Dunback Road, Macraes across from Stanley's Hotel	Consent compliance 96785_V5, RM16.138.19.V1 and RM12.378.15 RM10.351.52.V1	Wind speed, wind direction, temperature and rainfall. Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17. TSP	≤3 g/m^2/30 days above background 120 µg/m^3 24hr average, no limit 1 hourly
DG17	Horse Flat Rd	Consent compliance RM20.24.12 Background levels – control site for DG02, DG07, DG11, DG15, DG20 and DG21	Dust deposition above average of DG09, DG10 and DG24.	≤3 g/m^2/30 days above background except for twice per year
DG18	North of Top Tipperary Tailings Storage Facility	Monitoring only	Dust deposition	-
DG19	East of Top Tipperary Tailings Storage Facility	Monitoring only	Dust deposition	-
DG20	East of Frasers East Rock Stack	Consent compliance 96785_V5, RM16.138.19.V1 and RM12.378.15 RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17.	≤3 g/m^2/30 days above background except for twice per year

Site Num	Location of Monitor	Monitor Purpose	Parameters Recorded	Limit
DG21	East of Frasers South Rock Stack	Consent compliance, 96785_V5, RM16.138.19.V1, RM12.378.15 except for RM20.24.12 RM10.351.52.V1	Dust deposition above average of DG09, DG10 and DG24. Dust deposition above average of DG09, DG10 and DG17.	≤3 g/m^2/30 days above background except for twice per year
DG22	North of Coronation	Consent compliance RM12.378.15 and RM16.138.19.V1	Dust deposition above average of DG09, DG10 and DG24.	≤3 g/m^2/30 days above background except for twice per year
DG24	East of Coronation	Background levels- control site for DG02, DG07, DG15, DG17 DG20, DG21, DG22, DG25	Dust deposition.	-
DG25	North of Coronation North Pit	Consent compliance RM16.138.19 (installed in April 2017 to replace DG23 - RM12.378.15)	Dust deposition above average of DG09, DG10 and DG24.	≤3 g/m^2/30 days above background except for twice per year

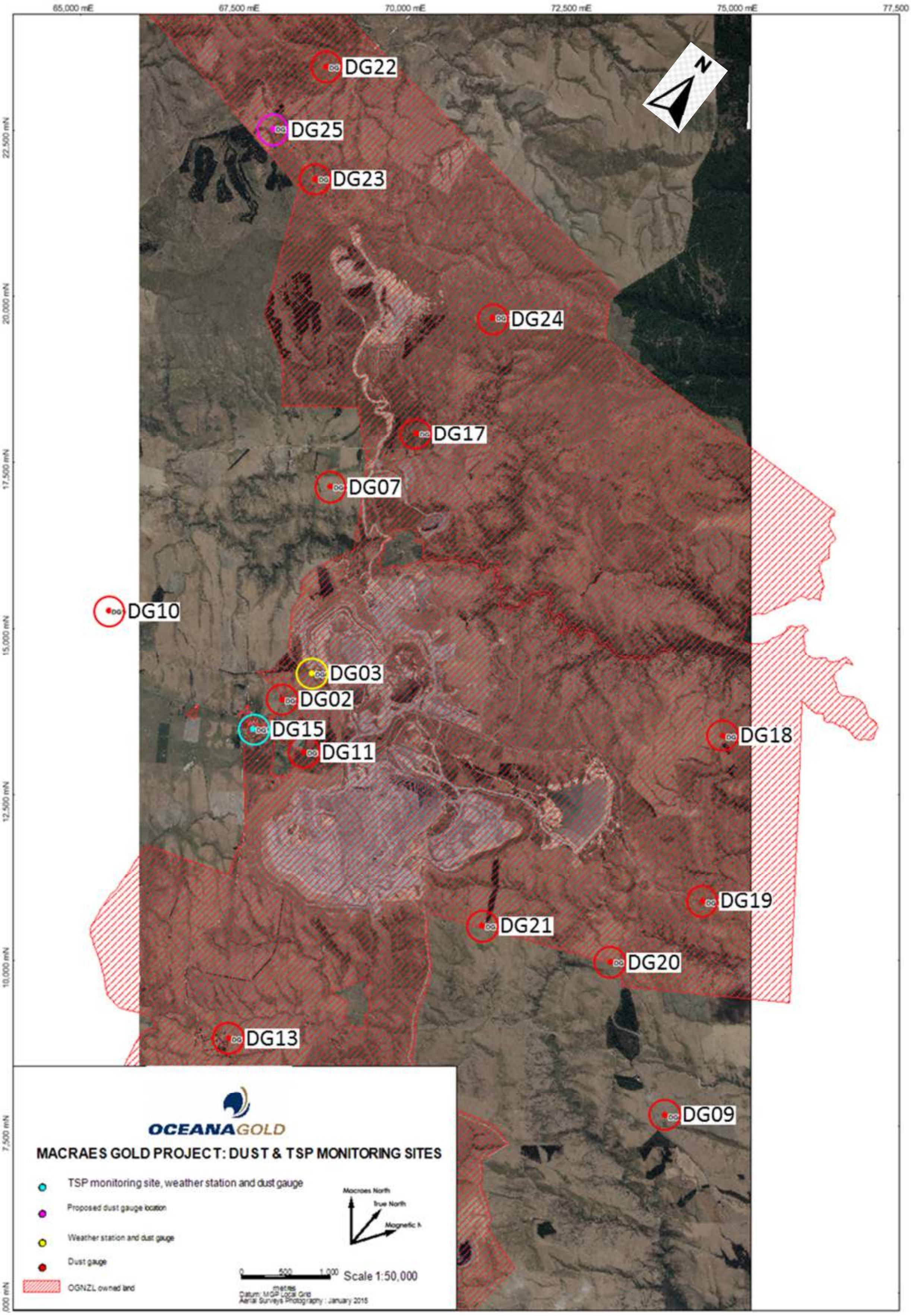

Figure 3-1. Locations of OGNZL meteorological stations, deposited dust and TSP monitoring sites.

3.3 Meteorology

3.3.1 Site DG03 Mixed Tailings Dam

Meteorological parameters recorded over the annual period from 1 January 2023 to 31 December 2023 at Site DG03 are:

- wind direction at 6 m above ground level,
- wind speed at 6 m above ground level,
- rainfall at ground level,
- temperature at 1.75 m and 6.0 m above ground level,
- solar radiation at 1.75 m, and
- relative humidity at 6.0 m.

3.3.2 Site DG15 Macraes Village

Meteorological parameters recorded over the annual period from 1 January 2023 to 31 December 2023 at Site DG15 are:

- wind direction at 6 m above ground level,
- wind speed at 6 m above ground level,
- rainfall at ground level,
- temperature at 1.5 m above ground level, and
- Total Suspended Particulate Matter.

The locations of the monitoring sites are shown in **Figure 3-1**.

3.4 Deposited Dust

Deposited dust is comprised of soluble and insoluble dust fractions. Soluble dust is only of interest downwind of sources that produce water-soluble emissions, such as milk powder from a dairy factory. For OGNZL, the only emissions of any significance are crustal dust particles, which are insoluble in rainwater, therefore only insoluble deposited particulate is discussed in this report.

Dust deposition rates are measured at the sites using dust gauges, as shown on **Figure 3-2**, in accordance with draft ISO Standard ISO/DIS 4222.2, *("Air Quality Measurement of Atmospheric Dustfall* – Horizontal *Deposit Gauge Method"* 1980). The monitoring is required by conditions in Consent 96785_V5, Consent RM10.351.52, Consent RM12.378.15, Consent RM16.138.19 and Consent RM20.024.12. The locations, purposes, relative background level and deposition limits of the monitoring sites are described in **Table 3-1**.

Figure 3-2. View of Frasers Pit West Waste Rock Store from Monitoring site DG11 (black dust deposition gauge) looking SE

3.5 TSP Monitoring

At the end of January 2013, OGNZL commissioned a new continuous TSP monitor at Site 15 (across from Stanleys Hotel in Macraes Village) in accordance with Condition 12(a) of Consent RM10.351.52 and Condition 10(a) of Consent RM12.368.15. The monitor is a Met One E-Sampler-9800, which is a type of nephelometer. Nephelometers measure particulate matter using forward laser light scattering. The instrument is able to record, and output, real-time measurements of particulate data which allows for reporting over a variety of averaging periods including 10-minute, 1-hour, and 24-hour. The accuracy of the instrument is +/-5% based on a traceable PSL 0.6 micron reference standard. The instrument has a particle size sensitivity of 0.1 to 100 microns with an optimal sensitivity of 0.5 to 10 micron particles.

Nephelometers of the type used at OceanaGold, are either calibrated by passing dust with known optical properties through the instrument and adjusting the response of the instrument or, by using an internal filter that allows for a gravimetric correction to be applied to the results.

Every instrument has an uncertainty associated with each measurement. Inadequate or faulty heating of the inlet air on some particulate monitors (most commonly seen on Beta Attenuation TSP Monitors (BAMs)) can allow moisture to affect the sample, giving rise to large positive spikes, normally followed by large negative spikes.

The monitors have heated inlets to reduce the effects of fog on measurements as fog also produces scattering of the laser light. Descriptions of the instrument and the monitoring method are included in the quarterly monitoring reports prepared by Watercare **(Appendix C)**.

In February 2021, in accordance with resource consent conditions for Frasers West (Consent RM10.351.52.V1) and Deepdell North Stage III (RM20.024.12), continuous total suspended particulate (TSP) monitoring commenced using nephelometers at two air quality monitoring stations: Horse Flat Road (at DG07) near the C and E Howard property and Macraes Road (at DG11). Thermo ADR-1500 Area Dust Monitors were installed by WaterCare Services Limited to monitor TSP.

In the monitoring report for 2022, the TSP monitoring at Macraes Road was compared to the monitoring results at DG15 and it was found there was little difference between them. Condition 6(a)(e) of consent RM10.351.52.V1 allowed OGNZL to apply for monitoring to cease at DG11 and this application was approved. The last monitoring undertaken at DG11 was in July 2023.

Total suspended particulate concentrations at Horse Flat (DG07) are continuously measured on a 10-minute average basis and reported as 1-hour and 24-hour averages. Results are compared against the consent limit of 250 ug/m^3 (1-hour average) and 80 ug/m^3 (24-hour average). If these levels are exceeded, an alert message is sent to OGNZL staff, and a review of dust sources and dust control measures onsite must be undertaken. If the onsite activities are likely to have contributed to or caused an exceedance of the consent limits, then dust control management needs to be revised or additional measures implemented. If the consent limits are exceeded again within a 7-day period, and the exceedance is likely to have been caused by or contributed to by onsite activities, the dust control measures need to be continued and potentially be added to the dust management plan.

3.6 Comments on the Programme

3.6.1 Anemometer height

The standard anemometer height is 10 m above ground level rather than the 6 m masts installed at the OGNZL site. Section 2.6.1 of AS/NZS 3580.14:2014 states that it is generally considered that the appropriate wind speed and direction monitoring height should be 10 m above ground. Table 0.12 of USEPA Quality Assurance Handbook[3] states that 10 m above open terrain level is the standard monitoring height. Section 5.9.1 of the World Meteorological Organisation[4] states "*Wind speed increases considerably with height, particularly over rough terrain. For this reason, a standard height of 10 m above open terrain is specified for the exposure of wind instruments*.". The Monitoring GPG states that the anemometer height should be between 6 and 10 m above ground level.

The OCNZL met mast height of 6 m is within the requirements of the Monitoring GPG and to maintain consistency with historical monitoring data it is recommended to keep the monitors at this level. However, any future meteorological installations should be installed at 10 m above ground level.

3.6.2 Temperature measurement

The Monitoring GPG recommends that if a temperature vs height measurement is undertaken, it should be at 1.5 and 10 m, the upper height is only 6 m at the site DG03. The monitoring GPG also recommends both temperature sensors have an accuracy of 0.1ºC and are the same model. The temperature monitors have the same accuracy but are not the same model, the 1.75 m temperature probe is a combined humidity and temperature probe.

3.6.3 Wind direction

Sections 2.8.1 and 2.9.1 of AS/NZS 3580.14:2014 state that wind direction should be referenced to true north. DG03 is currently aligned to magnetic north. Any new meteorological installations should be aligned to true north. To maintain the integrity of the wind direction data at site DG03 with historic data, the current monitoring configuration should be maintained. However, the data that is reported should include the recorded results and the wind direction corrected to true north.

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[3] EPA-454/B-08-002 Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements Version 2.0 (Final) 2008

[4] Guide to Instruments and Methods of Observation Volume I –Measurement of Meteorological Variables, World Meteorological Organization, 2021

3.6.4 Wind averaging

Watercare's averaging of site recorded 10-minute data to produce hourly averages has used linear averaging rather than vector averaging, which is incorrect.

Section 2.8.4.4 of AS/NZS 3580.14:2014 states that vector averaging is the preferred method of averaging data. Section 2.8.2 of the USEPA Quality Assurance Handbook recommends a unit-vector algorithm should be used for calculating scalar wind speed and wind direction.

Section 6.1 of Meteorological Monitoring Guidance[5] (which is referred to in AS/NZS3580.14) states that hourly averages can be calculated from shorter period averaged data. Section 6.2.2 of the document describes the vector averaging approach that was in AS2923:1987 which has been superseded by AS/NZS 3580.14:2014. A deviation to the vector method is the unit vector measurement which does not scale the vector components of the wind directions by the wind speed. The guidance comments that in general, the unit vector result will be comparable to the scalar average wind direction and may be used to model plume transport.

3.6.5 Deposition Monitoring Observations

Dust deposition data was not collected at four sites due to the dust gauge not being replaced after it had been removed from the site for analysis. It is recommended that the dust gauges are replaced every month to maintain consistent data monitoring.

Dust deposition monitoring for 2023 shows that there have been 18 occurrences of bird droppings noted during analysis. Bird repellent paste has been applied to the gauge upper support ring during 2023, however there were still instances of bird droppings have been detected. Another method to deter bird droppings may be the installation of spikes on the upper ring of the dust gauge. Implementation of these methods will help increase validity of data collected at the sites. In addition, there were two instances (DG17 and DG25) where the monitoring site was not accessible. Arrangements should be made to ensure OGNZL has ongoing access to these monitoring sites.

The consents incorrectly reference the dust deposition monitoring method draft ISO Standard ISO/SIS 4222.2. The correct reference is draft ISO Standard ISO/DIS 4222.2.

3.6.6 TSP Monitoring Observation

Condition 5d of Consent RM20.24.12 requires meteorological monitoring to be undertaken at Horse Flat Road (DG07), but this monitoring has not occurred. The meteorological monitoring sites at DG03 and DG15 are to the east of the Horse Flat Road valley and therefore, the correlation of wind direction data from Macraes Village to dust data on Horse Flat Road may not be as accurate as if the meteorological data was collected in the same location.

[5] Meteorological Monitoring Guidance for Regulatory Modelling Applications, EPA-454/R-99-005, 2000

4 Meteorological Monitoring Results

4.1 Meteorological Instrument Performance

4.1.1 Site DG03

Instrument performance at Site DG03 was consistently high over the monitoring period as shown by the instrument performance record for the site presented in **Table 4-1** as reported by Watercare.

Table 4-1. Site DG03 instrument performance (percentage data capture) December 2022 – November 2023

Period	Wind Speed	Wind Direction	Ambient Temp (1.5 m)	Ambient Temp (6m)	Relative Humidity	Rainfall	Solar Radiation
Dec 22-Feb 23	100%	100%	100%	100%	100%	100%	100%
Mar-May 23	100%	100%	100%	100%	100%	100%	100%
Jun-Aug 23	100%	100%	100%	100%	100%	100%	100%
Sep-Nov 23	100%	100%	100%	100%	100%	100%	100%

4.1.2 Site DG015

Instrument performance reported by Watercare at Site DG15 was consistently high over the 2023 monitoring period, as shown in **Table 4-2**. There was some TSP data loss in summer and autumn.

Table 4-2. Site DG15 instrument performance (percentage data capture) December 2022 – November 2023

Period	Wind Speed	Wind Direction	Ambient Temp	Rainfall	Continuous TSP (10-minute average)
Dec 22-Feb 23	100%	100%	100%	100%	89%
Mar-May 23	100%	100%	100%	100%	92%
Jun-Aug 23	100%	100%	100%	100%	100%
Sep-Nov 23	100%	100%	100%	100%	100%

4.2 Wind Speed and Direction

4.2.1 DG03 Wind Conditions for 2023

Figure 4-1 shows the distribution of hourly wind speeds and wind directions recorded at Site DG03 between 01 January 2023 and 31 December 2023. The windrose shows that winds are predominantly from the west to west-northwest (occur approximately 19.6% of the time), east-northeast (occur approximately 11% of the time) and south-southwest directions (occur approximately 9.6% of the time).

The average hourly wind speed measured at the monitoring station for 2023 was 3.61 m/s and hourly wind speeds reached a maximum of 19 m/s. Calm conditions (wind speeds <0.5 m/s) occurred for 1.2% of the time.

Similar wind direction patterns are also observed during the day and night, although average hourly wind speeds tend to be higher during the day (average wind speed of 4.27 m/s during the day compared to the average wind speed of 3.2 m/s at night). Diurnal, quarterly and monthly windroses for DG03 are presented in **Appendix E.**

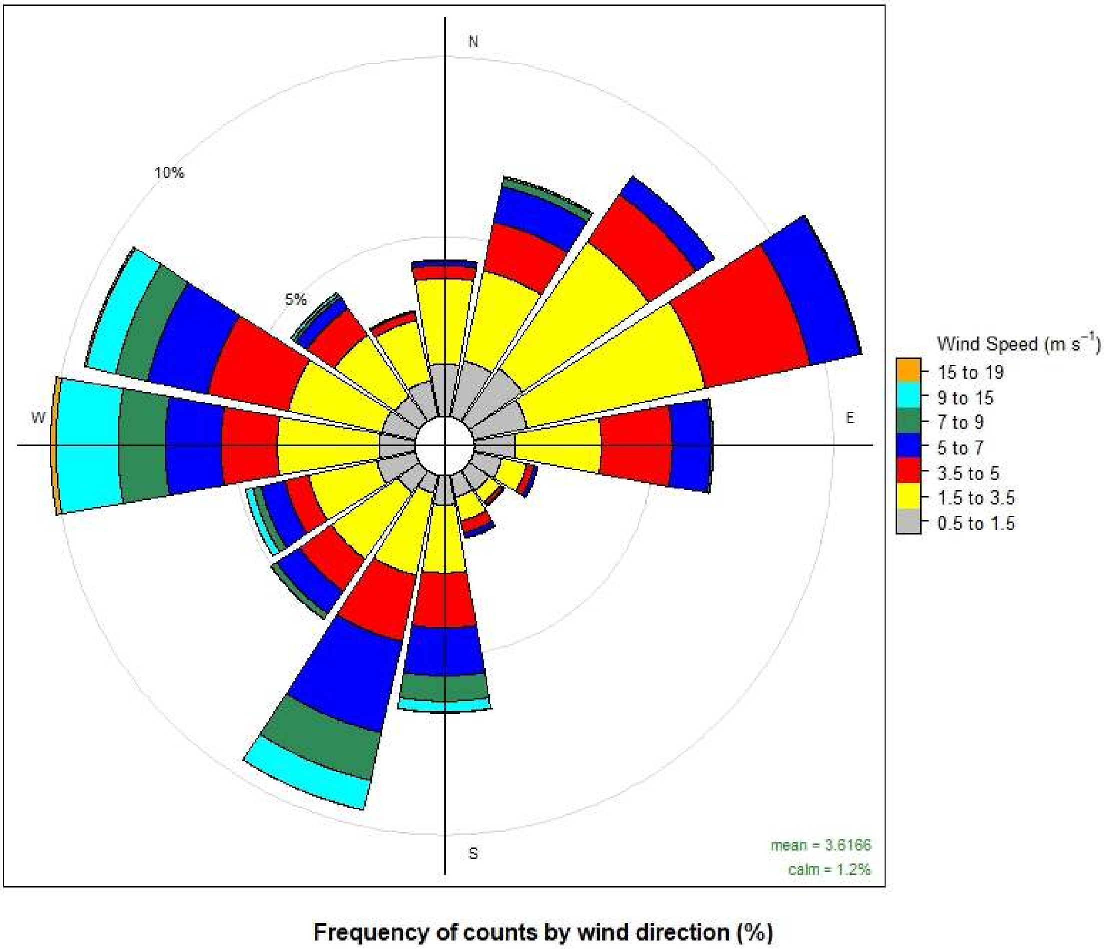

Figure 4-1. Site DG03 annual windrose (hourly averages) from 1 January 2023 – 31 December 2023 (Met data provided by OGNZL)

Table 4-3. Monthly summary of wind data for 2023 at DG03

Month	Maximum Hourly Wind Speed (m/s)	Average Hourly Wind Speed (m/s)	Predominant Wind Direction
January	8.0	3.0	ENE
February	14.0	3.4	ENE
March	15.3	3.7	NE
April	13.6	3.2	NE
May	14.4	3.1	WNW
June	14.3	2.7	NNE
July	14.6	4.1	SSW
August	17.7	3.2	WNW
September	19.0	4.8	W
October	17.9	4.6	WNW
November	13.6	3.4	E
December	13.2	4.1	E
Annual	**19.0**	**3.6**	**NE**

4.2.2 DG15 Wind Conditions for 2023

Figure 4-2 shows the distribution of hourly wind speeds and wind directions recorded at Site DG15 between 01 January 2023 and 31 December 2023. The windrose shows that winds are predominantly from the east (occur approximately 12.6% of the time), west southwest and southwest (occur approximately 18% of the time) and north northwest and northwest directions (occur approximately 18.5% of the time).

The average hourly wind speed measured at the monitoring station for 2023 was 2.9 m/s and the hourly wind speeds reached a maximum of 16.1 m/s. Calm conditions (wind speeds <0.5 m/s) occurred for 0.1% of the time.

Similar wind direction patterns are also observed during the day and night, although average wind speeds tend to be higher during the day (average wind speed of 3.3 m/s compared to the night average wind speed of 2.4 m/s). Diurnal, quarterly and monthly windroses for DG15 are presented in **Appendix E.**

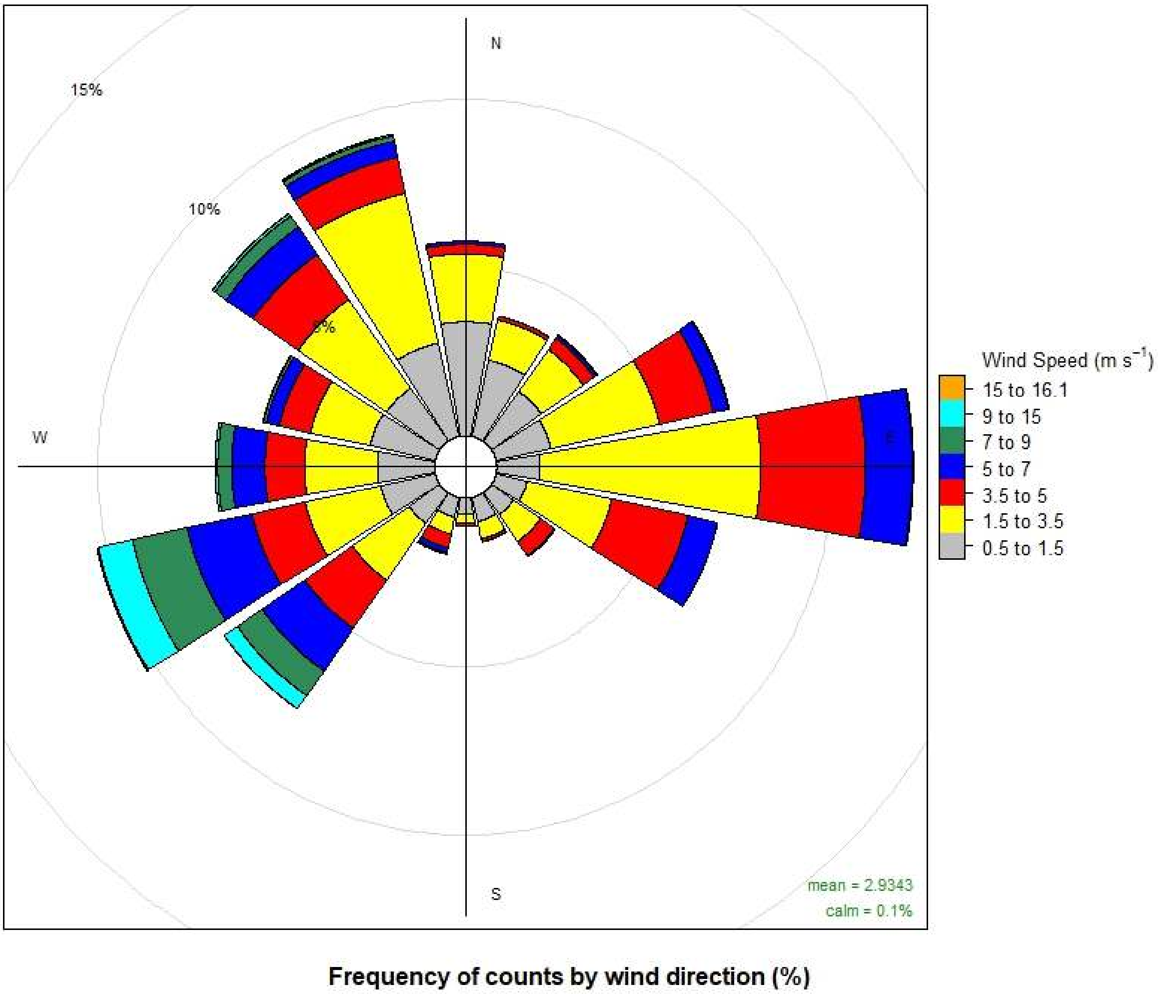

Figure 4-2. Site DG15 annual windrose (hourly averages) from 1 January 2023 – 31 December 2023 (Met data provided by OGNZL)

Table 4-4. Monthly summary of wind data for 2023 at DG15

Month	Maximum Hourly Wind Speed (m/s)	Average Hourly Wind Speed (m/s)	Predominant Wind Direction
January	9.0	2.8	E
February	9.8	2.7	E
March	13.6	2.9	WSW
April	11.9	2.6	NNW
May	10.1	2.3	NNW
June	8.7	2.1	ENE
July	16.1	3.6	WSW
August	11.8	2.7	WSW
September	11.7	3.5	NW
October	14	3.6	NNW
November	12.2	2.8	E
December	13.7	3.5	E
Annual	**16.1**	**2.80**	**E**

4.2.3 Long Term Meteorological Data

Figure 4-3 shows the distribution of hourly wind speeds and wind directions recorded at Sites DG03 and DG15 between 2019 and 2023. The DG03 windrose shows that winds are predominantly from the northeast, west and south directions. The strongest winds come from the west and south directions. However, the DG15 windrose shows that the winds are predominantly from the east, northwest and southwest directions. The strongest winds come from the southwest direction.

Figure 4-4 shows the distribution of wind flows at monitoring sites DG03 and DG15 when wind speeds are greater than 5 m/s. Winds that exceed 5 m/s, which is the critical wind speed for the lifting of dust from unconsolidated surfaces, occur for approximately 24% of the time at DG03 and 16% of the time at DG15. At DG03, winds with speeds greater than 5 m/s are predominantly from west-southwest to west (occur for approximately 9.9% of the time) and south directions (and occur for approximately 4.5% of the time). At DG15, wind speeds greater than 5 m/s are predominantly from southwest to west-southwest directions (occur for approximately 7.9% of the time).

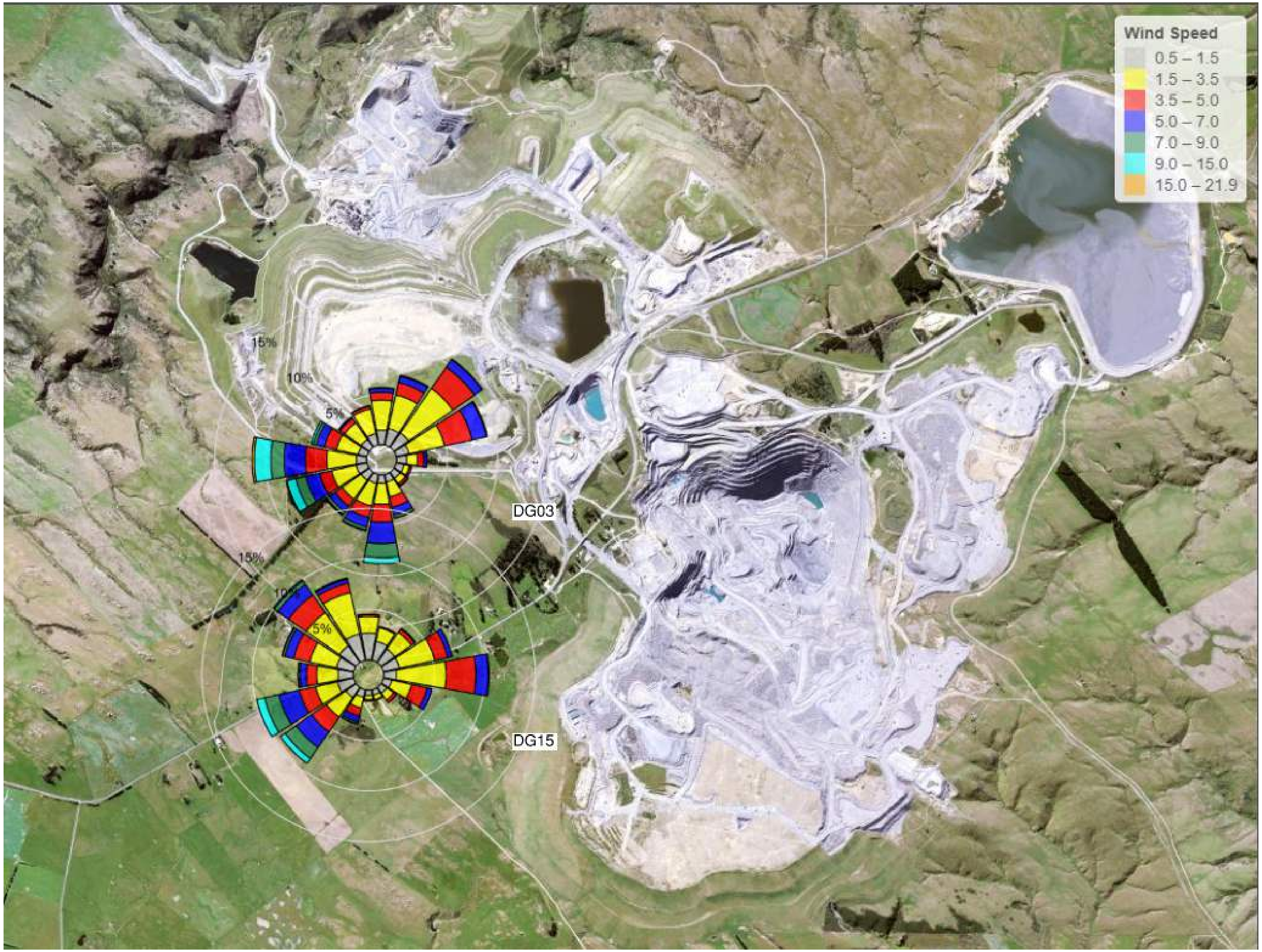

Figure 4-3. Site DG03 and DG15 annual windroses (hourly averages) from 1 January 2019– 31 December 2023 (Met data provided by OGNZL).

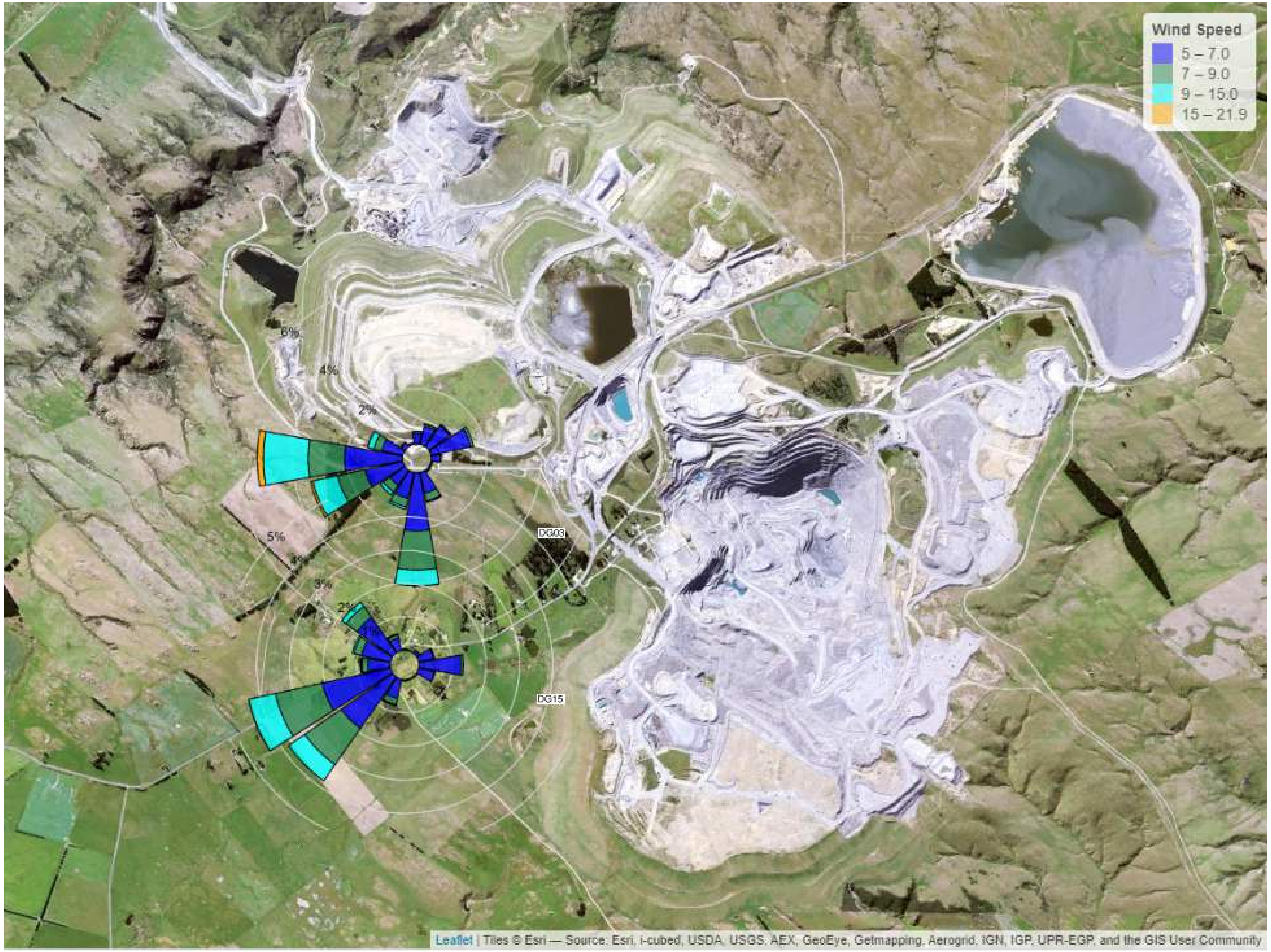

Figure 4-4. Site DG03 and DG15 annual windroses (hourly averages) of wind speeds >5m/s from 1 January 2019 – 31 December 2023 (Met data provided by OGNZL).

4.3 Air Temperature and Solar Radiation

Air temperature is measured at Site DG03 and DG15 weather stations as 10-minute averages. Figure 4-5 shows the average daily temperature measured at DG15, DG03 (for both mast heights of 1.75 m and 6 m) and solar radiation measured at DG03 from 01 January 2023 to 31 December 2023. As would be expected, temperature and solar radiation were on average lowest in winter months (June – August) and highest during the summer months (December, January, and February). There is no significant difference with the temperatures recorded at DG03 (at a mast height of 1.75 m) and DG15 with approximately 95% of the temperature data within a 5ºC difference.

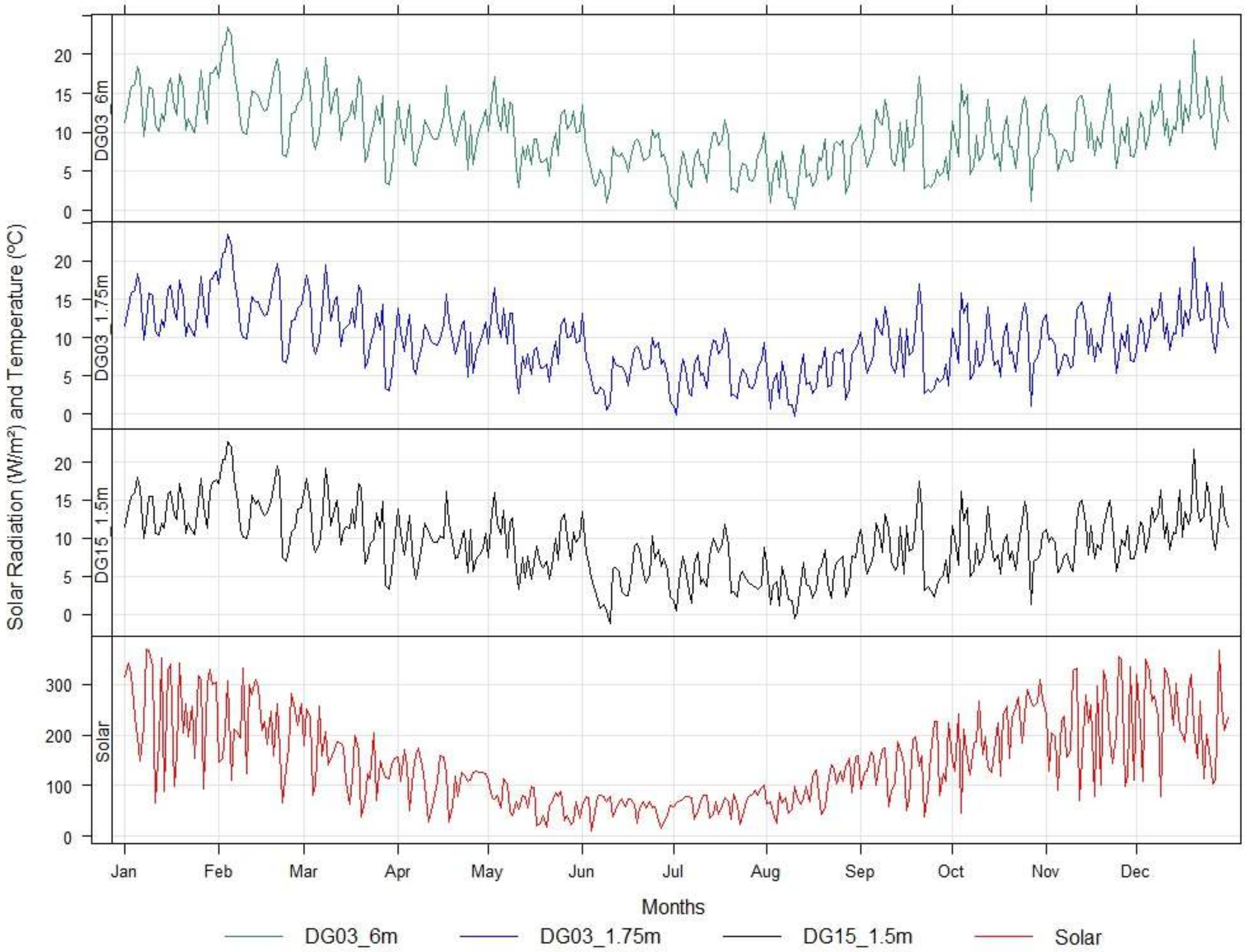

Figure 4-5. Site DG03 and DG15 daily average temperature and site DG03 solar radiation for 01 January 2023 – 31 December 2023 (Met data provided by OGNZL).

4.3.1 DG03 Temperature

A summary of the 2023 hourly ambient temperature for DG03, at a height of 1.75 m and 6 m, for 2023 is presented in **Table 4-5**. The annual average hourly temperature measured at DG03 at 1.75 m for 2023 was 9.6ºC, with a minimum of -2.9ºC and maximum of 29.3ºC. The 2023 annual hourly average temperature measured at DG03 at a height of 6 m was 9.8ºC, with a minimum of -1.9ºC and maximum of 28.3ºC.

Table 4-5. Hourly ambient temperature at DG03 for 01 January 2023 to 31 December 2023

Month	At 1.75 m			At 6 m		
	Minimum Hourly Average Temperature (°C)	Maximum Hourly Average Temperature (°C)	Monthly Average Temperature (°C)	Minimum Hourly Average Temperature (°C)	Maximum Hourly Average Temperature (°C)	Monthly Average Temperature (°C)
January	4.9	25.5	14.1	5.9	24.5	14.1
February	4.0	29.3	14.6	4.6	28.3	14.6
March	0.3	25.5	11.6	0.6	24.6	11.8
April	0.7	21.9	9.8	1.2	21.4	10.2
May	1.0	20.6	9.2	1.1	20.8	9.7
June	-2.9	16.8	6.0	-1.2	16.7	6.6
July	-1.2	15.2	5.5	-0.8	14.7	5.9
August	-2.4	14.9	5.0	-1.9	14.6	5.4
September	-1.0	20.6	7.9	0.1	20.0	8.1
October	-1.7	21.8	9.2	-1.6	19.5	9.3
November	0.6	21.7	9.6	1.6	21.3	9.7
December	4.5	28.7	12.5	4.9	27.8	12.5
Annual	-2.9	29.3	9.6	-1.9	28.3	9.8

4.3.2 DG15 Temperature for 2023

A summary of the 2023 hourly ambient temperature measurements for DG15 at 1.5 m is presented in **Table 4-6.** The annual average hourly temperature at DG15 for 2023 was 9.4°C. With a minimum hourly average temperature of -6.6°C, measured in June, and a maximum hourly average of 29.4°C, measured in February.

Table 4-6. Hourly ambient temperature summary at DG15 for 01 January 2023 to 31 December 2023

Month	Minimum Hourly Average Temperature (°C)	Maximum Hourly Average Temperature (°C)	Average Hourly Average Temperature (°C)
January	3.2	25.5	13.9
February	2.1	29.4	14.4
March	0.4	25.3	11.6
April	-1.9	22.0	9.5
May	-2.6	21.0	8.9
June	-6.6	17.7	5.3
July	-4.5	15.4	5.4
August	-4.1	14.9	4.5
September	-3.6	20.7	7.9
October	-1.2	19.9	9.0
November	-1.3	22.0	9.6
December	3.5	28.3	12.6
Annual	-6.6	29.4	9.4

4.4 Relative Humidity

Ten-minute average relatively humidity is only measured at the DG03 weather station. **Table 4-7** summarises the hourly average humidity data for 01 January 2023 to 31 December 2023. **Figure 4-6** shows the average daily relative humidity measured at DG03 from 01 January 2023 to 31 December 2023.

Table 4-7. Site DG03 relative humidity data summary for 2023 (1-hour average)

Month	Minimum Hourly Average Relative Humidity (%)	Maximum Hourly Average Relative Humidity (%)	Average Hourly Relative Humidity (%)
January	30.7	100.0	82.1
February	31.3	100.0	76.1
March	30.8	100.0	80.0
April	37.6	100.0	81.2
May	42.7	100.0	79.2
June	31.9	100.0	82.9
July	39.6	100.0	75.5
August	35.5	100.0	75.3
September	22.0	100.0	70.1
October	13.8	100.0	70.3
November	26.8	100.0	80.9
December	30.3	100.0	79.3
Annual	**13.8**	**100.0**	**77.7**

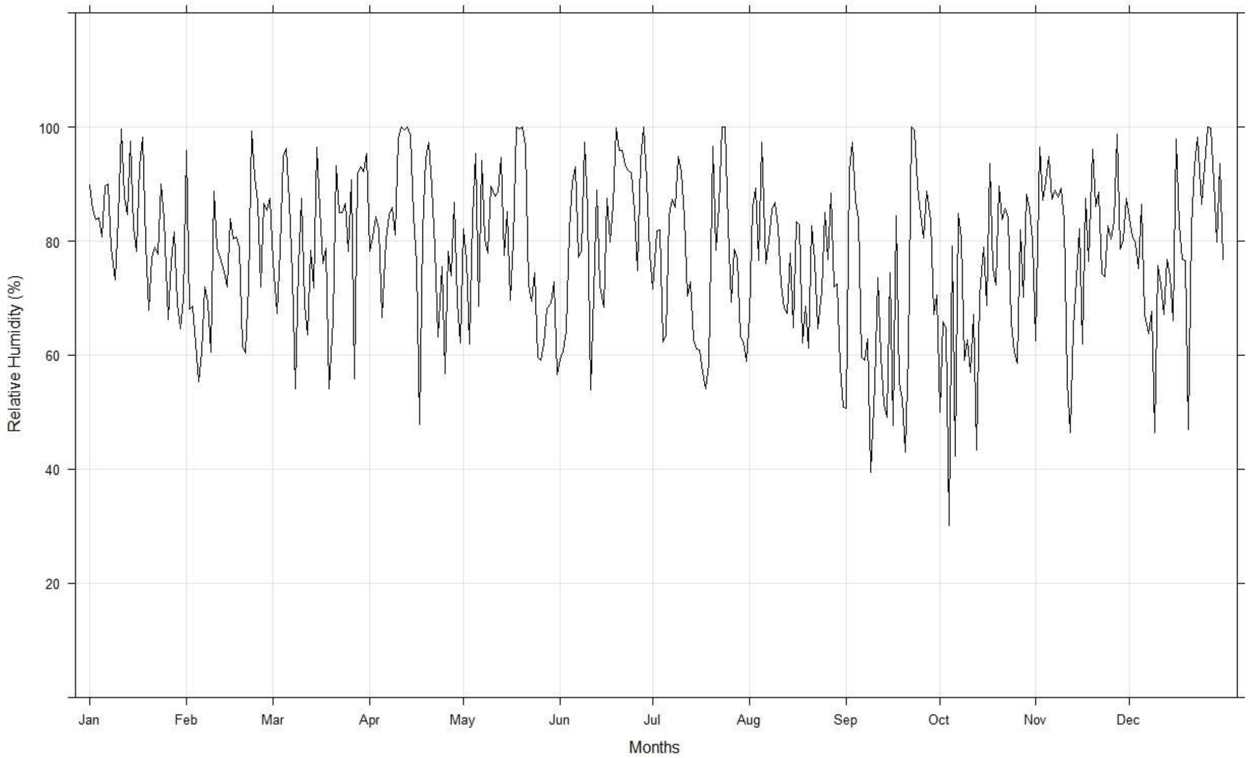

Figure 4-6. Site DG03 daily average relative humidity (%) for 01 January 2023 – 31 December 2023 (Met data provided by OGNZL)

4.5 Rainfall

Ten-minute average rainfall is recorded at the DG03 and DG15 weather stations. A summary of the 2023 rainfall data for both sites (DG03 and DG15) is presented in **Table 4-8**. The table presents the number of 'rain days'[6] per month as well as maximum daily rainfall and total monthly rainfall. The data shows that the wettest month was March with approximately 17% of the annual rainfall recorded at DG03 and DG15, with a total rainfall of 118 and 104.4 mm for the month respectively.

The driest month measured at DG03 and DG15 for 2023 was in August, with only 18.2 and 18.6 mm rainfall measured for the month, respectively.

[6] A rain day is classified as a day with total rainfall exceeding 1 mm over a 24-hour period.

Table 4-8. Rainfall data summary for 2023 for Sites DG03 and DG15 (24-hour average)

Month	DG03			DG15		
	No. of Rain Days per Month	Daily Maximum Rainfall (mm)	Total Rainfall (mm)	No. of Rain Days per Month	Daily Maximum Rainfall (mm)	Total Rainfall (mm)
January	4	16.0	25.2	3	22.2	30.2
February	2	35.0	69.6	2	31.8	63.2
March	11	33.2	118.0	10	27.2	104.4
April	8	28.4	65.0	8	25.0	55.8
May	9	27.4	73.4	10	22.8	64.2
June	5	14.0	38.0	5	9.4	28.8
July	9	30.4	56.6	8	18.6	40.0
August	5	4.8	18.2	6	5.2	18.6
September	3	30.6	59.6	3	28.0	52.8
October	6	7.6	32.4	7	7.8	36.2
November	9	26.8	64.8	7	29.0	60.6
December	8	18.8	60.0	9	19.8	71.0
Annual	79	35.0	680.8	78	31.8	625.8

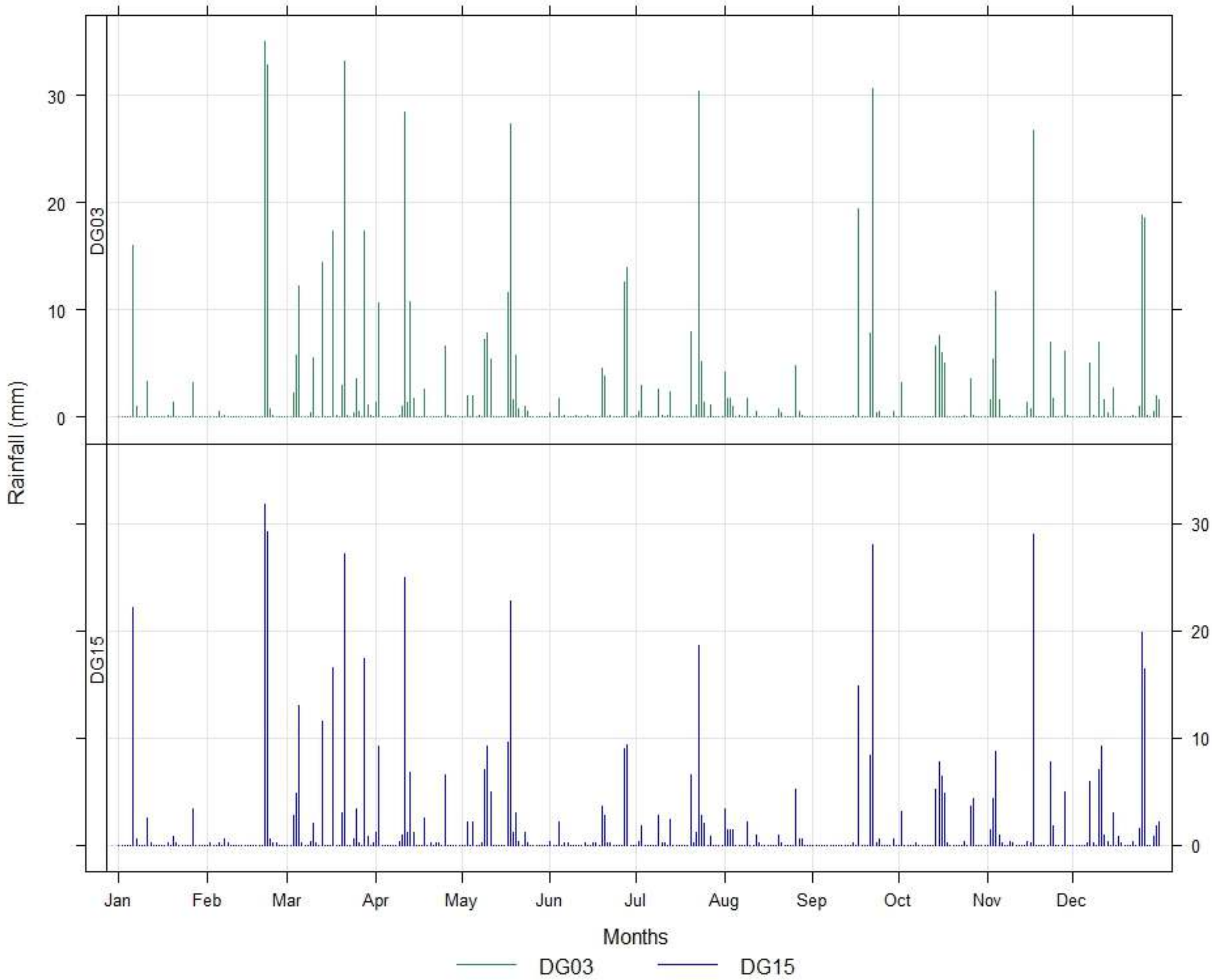

Figure 4-7. Daily Rainfall for 2023 at DG03 and DG15

5 Deposited Dust Monitoring Results

5.1 Overview

Table 5-1 summarises the existing air discharge consent requirements with regards to dust deposition rates compared to two different sets of background sites. The background deposition rate used for calculating the relative difference between deposition is similar for most consents (listed as "A" in Table 5-1), but consent RM10.351.52.V1 (listed as "B" in Table 5-1) uses site DG17 rather than DG24. The same deposition rate consent limit (of 3 g/m^2/30 days above background) applies to all the monitoring sites. At some sites, the deposition limit is allowed to be exceeded twice per calendar year.

The dust deposition monitoring sites listed in **Table 5-2** are for monitoring purposes only (i.e., not for consent compliance). **Table 5-3** summarises the dust deposition rates compared to both background sites.

Table 5-1. Summary of Consent Dust Deposition Monitoring Limits

Site	Monitoring Limit, g/m^2/30 days above background	Background Applied	No of Exceedences allowed per year
DG02	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	0
DG07	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	2
DG11	3	B: Average of DG 9, 10 and 17	2
DG15	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	0
DG17	3	A: Average of DG 9, 10 and 24	2
DG20	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	2
DG21	3	A: Average of DG 9, 10 and 24 B: Average of DG 9, 10 and 17	2
DG22	3	A: Average of DG 9, 10 and 24	2
DG25	3	A: Average of DG 9, 10 and 24	2

Table 5-2. Additional Dust Deposition Monitoring

Site	Background Applied
DG03	A: Average of DG 9, 10 and 24
DG13	A: Average of DG 9, 10 and 24
DG18	A: Average of DG 9, 10 and 24
DG19	A: Average of DG 9, 10 and 24

5.2 Dust Deposition Results

Table 5-3 shows the insoluble dust deposition rates above background levels at monitoring sites for 2023. The results that are annotated as 'NR' mean no result was able to be calculated at that site for the month. Either there was contamination of the sample by bird droppings, or a dead bird, or the gauge wasn't available for analysis. A zero result represents a higher background result than the site sample result. **Figure 5-1** to **Figure**

5-4 show the dust deposition rates at the different sites for 2023 for the two consent limit backgrounds and **Figure 5-5** and **Figure 5-6** show results from 2019 to 2023.

The dust monitoring results have not exceeded the consent limit for the year 2023. High deposition rates were measured at DG03 as the site is beside the OGNZL gravel road entrance to their offices and the unsealed Golden Point Road.

Table 5-3. Deposition monitoring results for 2023 (g/m^2 over 30 days above background)

Site	Limit, Background, No x	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Most Consents													
DG02	3, A	0.99	0.44	0.00	0.05	0.60	0.49	0.18	0.42	0.33	0.58	1.03	0.41
DG07	3, A, 2x	1.27	1.25	0.77	0.00	0.83	0.40	NR	NR	NR	NR	1.14	0.00
DG15	3, A	0.55	0.21	0.00	0.00	0.38	0.41	0.15	0.54	0.77	0.70	0.69	0.29
DG17	3, A, 2x	1.74	0.83	0.15	0.27	NR	0.24	0.18	0.12	NR	NR	NR	0.00
DG20	3, A, 2x	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NR	0.00	0.00
DG21	3, A, 2x	0.00	0.00	0.00	NR	NR	NR	NR	NR	0.83	0.51	0.46	0.73
DG22	3, A, 2x	0.58	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.12	0.19	0.42	0.00
DG25	3, A, 2x	0.00	NR	0.00	0.00	0.03	NR	0.00	0.00	0.00	NR	NR	0.00
Under Consent RM10.351.52.V1													
DG02	3, B	0.40	0.41	0.00	0.00	0.66	0.37	0.09	0.36	0.36	0.57	1.04	0.54
DG07	3, B, 2x	0.68	1.22	0.57	0.00	0.89	0.28	NR	NR	NR	NR	1.15	0.07
DG11	3, B, 2x	NR	1.17	NR	0.48	0.85	0.75	0.48	1.06	0.91	1.44	1.32	1.00
DG15	3, B	0.00	0.18	0.00	0.00	0.44	0.29	0.06	0.48	0.80	0.69	0.70	0.42
DG20	3, B, 2x	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	NR	0.02	0.00
DG21	3, B, 2x	0.01	0.01	0.01	NR	NR	NR	NR	NR	0.86	0.50	0.47	0.86
Additional Monitoring (not a consent requirement)													
DG03	A	21.70	20.03	12.02	7.42	6.78	4.55	2.52	7.20	9.42	7.87	10.36	7.10
DG13	A	0.15	0.10	0.00	0.00	0.00	0.00	0.00	0.07	0.73	0.23	0.30	12.20
DG18	A	NR	NR	0.00	0.00	NR	0.09	0.54	0.10	0.00	NR	NR	NR
DG19	A	0.00	0.00	0.00	0.00	0.00	0.04	NR	0.13	NR	0.11	0.11	0.38

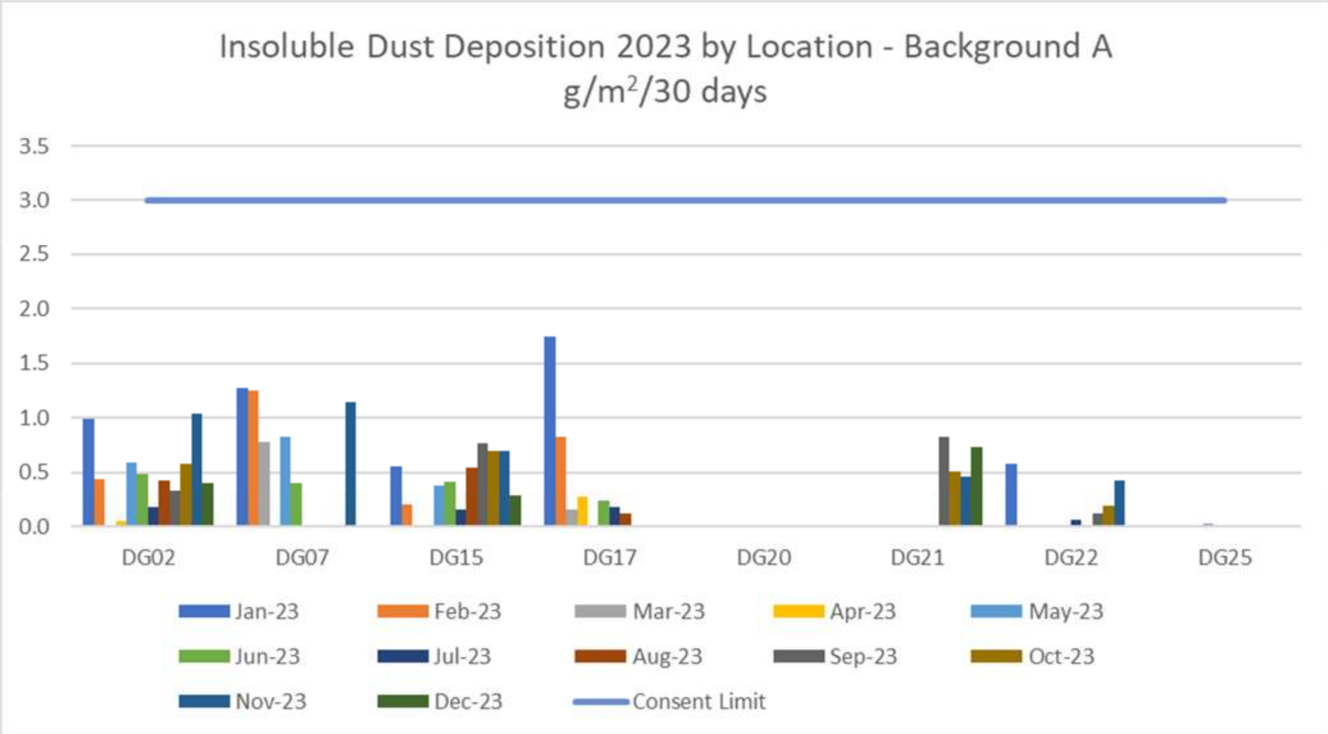

Figure 5-1. Insoluble Dust Deposition Monitoring by Location for 2023 most consents background

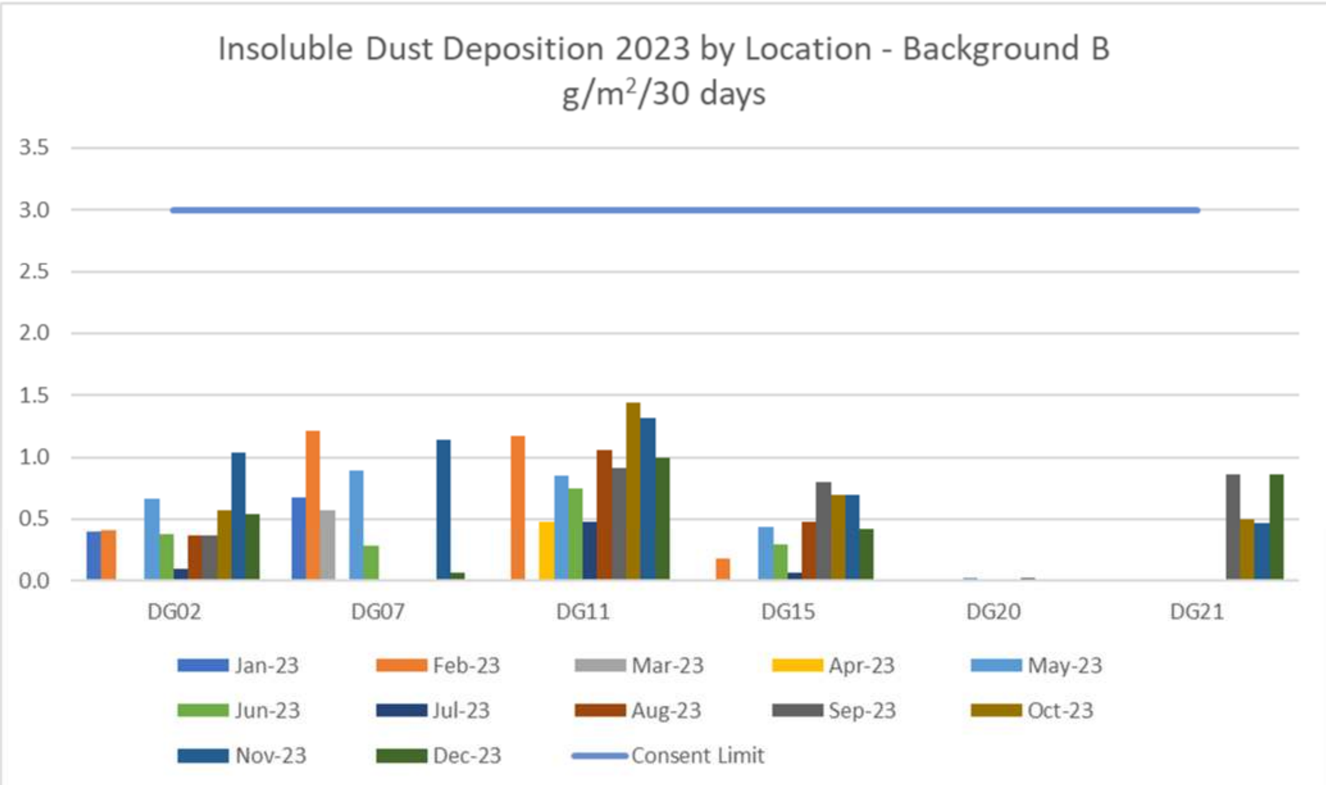

Figure 5-2. Insoluble Dust Deposition Monitoring by Location for 2023 consent RM10.351.52.V1 background

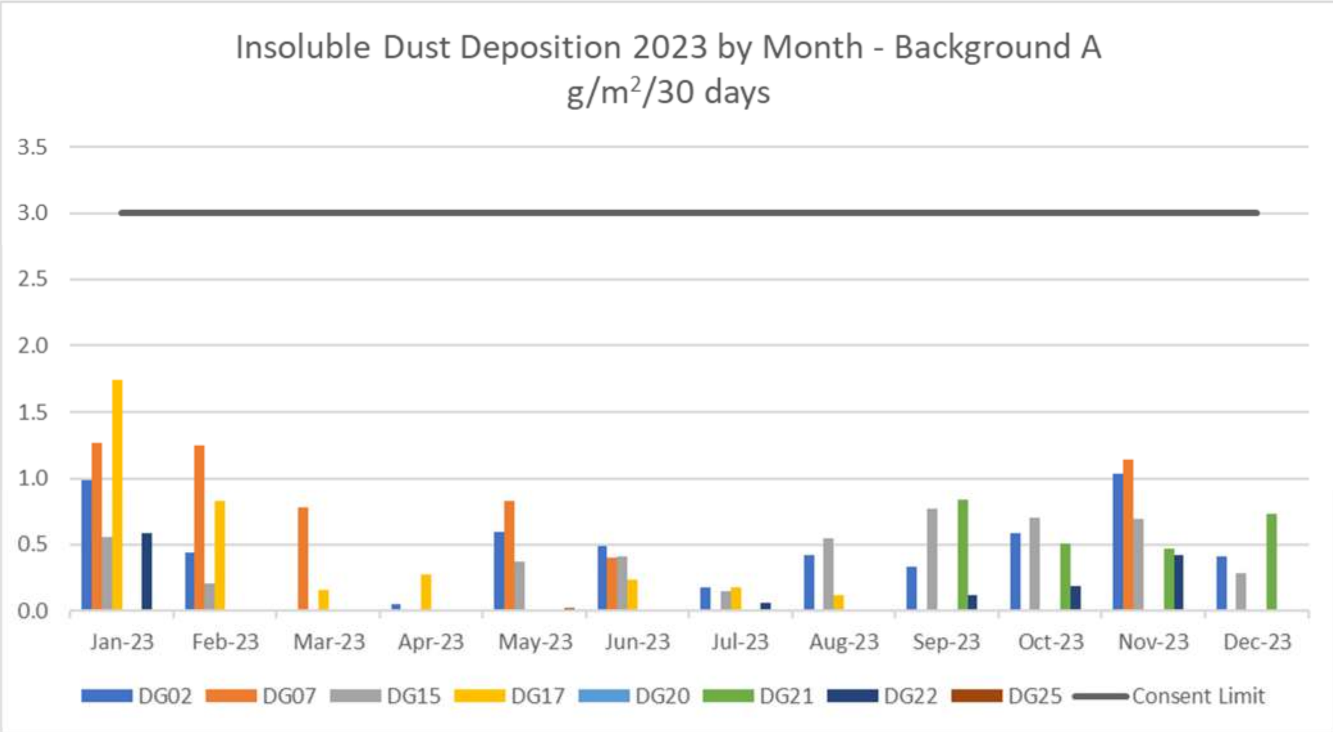

Figure 5-3. Insoluble Dust Deposition Monitoring by Month for 2023 most consents background.

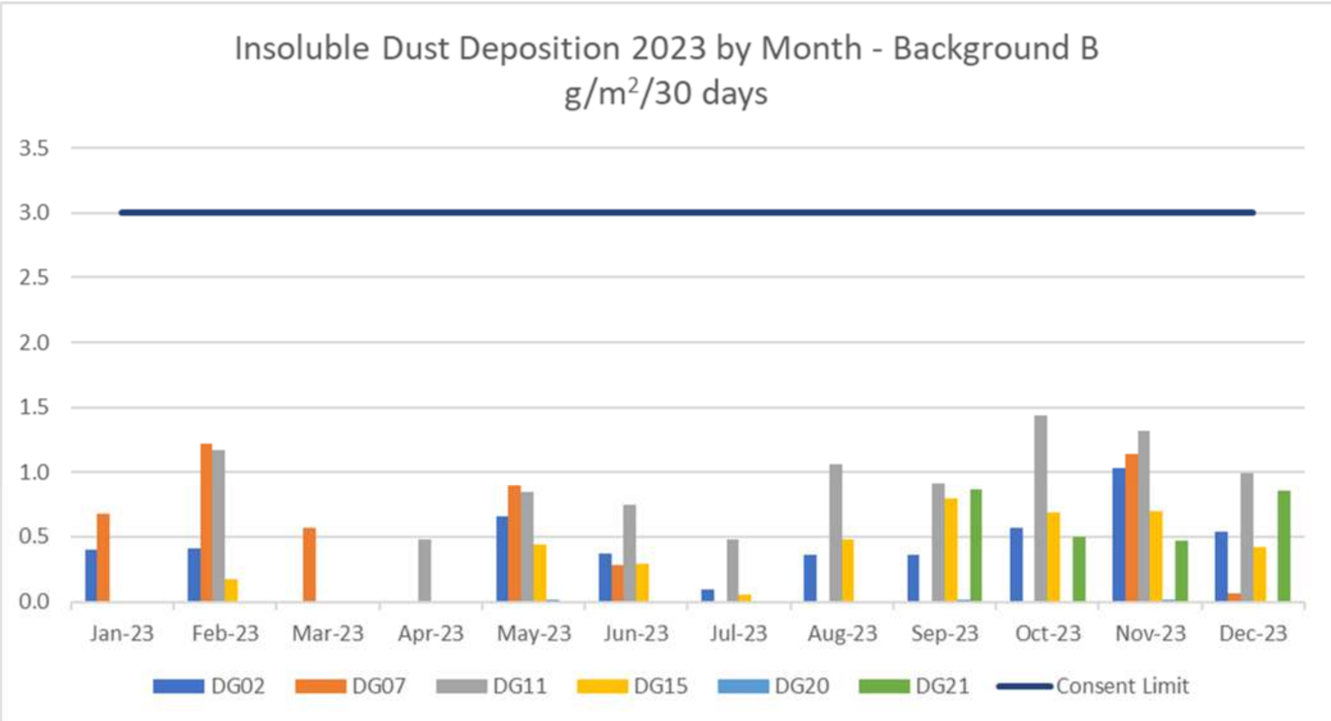

Figure 5-4. Insoluble Dust Deposition Monitoring by Month for 2023 consent RM10.351.52.V1 background.

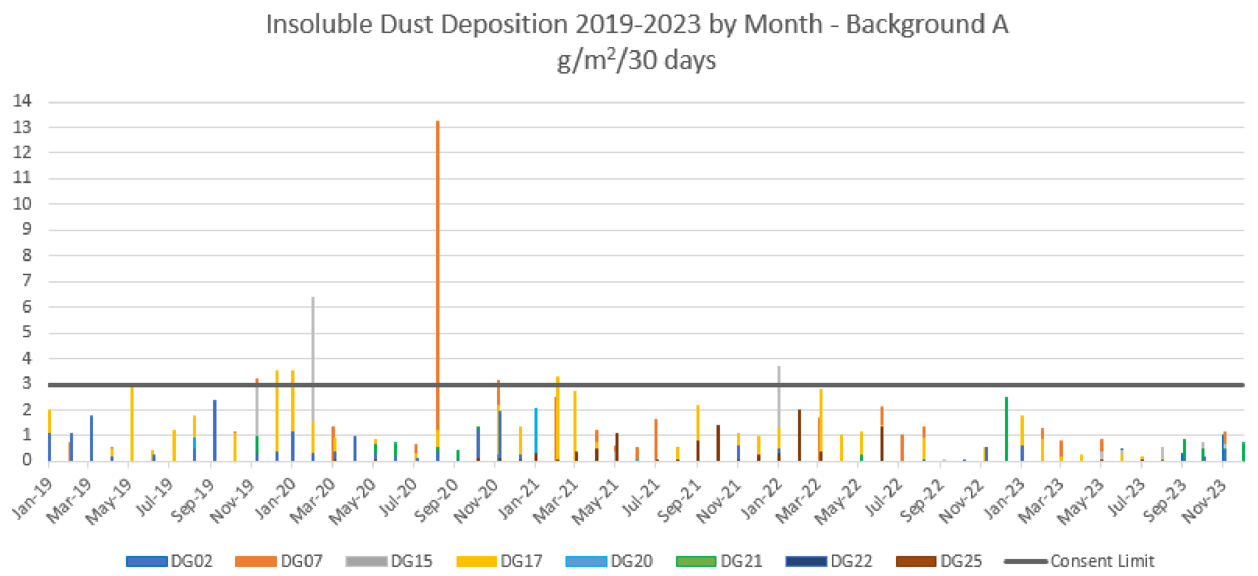

Figure 5-5. Historic Insoluble Deposited Deposition Monitoring 2019 – 2023, most consents background.

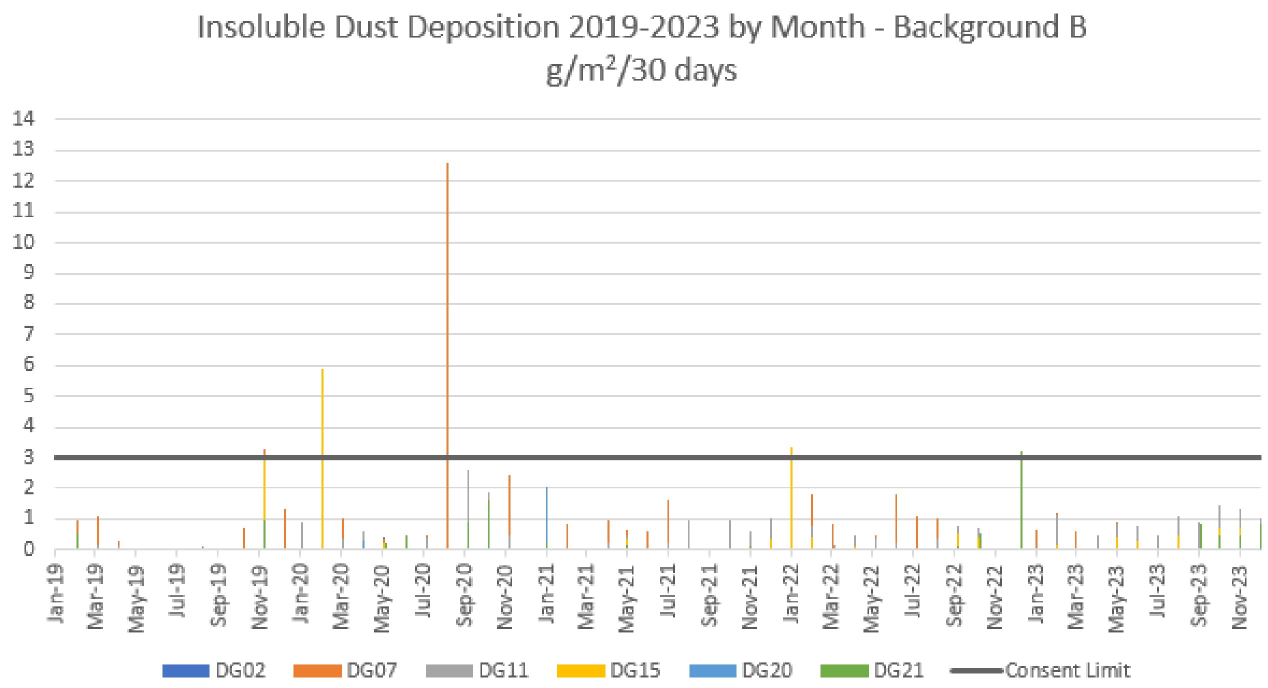

Figure 5-6. Historic Insoluble Deposited Deposition Monitoring 2019 – 2023, consent RM10.351.52.V1 background.

6 Total Suspended Particulate Monitoring

6.1 Instrument Performance

The performance of the TSP monitor at DG15 is presented in Table 4-2. The percentage of data acquired at the other two TSP monitoring sites is presented in **Table 6-1**. The monitor at DG11 was removed during July 2023 as authorised by ORC. The monitor at DG07 stopped operating in August 2023 and has yet to be reinstated.

Table 6-1. TSP instrument performance (percentage data capture) for 01 January 2023 – 31 August 2023

Month	DG07 (%)	Reason for <100% data collection	DG11 (%)	Reason for <100% data collection
January	94	Communication error	59	Instrument errors
February	73	Communication error	41	Instrument and communication errors
March	100	n/a	74	Instrument error
April	100	n/a	30	Analyser error
May	61	Instrument error i.e. low voltage due to reduced sunlight	98	Analyser error
June	14	Instrument error i.e. low voltage due to reduced sunlight	80	Analyser error
July	93	Instrument error i.e. low voltage due to reduced sunlight	93	Instrument error i.e. low voltage due to reduced sunlight
August	26	Instrument error i.e. low voltage and communication issues	81	Communication issues

6.1 TSP Monitoring Results

The 24-hour average TSP concentrations for 2023 for the three sites are presented in **Figure 6-1** alongside the relative humidity measured at DG03. There are instances of high humidity which correspond with high TSP levels recorded at the three sites. They indicate that high levels of moisture can give rise to anomalous high TSP readings due to fog obscuring the optical monitor's light path which is interpreted as a high dust concentration. The tables in **Appendix F** show the strong correlation of humidity and high TSP results.

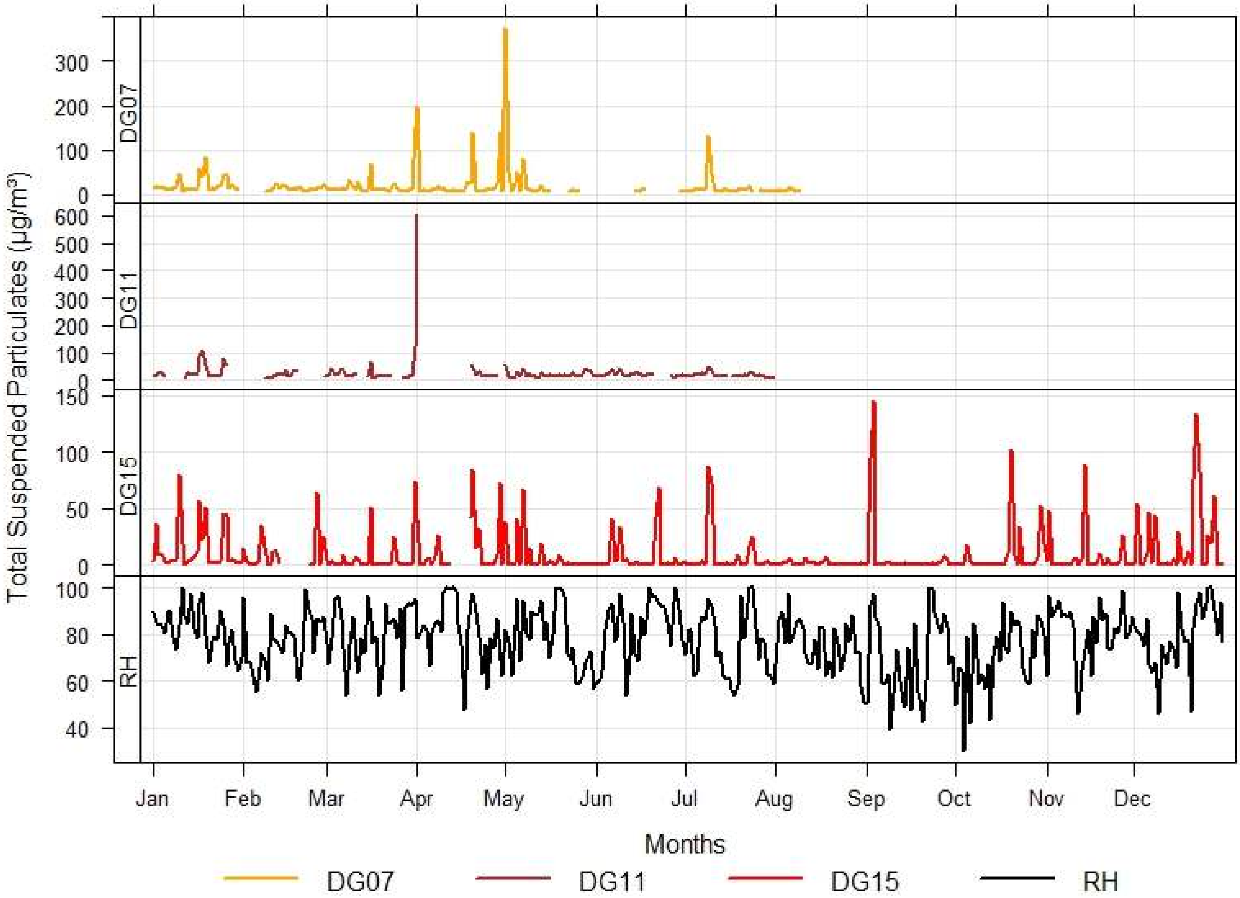

Figure 6-1: Overview of the 24-hour average TSP concentrations at DG07, DG11 and DG15 in relation to the relative humidity recorded at DG03

6.1.1 DG07 TSP Monitoring 1-hour Average Results

The 1-hour average TSP concentrations at DG07 for 2023 are presented in **Figure 6-2** and **Table 6-2**, alongside the 250 µg/m^3 consent limit. The annual hourly average of TSP measured for 2023 was 18.2 µg/m^3. The maximum TSP 1-hour average concentration for 2023 was 1907 µg/m^3. There was a total of 61 exceedances of the 250 µg/m^3 1-hour average consent limit throughout the year which all related to high humidity levels at the time.

Table F 1 in **Appendix F** presents the exceedances of the hourly consent limit recorded for DG07 alongside the hourly relative humidity measurements at DG03. For all exceedances, the relative humidity measured at the monitoring station was 99.9% or above. The correlation between a TSP exceedance and the relative humidity would suggest that during these periods, the instrument was reporting water aerosol (fog) concentrations rather than dust from mining activities.

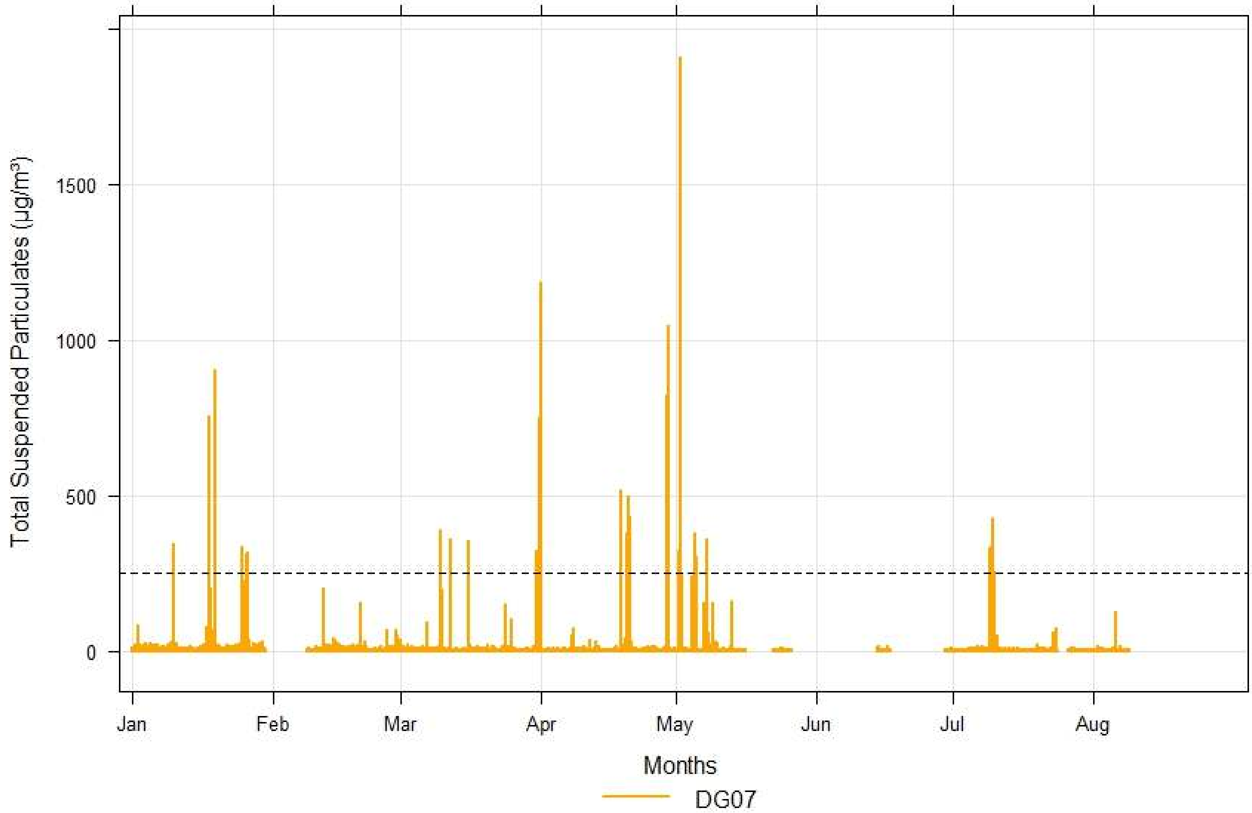

Figure 6-2. 1-hour average measured TSP concentrations recorded at Site DG07 for 2023

Table 6-2. Summary of 1-hour average measured TSP concentrations (µg/m³) at Site DG07 for 2023

Month	Minimum Hourly Concentration (µg/m³)	Maximum Hourly Concentration (µg/m³)	Average Hourly Concentration (µg/m³)	Number of Exceedances (> 250 µg/m³)
January	4.0	944.0	20.9	7
February	4.0	201.0	13.0	0
March	4.0	750.0	18.3	12
April	4.0	1182.0	25.5	20
May	4.0	1907.0	36.8	14
June	6.0	20.0	8.2	0
July	4.0	427.0	14.1	8
August	4.8	126.7	9.0	0
Annual (8 months)	**4.0**	**1907.0**	**18.2**	**61**

6.1.2 DG07 TSP Monitoring 24-hour Average Results

The 24-hour average TSP concentrations for 2023 at DG07 are presented in **Figure 6-3** and **Table 6-3**, alongside the 24-hour consent limit of 80 µg/m³. The maximum 24-hour average concentration at DG07 for 2023 was 317 µg/m³, while the annual average 24-hour concentration for 2023 was 18.5 µg/m³.

There were 7 exceedances of the 24-hour consent limit. These exceedances can all be attributed to the nephelometer over reporting TSP concentrations when high relative humidity conditions occurred.

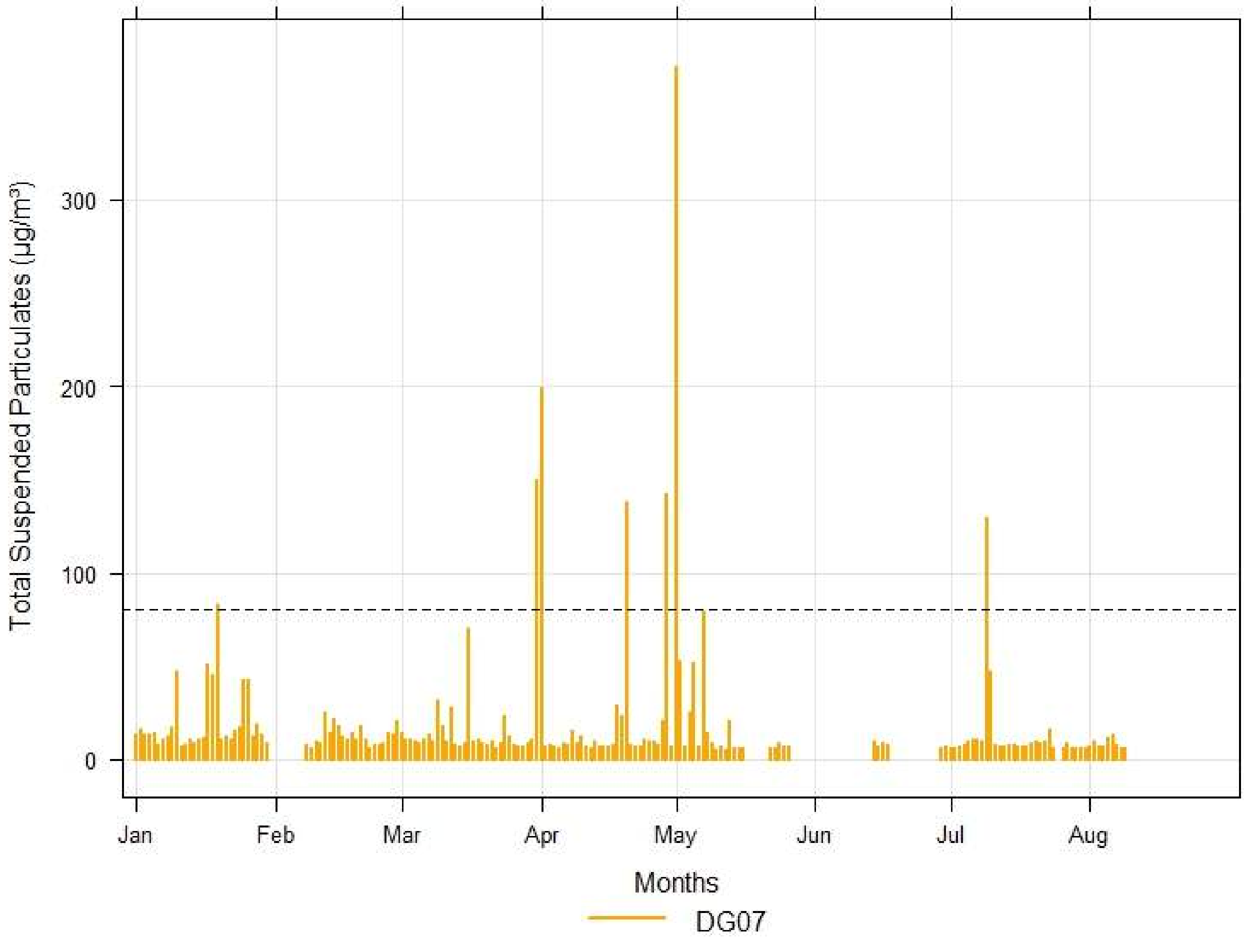

Figure 6-3. 24-hour average measured TSP concentrations recorded at Site DG07 for 2023

Table 6-3. Summary of 24-hour average measured TSP concentrations (µg/m^3) at Site DG07 for 2023

Month	Minimum 24 hour Average Concentration (µg/m^3)	Maximum 24-hour Average Concentration (µg/m^3)	Monthly Average Concentration (µg/m^3)	Number of Exceedances (> 80 µg/m^3)
January	7.0	83.0	20.9	1
February	6.0	25.0	13.2	0
March	6.0	150.0	18.3	1
April	7.0	199.0	25.5	3
May	5.0	371.0	38.4	1
June	8.0	9.0	8.3	0
July	6.0	130.0	14.2	1
August	6.5	13.6	9.0	0
Annual (8 months)	**5.0**	**371.0**	**18.5**	**7**

6.1.3 DG11 TSP Monitoring 1-Hour Average Results

The 1-hour average TSP concentrations for 2023 at DG11 are presented in **Figure 6-4** and **Table 6-4**, alongside the 250 µg/m^3 consent limit. presents a summary of the measured TSP data for 2023 for DG11.

The annual hourly average TSP concentration measured for 2023 was 24.4 μg/m^3. The maximum TSP concentration measured for 2023 was 836 μg/m^3. There was a total of 25 exceedances of the 250 μg/m^3 consent limit through the year, with most of these exceedances occurring in the first three months of the year.

Table F 2 in **Appendix F** presents the exceedances of the hourly consent limit recorded for DG11 and the relative humidity measurements from DG03. As previously mentioned, these exceedances can be attributed to the nephelometer over reporting TSP concentrations when high relative humidity (fog) conditions occur, rather than dust from mining activities.

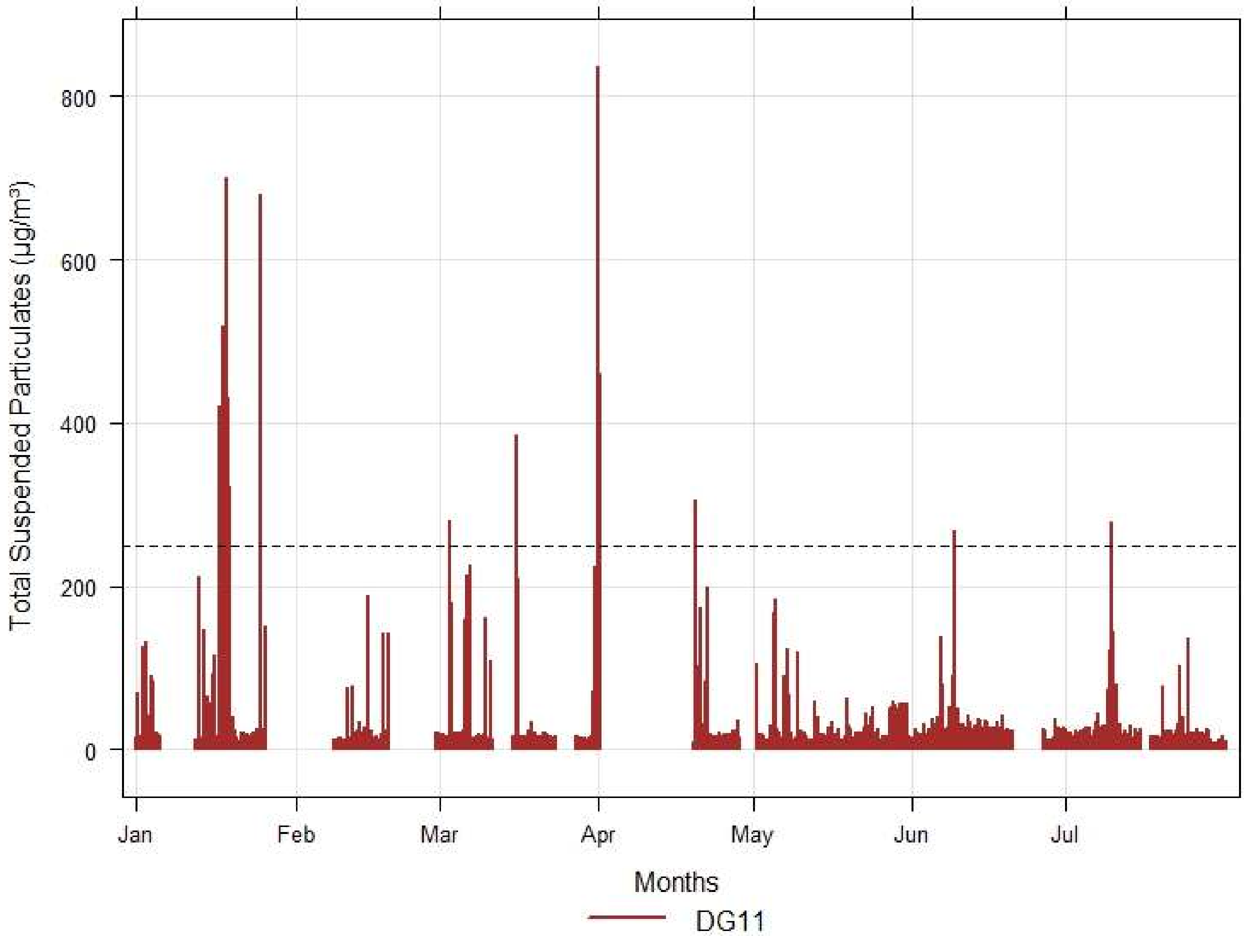

Figure 6-4. 1-hour average ambient TSP concentrations recorded at Site DG11 for 2023

Table 6-4. Summary of 1-hour average measured TSP concentrations (µg/m^3) at Site DG11 for 2023

Month	Minimum Hourly Concentration (µg/m^3)	Maximum Hourly Concentration (µg/m^3)	Average Hourly Concentration (µg/m^3)	Number of Exceedances (> 250 µg/m^3)
January	5.0	781.0	33.7	12
February	5.0	188.0	18.7	0
March	1.0	741.0	25.7	7
April	2.0	836.0	32.2	4
May	3.0	185.0	20.7	0
June	5.0	268.0	21.1	1
July	2.0	278.0	18.9	1
Annual (8 months)	**1.0**	**836.0**	**24.4**	**25**

6.1.4 DG11 TSP Monitoring 24-Hour Average Results

The 24-hour average TSP concentrations measured at DG11 are presented in **Figure 6-5** and **Table 6-5**, alongside the 24-hour consent limit of 80 µg/m^3. The annual average concentration for 2023 was 23.3 µg/m^3, with a maximum daily average concentration of 121 µg/m^3.

There were 3 exceedances of the 24-hour consent limit (of 80 µg/m^3) over 2023. Similarly, these exceedances can be attributed to the nephelometer over reporting TSP concentrations when high relative humidity conditions occur.

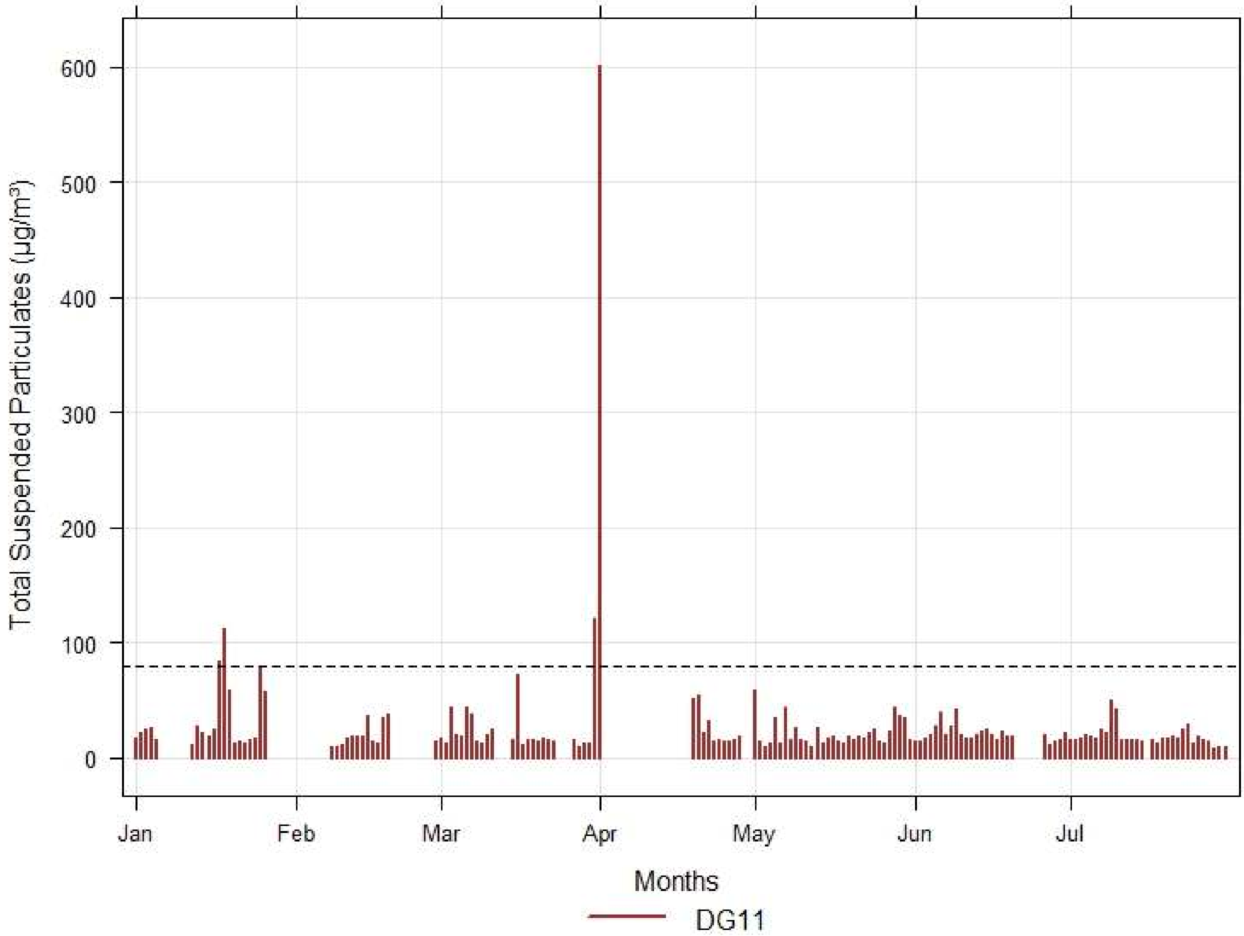

Figure 6-5. 24-hour average ambient TSP concentrations recorded at Site DG11 for 2023

Table 6-5. Summary of 24-hour average measured TSP concentrations (µg/m³) at Site DG11 for 2023

Month	Minimum 24 hour Average Concentration (µg/m³)	Maximum 24-hour Average Concentration (µg/m³)	Monthly Average Concentration (µg/m³)	Number of Exceedances (> 80 µg/m³)
January	13.0	111.0	34.4	2
February	10.0	36.0	18.9	0
March	9.0	121.0	26.6	1
April	14.0	55.0	22.8	0
May	10.0	44.0	20.2	0
June	11.0	42.0	21.3	0
July	8.0	49.0	19.0	0
Annual (8 months)	**8.0**	**121.0**	**23.3**	**3**

6.1.5 DG15 1 Hour Average TSP Monitoring Results

The hourly average ambient TSP concentrations measured at DG15 for 2023 are presented in **Figure 6-6** and **Table 6-6**. There is no 1-hour TSP consent limit in any of the resource consents for DG15. The results show the annual 1-hour average TSP concentration for 2023 was 9.2 µg/m^3. The maximum 1-hour average TSP concentration was 816 µg/m^3.

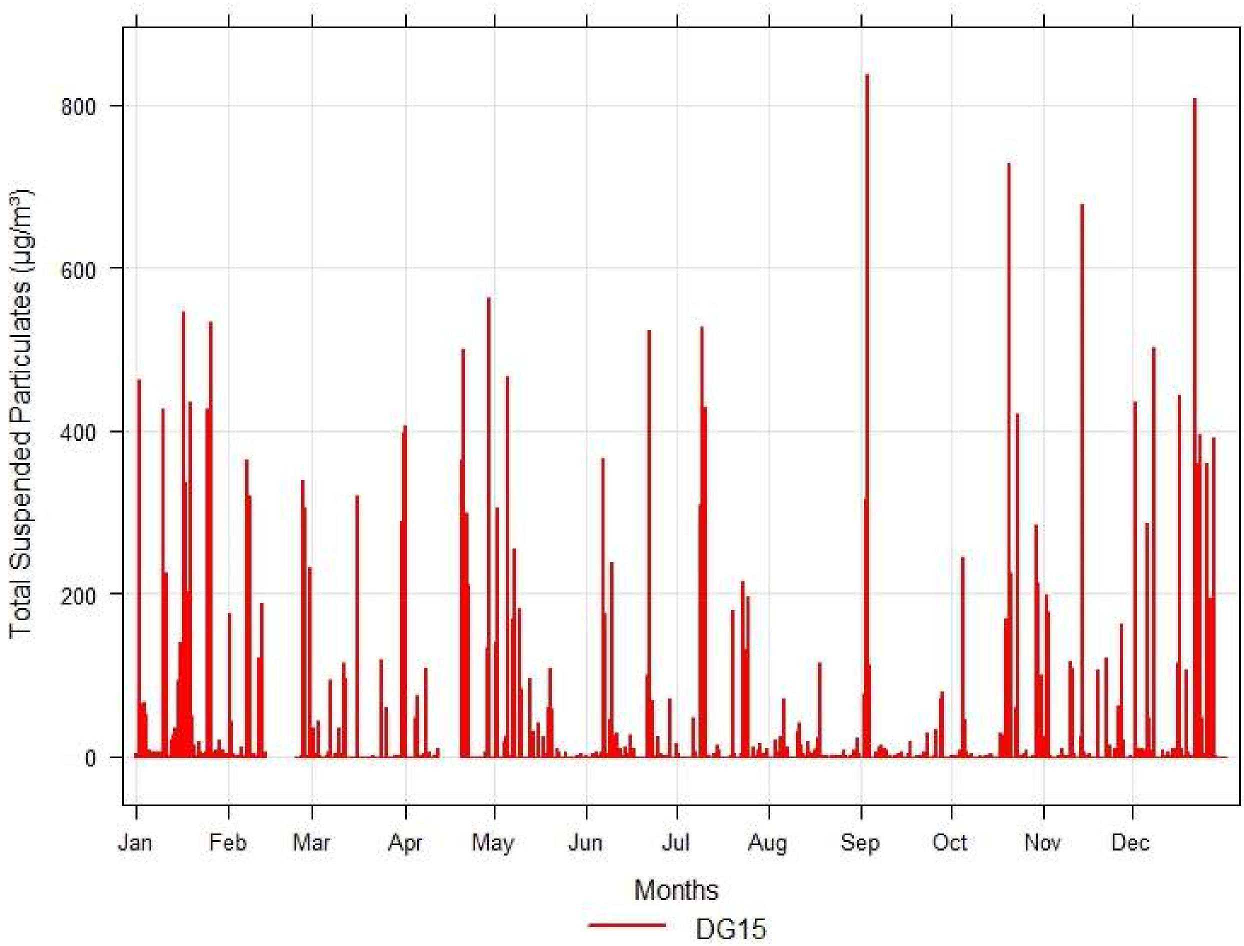

Figure 6-6. Hourly average ambient TSP concentrations recorded at Site DG15 from 2023

Table 6-6. Summary of 1-hour average measured TSP concentrations (μg/m³) at Site DG15 for 2023

Month	Minimum Hourly Concentration (μg/m³)	Maximum Hourly Concentration (μg/m³)	Average Hourly Concentration (μg/m³)
January	0.0	636.0	14.2
February	0.0	412.8	10.5
March	0.0	377.0	5.9
April	0.0	555.3	13.8
May	0.0	437.5	6.5
June	0.0	460.3	7.1
July	0.0	493.5	7.2
August	0.0	118.7	1.3
September	0.0	816.0	8.9
October	0.0	772.2	8.3
November	0.0	643.9	6.8
December	0.0	778.3	19.6
Annual (8 months)	0.0	816.0	9.2

6.1.6 DG15 24 Hour Average TSP Monitoring Results

Figure 6-7 and **Table 6-7** shows the 24-hour average TSP concentrations observed at Site DG15 for 2023 alongside the 24-hour consent limit of 120 μg/m³. The results show that there were two exceedances of the 24-hour consent limit of 120 μg/m³ in 2023. The TSP levels at Site DG15 were otherwise well below the consent limit, with an annual 24-hour average of 9.2 μg/m³.

As previously mentioned, the nephelometer uses an optical monitoring method, and TSP concentrations during high humidity events may be over-estimated as the airborne water aerosols would be measured by the instrument as TSP.

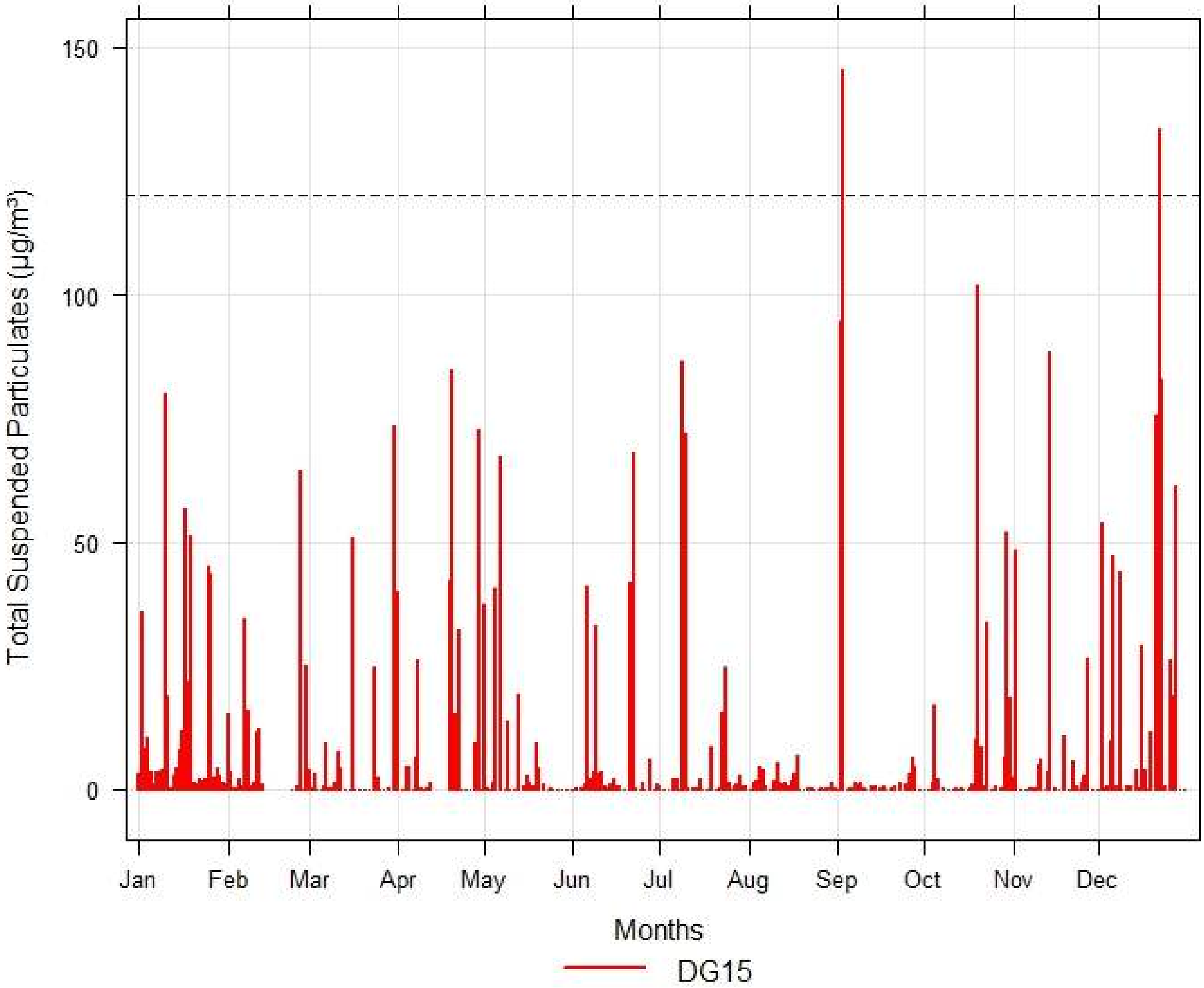

Figure 6-7. 24-hour average ambient TSP concentrations recorded at Site DG15 from 2023

Table 6-7. Summary of 24-hour average measured TSP concentrations (µg/m³) at Site DG15 for 2023

Month	Minimum 24-hour Average Concentration (µg/m³)	Maximum 24-hour Average Concentration (µg/m³)	Monthly Average Concentration (µg/m³)	Number of Exceedances (> 120 µg/m³)
January	0.5	80.0	14.2	0
February	0.0	64.3	11.1	0
March	0.0	73.7	5.9	0
April	0.0	84.7	13.5	0
May	0.0	67.5	6.5	0
June	0.0	68.0	7.1	0
July	0.0	86.7	7.2	0
August	0.0	6.9	1.3	0
September	0.0	145.5	8.9	1
October	0.0	101.8	8.3	0
November	0.0	88.4	6.8	0
December	0.0	133.4	19.6	1
Annual	**0.0**	**145.5**	**9.2**	**2**

7 Evaluation of Dust Mitigation Measures

7.1 Main Dust Control Measures

The current dust control measures on-site include reducing vehicle speeds, ceasing overburden stripping and bund construction activities and increasing the quantity of water used as a dust suppressant during dry and windy conditions.

7.2 Summary of 2023 Mining Activities

Open pit mining and processing activities from 1 January 2023 - 31 December 2023 included:

- Processing of low-grade ore stockpiles;
- Ore haulage back to the processing plant from the Deepdell North and Frasers operations;
- Processing Run of Mine (ROM) ore from Coronation North, Deepdell North, Frasers and underground mine sources;
- Ongoing mining in Deepdell North and Frasers Pits.
- Ongoing construction of the Deepdell East, Frasers East and Frasers West Waste Rock Stacks (WRS);
- Partial backfill of Frasers and Gay Tans Pits;
- Ongoing construction of the Top Tipperary Tailings Storage Facility Embankment.

7.2.1 Mining Activities 2024

For calendar year 2024, OGNZL intends to continue mining the Frasers/Innes Mills and Gay Tan Pits, the Golden Point Underground operation and later in the year return to Coronation Pit using the current mining fleet and mining practices. This ore will be fed into the existing processing plant using the same gold recovery methodologies as used in 2023.

7.3 Dust Control Level Indicated by Monitoring Results

Dust is being managed effectively as:

- The dust monitoring results did not exceed the consent limit of 3 $g/m^2/30$ days over the year.
- Although several TSP exceedances were recorded at each of the monitoring sites DG07, DG11 and DG15, most of them can be attributed to the monitoring instrument being affected by fog during high relative humidity conditions.
- The monthly 24-hourly average TSP ranges from 8.3 – 38.4 $\mu g/m^3$ for DG07, 18.9 – 34.4 $\mu g/m^3$ for DG11 and 1.3 – 19.6 $\mu g/m^3$ for DG15, indicating that for much of the time TSP concentrations are low compared to the consent limit.

7.4 Ongoing TSP Monitoring at DG07 and DG11

Condition 6(a)(e) of Consent RM10.351.52.V1 allows for review of the need for ongoing monitoring at DG11 and removal of the monitor as authorised by ORC, which has now happened. Condition 5(e) of Consent RM20.24.12 allows for review of the need for ongoing monitoring at DG07. The total suspended particulate monitoring may be amended, or suspended if such agreement is provided in writing by the Consent Authority.

TSP monitoring at DG07 was only undertaken between January to August 2023 due to malfunctioning of the monitor unit. DG07 is in a separate valley to DG11 and DG15 and therefore, provides monitoring data representative of that separate location. It is recommended this site continues to be used in the monitoring and management of mine dust in that area. In addition, a local meteorological station should be installed at DG07 to allow for determination of wind conditions (>5 m/s) to aid in dust management in that valley. This was recommended in 2022 but has not yet been implemented.

A

Appendix A – Consent Monitoring Requirements

Consent Monitoring Requirements

The monitoring requirements for each consent and the consent limits are summarised in **Table A- 1** for dust deposition and **Table A- 2** for total suspended particulate matter. The dust deposition monitoring method is ISO Standard ISO/DIS 4222.2. TSP monitoring is undertaken using a nephelometer sited in accordance with AS/NZS 3580.1.1:2007. For the first year of the consents Hi-vol monitoring has been required at several sites, it is assumed that this monitoring has been undertaken and there is no further monitoring required using that method.

Table A- 1. Summary of Dust Deposition Monitoring Consent requirements.

Consent Number	Cnd No	Insoluble Dust Deposition sites	Dust Limit, $g/m^2/30$ days above background
96785_V5 most of site	7	DG07, DG20 and DG21	≤3 for no more than twice per year
	8	DG02 and DG15	≤3
	8a	DG09, DG10 and DG24 averaged	Background
RM10.351.52.V1 Frasers Pit	6	DG07, DG11, DG20 and DG21	≤3 for no more than twice per year
	7	DG02 and DG15	≤3
	8	DG09, DG10 and DG17 averaged	Background
RM12.378.15 Coronation	4	DG07, DG20, DG21, DG22 and DG23	≤3 for no more than twice per year
	5	DG02 and DG15	≤3
	6	DG09, DG10 and DG24 averaged	Background
RM16.138.19.V1 Coronation	4	DG07, DG20, DG21, DG22 and DG25	≤3 for no more than twice per year
	5	DG02 and DG15	≤3
	6	DG09, DG10 and DG24 averaged	Background
RM20.24.12 Deep Dell	7	DG07 and DG17	≤3 for no more than twice per year
	9	DG09, DG10 and DG24 averaged	Background

Table A- 2. Summary of Total Suspended Particulate Matter Monitoring Consent requirements

Consent Number	Cnd No	TSP sites	Dust Limit and Averaging Period
96785_V5 most of site	9 and 12c	DG15	120 $\mu g/m^3$ 24hr average
RM10.351.52.V1	6a	DG11	80 $\mu g/m^3$ 24hr average, 250 1 hourly
	9 and 12c	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly
RM12.378.15	7 and 10c	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly
RM16.138.19.V1	7 and 10c	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly
RM20.24.12 Deep Dell	5c	DG07 Howard Res[7]	80 $\mu g/m^3$ 24hr average, 250 1 hourly
	10 and 13b	DG15	120 $\mu g/m^3$ 24hr average, no limit 1 hourly

[7] 406 Horse Flat Road

Meteorological Monitoring requirements are presented in **Table A- 3**.

Table A- 3. Summary of Meteorological Monitoring Consent requirements

Consent Number	Condition No	Met sites	Wind speed	Wind Dir.	Temperature	Rainfall	Solar Radiation	Humidity
96785_V5 most of site	14a	DG03	Y	Y	Y, 2 heights[8]	Y	Y	Extra
	14b	DG15	Y	Y	Y	Y		
RM10.351.52.V1	13a	DG03	Y	Y	Y, 2 heights	Y	Y	Extra
	6a(d)	DG11	Y	Y				
	13b	DG15	Y	Y	Y	Y		
RM12.378.15	11a	DG03	Y	Y	Y, 2 heights	Y	Y	Extra
	11b	DG15	Y	Y	Y	Y		
RM16.138.19.V1	11a	DG03	Y	Y	Y, 2 heights	Y	Y	Extra
	11b	DG15	Y	Y	Y	Y		
RM20.24.12	5d	DG07	Y	Y				

Note: Meteorological monitoring was not undertaken at DG07 and DG11.

[8] Used to estimate atmospheric stability with solar radiation.

B

Appendix B – Reviewer's Qualifications

Reviewer’s Experience

Rhys Kevern has over 30 years’ engineering experience with over 24 years of specialist knowledge with air quality issues arising from industrial operations such as timber processors and chemical industries. He has worked for a Regional Council, Consultancy and Industry. His experience includes reviewing site operations for regulatory compliance and the preparation and processing of consent applications, the use of air dispersion modelling, reviewing the appropriateness of air pollution control technologies and has undertaken source and ambient monitoring. He has facilitated location compliance certificates for hazardous substance storage locations and assessed bulk storage tank compliance against API650. Rhys is also familiar with international food contact material regulations and FSSC22000.

C

Appendix C – Watercare Quarterly Reports

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Summer 2023

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2023-047

Ambient Air Quality Monitoring
Quarterly Summary Report
Summer 2023

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

10 January 2023

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

Watercare report number: AQ-2023-047
Watercare reference: 15-54681

Author

Kath McLeod
Senior Air Quality data Analyst
Data Management Team
Watercare Services Ltd

Peer Reviewer & Authoriser

Vilani Abeyratne
Ambient Data - Team Leader
Data Management Team
Watercare Services Ltd

Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Summer 2023 (December 2022 to February 2023) showed:

At DG15:

- There were no exceedences of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 89%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 80 $\mu g/m^3$ on 10 January 2023.
- There were higher (>250 $\mu g/m^3$) TSP E-Sampler hourly concentrations from all directions direction except northeast, south-southwest to southwest and west-northwest.
- Elevated (>15 $\mu g/m^3$) diurnal TSP hourly concentrations occurred from 22:00 to 07:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the east.

At DG03:

- Valid data captured for ambient temperature at 6 m, ambient temperature at 1.5 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%.
- The predominant wind direction was from the east.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Summer 2023
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer’s instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer’s operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare’s quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method’s requirements and the manufacturer’s instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Summer 2023.

Table 2: Site performance Summer 2023

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	89	No valid data from 13/02/2023 8:20 to 23/02/2023 07:00 as the unit was frozen and then rebooted.
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Summer 2023. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there were no exceedences of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration was 80 µg/m³ on 10 January 2023. The 1-hour TSP concentrations greater than 250 µg/m³ (Figure 3) came from all direction except northeast, south-southwest to southwest and west-northwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred from 22:00 to 07:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
December 2022	0	14	62
January 2023	1	14	80
February 2023	0	11	64
Summer 2023	**0**	**13**	**80 10/01/2023**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		Nil	
Wind direction (DG15)			
Hourly TSP >250 µg/m³		all except NE, SSW-SW & WNW	
Diurnal variation			
Hourly Diurnal TSP >15 µg/m³		22:00 – 07:00	

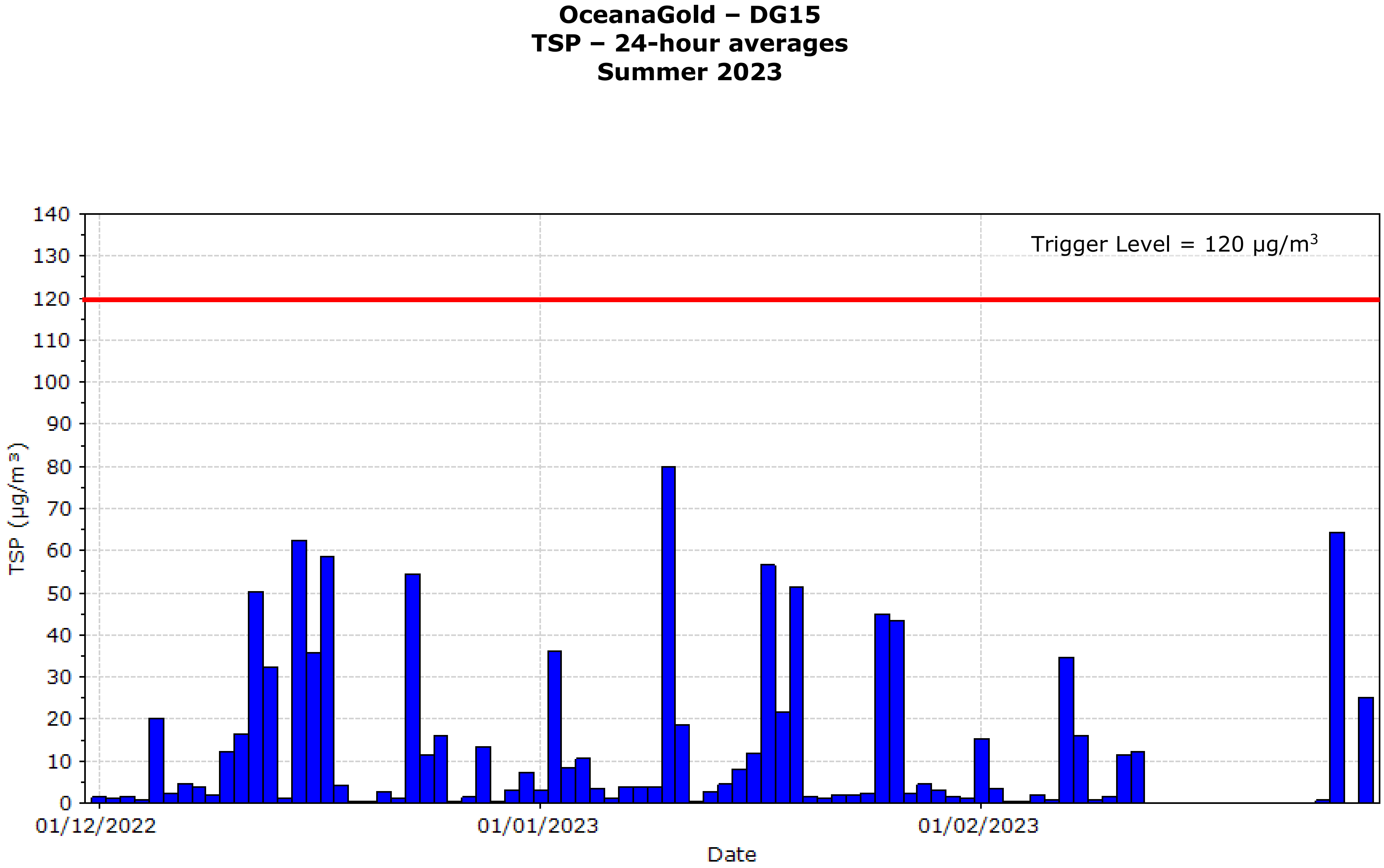

Figure 2: **OceanaGold – DG15: TSP E-Sampler (24-hour averages)**

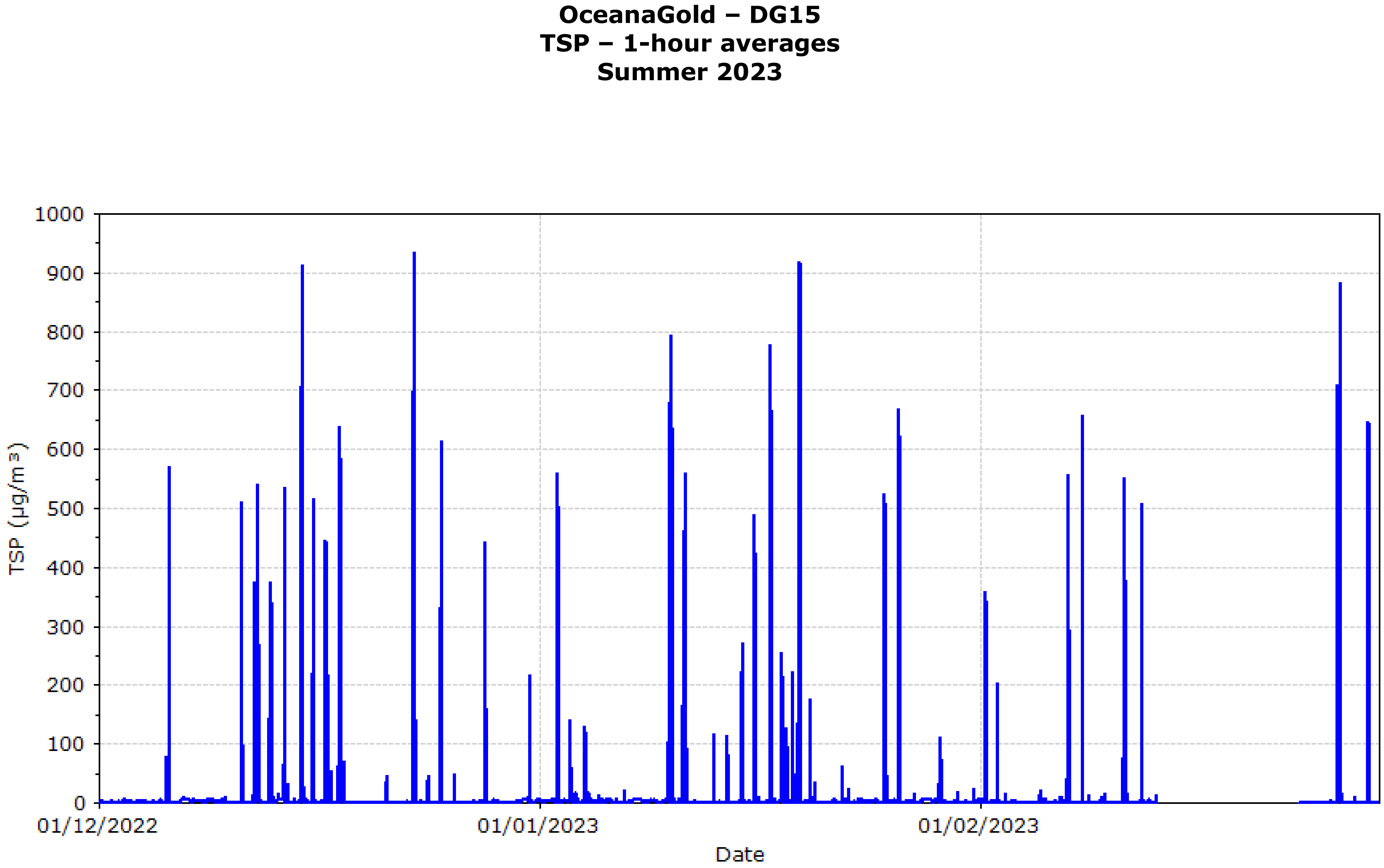

Figure 3: **OceanaGold – DG15: TSP E-Sampler (1-hour averages)**

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Summer 2023

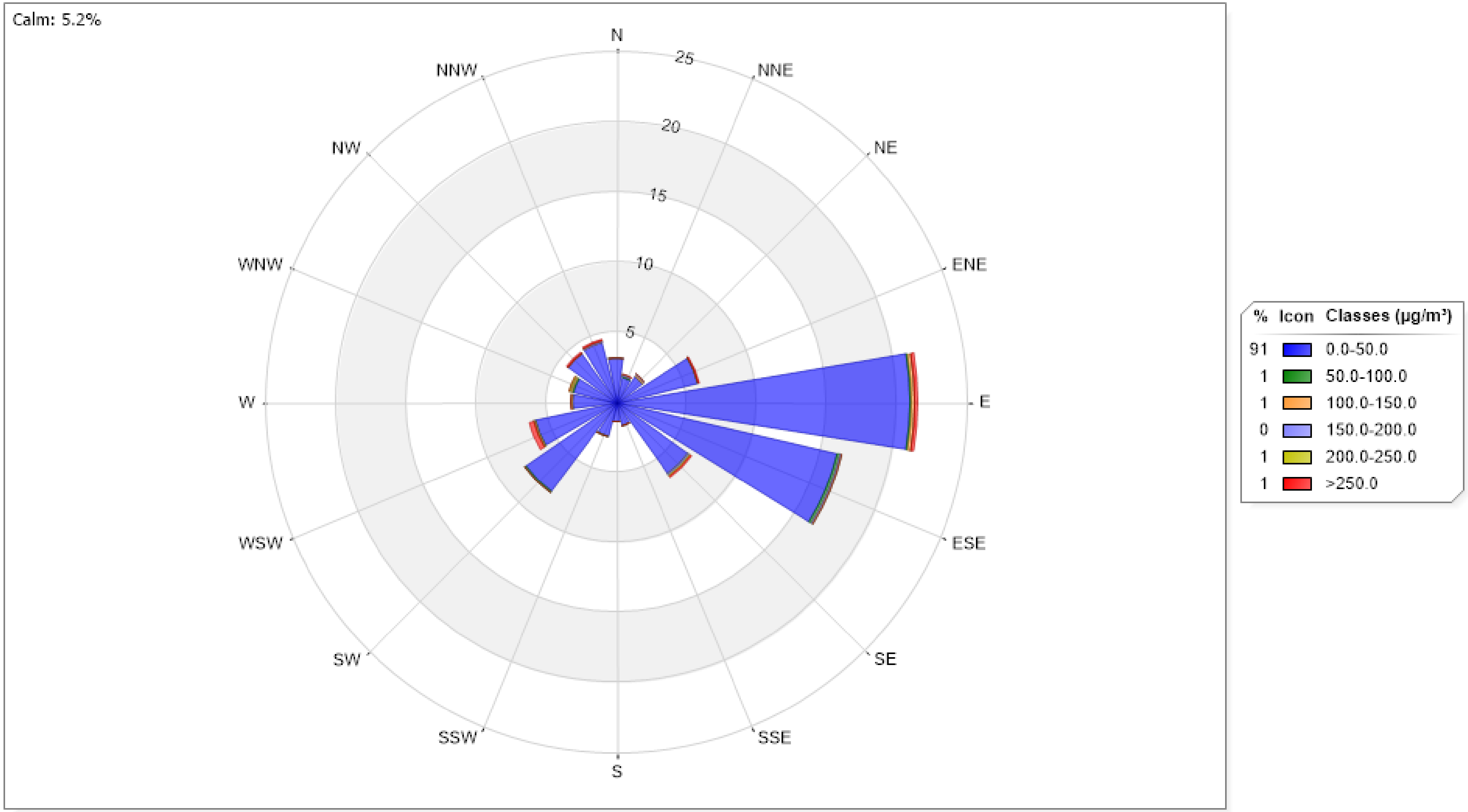

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

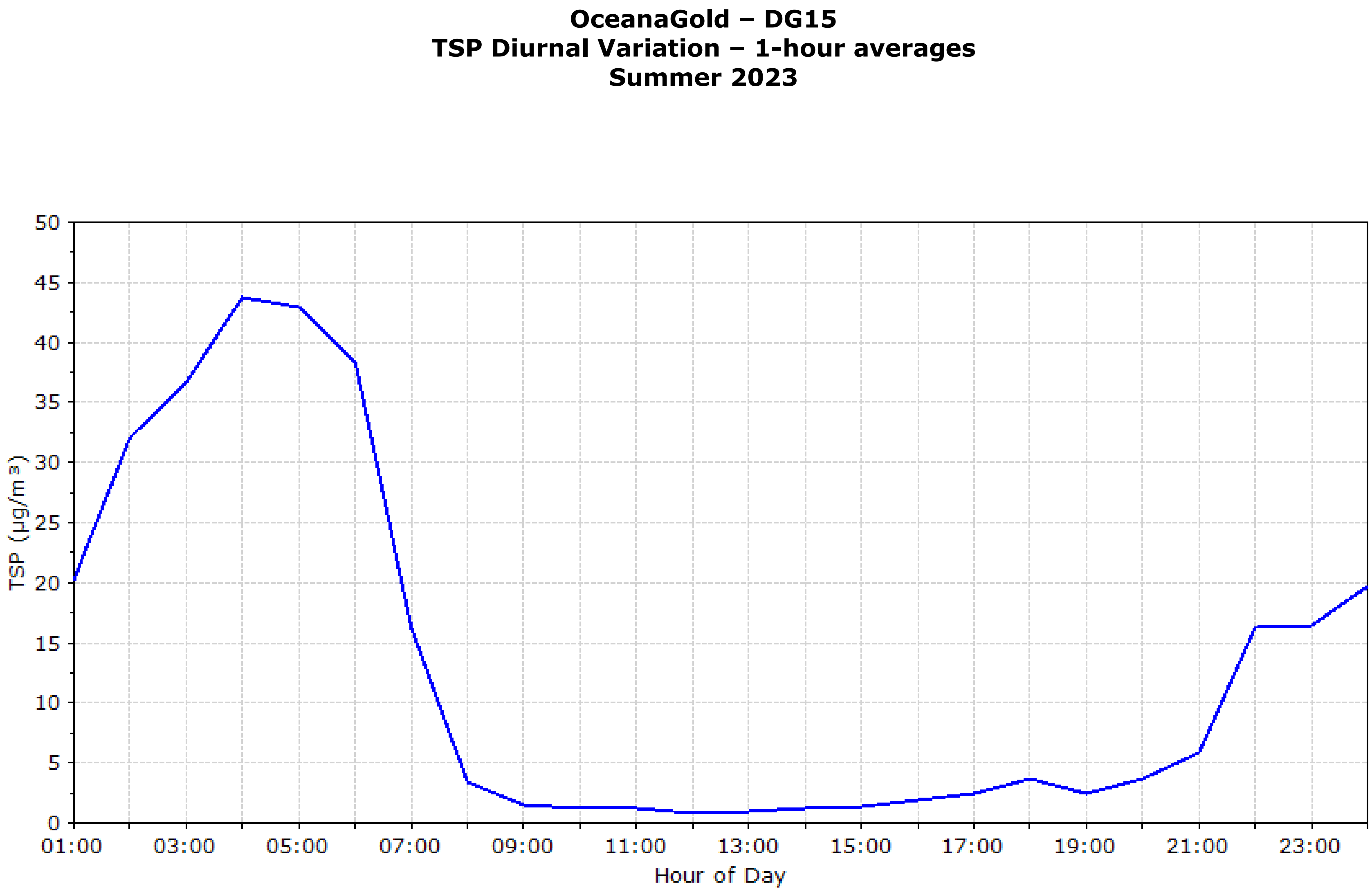

Figure 5: OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Summer 2023 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	2.8	12.1	26.5
January 2023	3.2	13.9	25.5
February 2023	2.1	14.4	29.4
Summer 2023	**2.1** **25/02/2023 06:00**	**13.5**	**29.4** **04/02/2023 15:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	7.0	12.1	20.9
January 2023	10.0	13.9	18.0
February 2023	7.0	14.4	22.7
Summer 2023	**7.0** **23/02/2023**	**13.5**	**22.7** **04/02/2023**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
December 2022	E-ESE	7.08	3.0	8.8
January 2023	E	5.9	2.8	9.0
February 2023	E	3.5	2.7	9.8
Summer 2023	**E**	**5.5**	**2.8**	**9.8**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
December 2022	2.5	30.4	78.2	17
January 2023	0.8	16.0	25.2	6
February 2023	2.5	35.0	69.6	6
Summer 2023	**1.9**	**35.0**	**173.0**	**29**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Summer 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	56	10	1	0	0	0	67	3.1
NNE	38	5	0	0	0	0	43	2.0
NE	42	13	3	0	0	0	58	2.7
ENE	43	56	37	7	0	0	143	6.6
E	69	220	135	29	0	0	453	**21.0**
ESE	49	138	138	11	0	0	336	15.6
SE	48	55	25	3	0	0	131	6.1
SSE	28	13	4	0	0	0	45	2.1
S	22	5	3	0	0	0	30	1.4
SSW	29	19	7	1	0	0	56	2.6
SW	33	63	57	21	9	0	183	8.5
WSW	59	58	16	10	6	0	149	6.9
W	42	27	8	3	0	0	80	3.7
WNW	48	22	6	2	0	0	78	3.6
NW	46	31	19	3	0	0	99	4.6
NNW	58	39	4	0	0	0	101	4.7
All	**710**	**774**	**463**	**90**	**15**	**0**	**2052**	**95**
Calm	108						108	5.0

Table 8 shows the proportion of wind strengths at each wind direction. Stronger winds, greater than 8 m/s, were observed from the southwest to west-southwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the east.

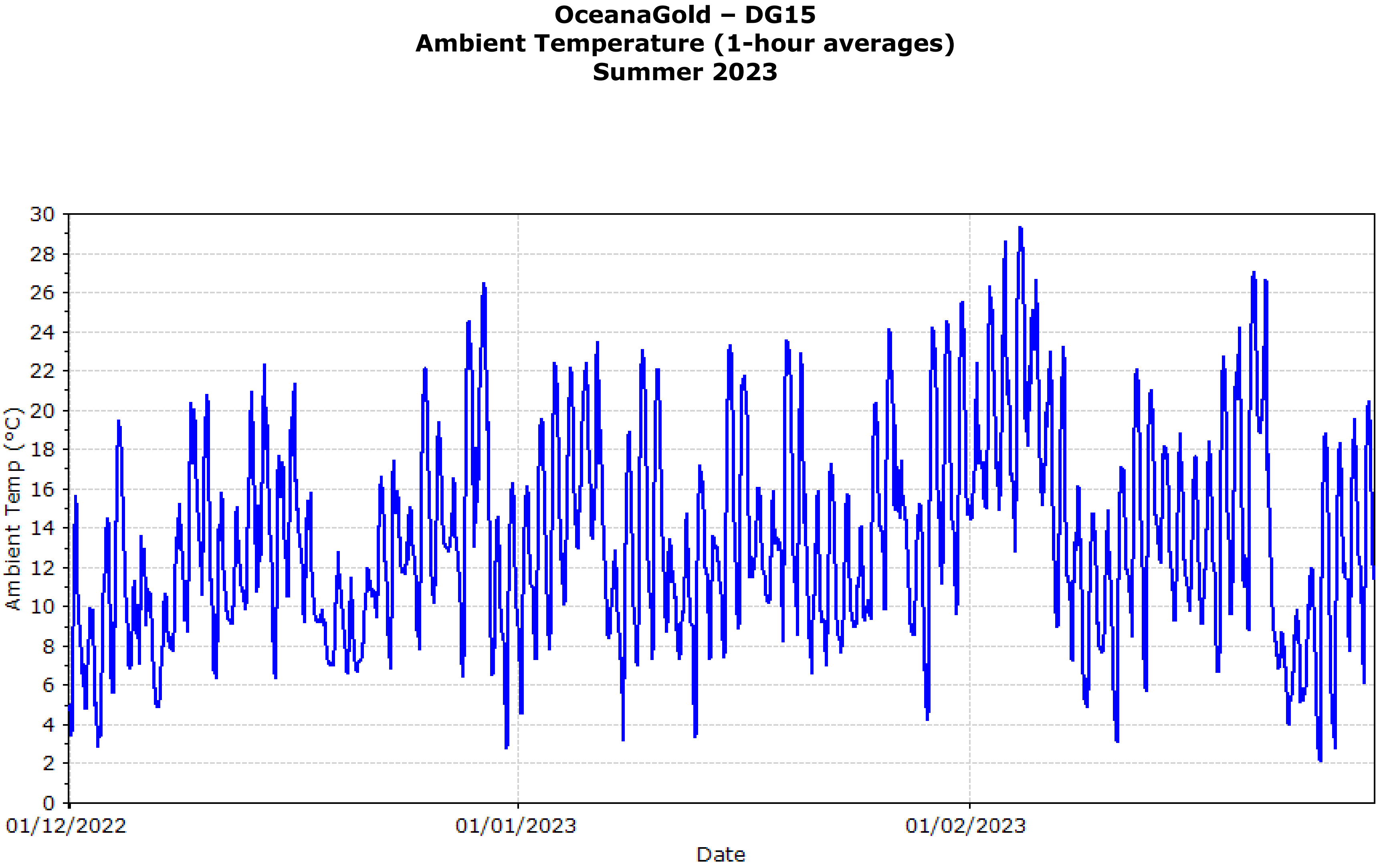

Figure 6: **OceanaGold – DG15: Ambient Temperature (1-hour averages)**

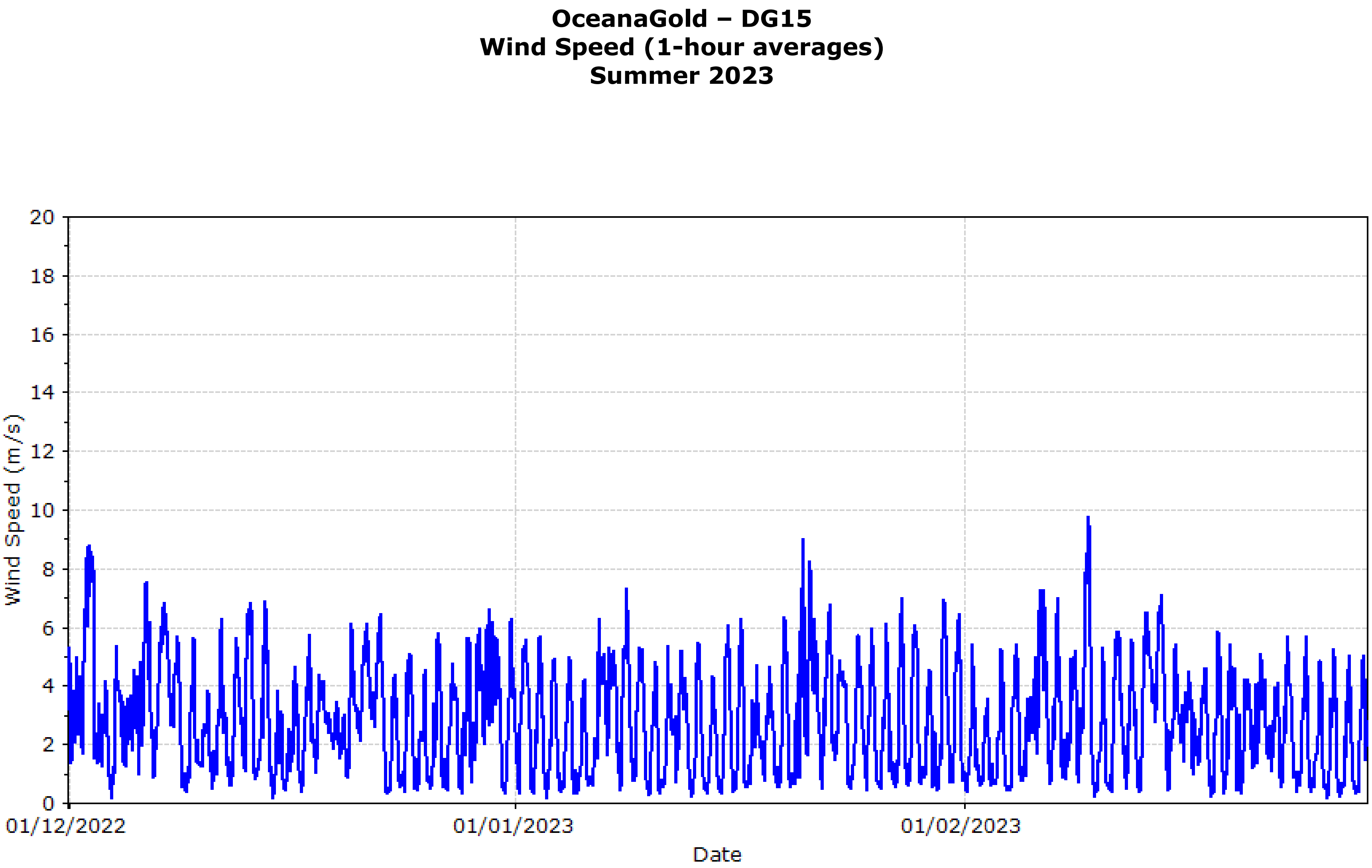

Figure 7: OceanaGold – DG15: Wind Speed (1-hour averages)

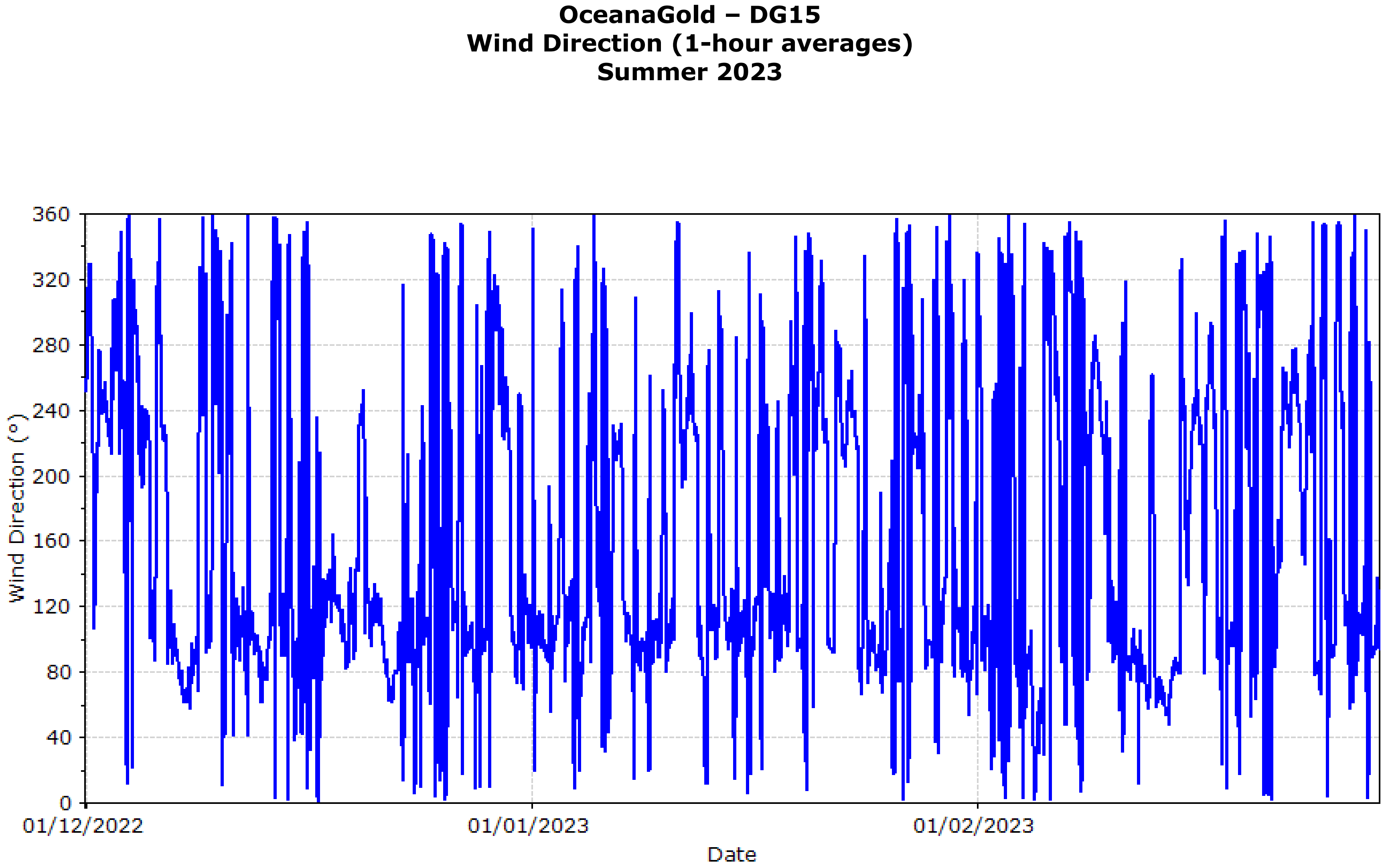

Figure 8: **OceanaGold – DG15: Wind Direction (1-hour averages)**

OceanaGold – DG15
Wind Rose (1-hour averages)
Summer 2023

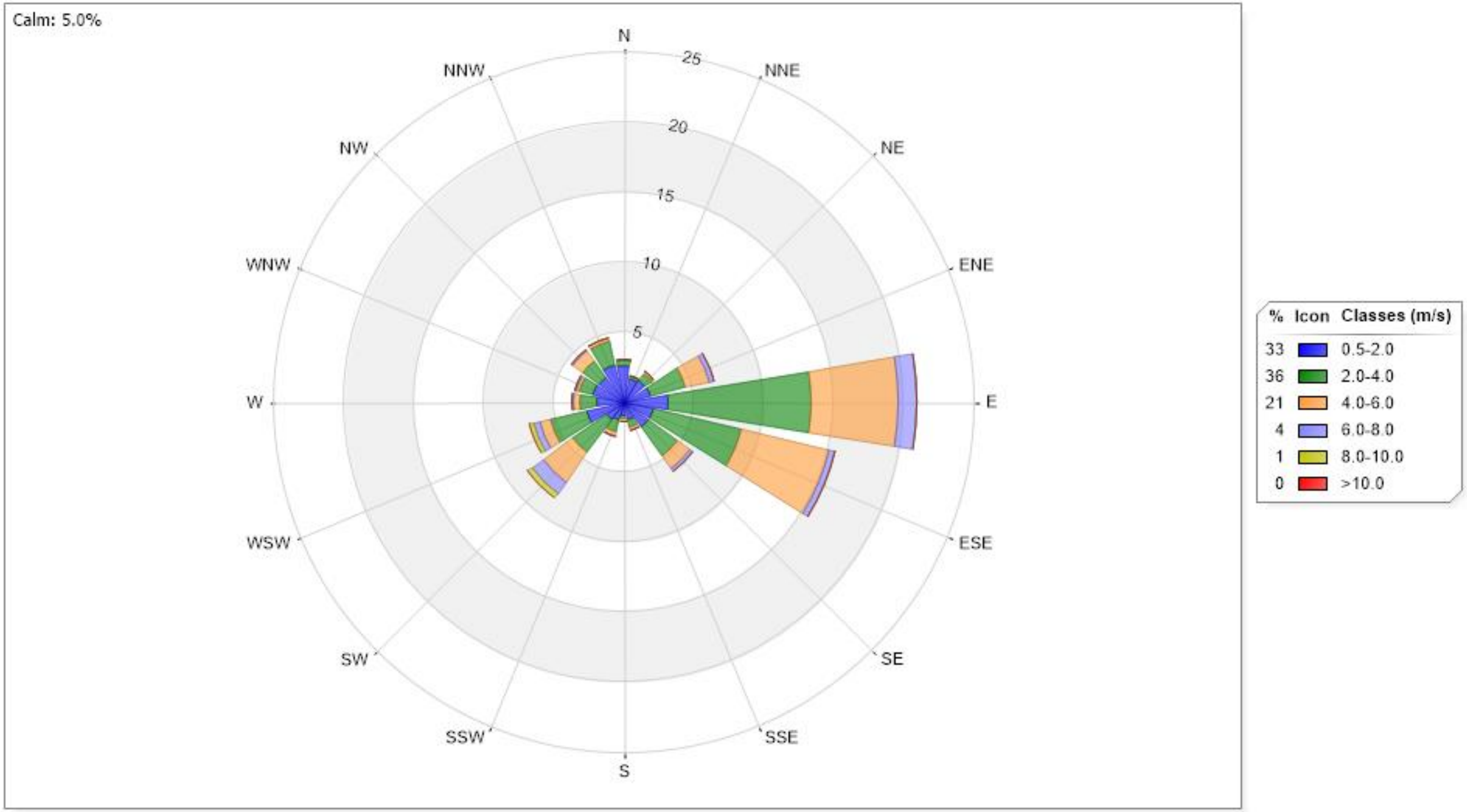

Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

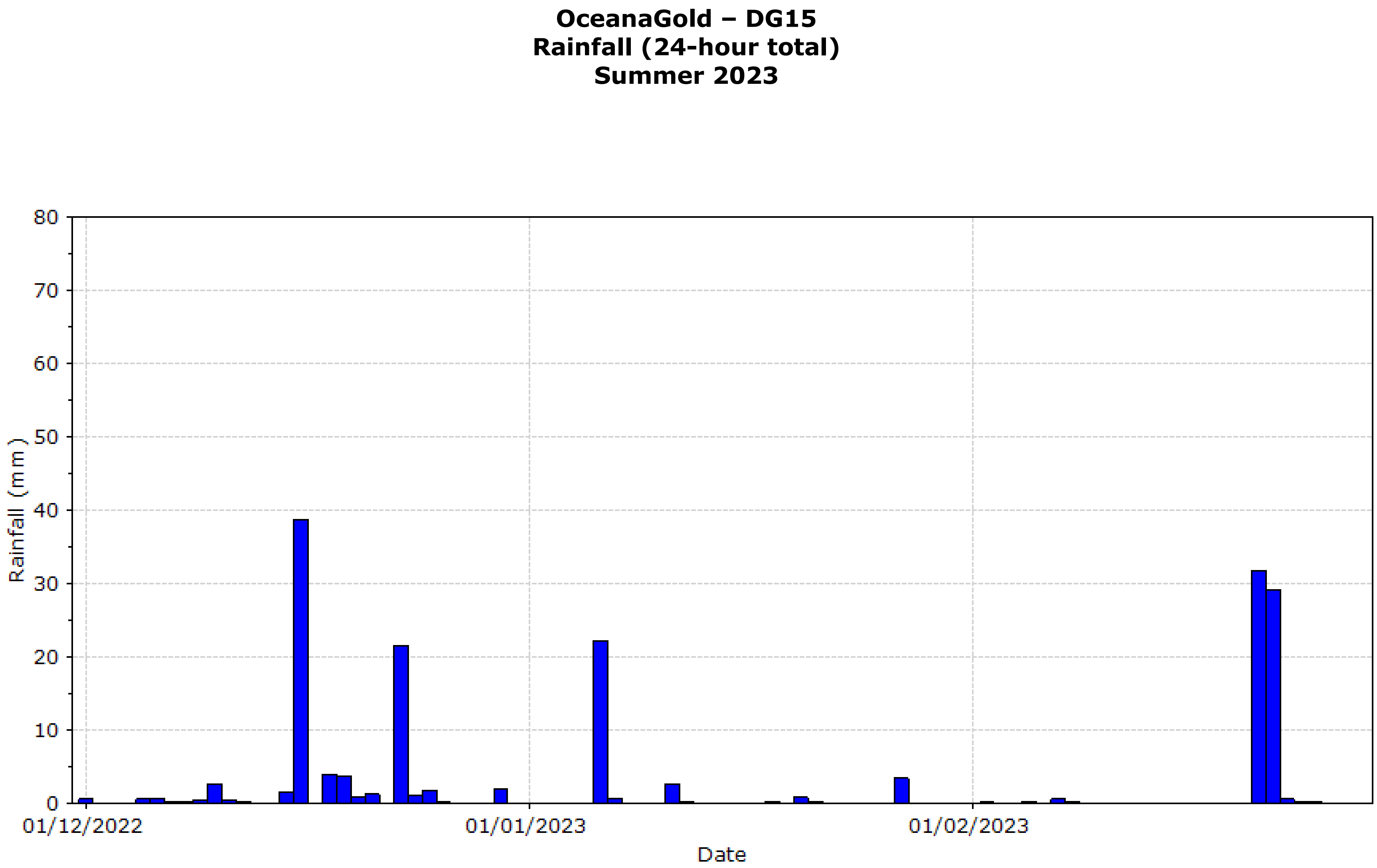

Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Summer 2023 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	2.5	12.1	26.6
January 2023	4.9	14.1	25.5
February 2023	4.0	14.6	29.3
Summer 2023	**2.5 03/12/2022 05:00**	**13.6**	**29.3 04/02/2023 15:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	3.1	12.1	25.8
January 2023	5.9	14.1	24.5
February 2023	4.6	14.6	28.3
Summer 2023	**3.1 03/12/2022 05:00**	**13.6**	**28.3 04/02/2023 15:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
December 2022	28.7	84.5	100.0
January 2023	30.7	82.1	100.0
February 2023	31.3	76.1	100.0
Summer 2023	**28.7**	**81.1**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	6.7	12.1	20.9
January 2023	9.6	14.1	18.6
February 2023	6.7	14.6	23.5
Summer 2023	**6.7** **23/02/2023**	**13.6**	**23.5** **04/02/2023**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	6.7	12.1	21.0
January 2023	9.5	14.1	18.5
February 2023	6.8	14.6	23.5
Summer 2023	**6.7** **02/12/2022**	**13.6**	**23.5** **04/02/2023**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
December 2022	41.2	84.5	100.0
January 2023	64.7	82.1	99.7
February 2023	55.3	76.1	99.2
Summer 2023	**41.2**	**81.1**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)*	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
December 2022	E	2.9	3.4	10.6
January 2023	E	1.6	3.0	8.0
February 2023	E	0.8	3.4	14.0
Summer 2023	**E**	**1.8**	**3.3**	**14.0**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
December 2022	2.5	30.4	78.2	17
January 2023	0.8	16.0	25.2	6
February 2023	2.5	35.0	69.6	6
Summer 2023	**1.9**	**35.0**	**173.0**	**29**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
December 2022	78.5	225.2	366.0
January 2023	65.9	252.9	371.6
February 2023	65.0	214.9	332.9
Summer 2023	**65.0 22/02/2023**	**231.5**	**371.6 08/01/2023**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Summer 2023)

	Wind speed time (hours)							
Wind Direction*	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	32	12	0	0	0	0	44	2.0
NNE	54	25	3	0	0	0	82	3.8
NE	53	34	37	30	7	0	161	7.4
ENE	66	96	61	15	0	0	238	11.0
E	76	218	196	43	0	0	533	**24.7**
ESE	67	73	68	17	0	0	225	10.4
SE	22	25	11	0	0	0	58	2.7
SSE	25	9	4	0	0	0	38	1.8
S	25	18	10	3	0	0	56	2.6
SSW	23	72	54	24	4	0	177	8.2
SW	17	49	12	13	1	0	92	4.3
WSW	32	22	9	3	0	0	66	3.1
W	34	25	6	4	1	1	71	3.3
WNW	28	21	25	24	9	7	114	5.3
NW	22	29	19	11	2	0	83	3.8
NNW	22	20	1	1	0	0	44	2.1
All	**598**	**748**	**516**	**188**	**24**	**8**	**2083**	**96**
Calm	77						77	3.6

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from west to west-northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the east.

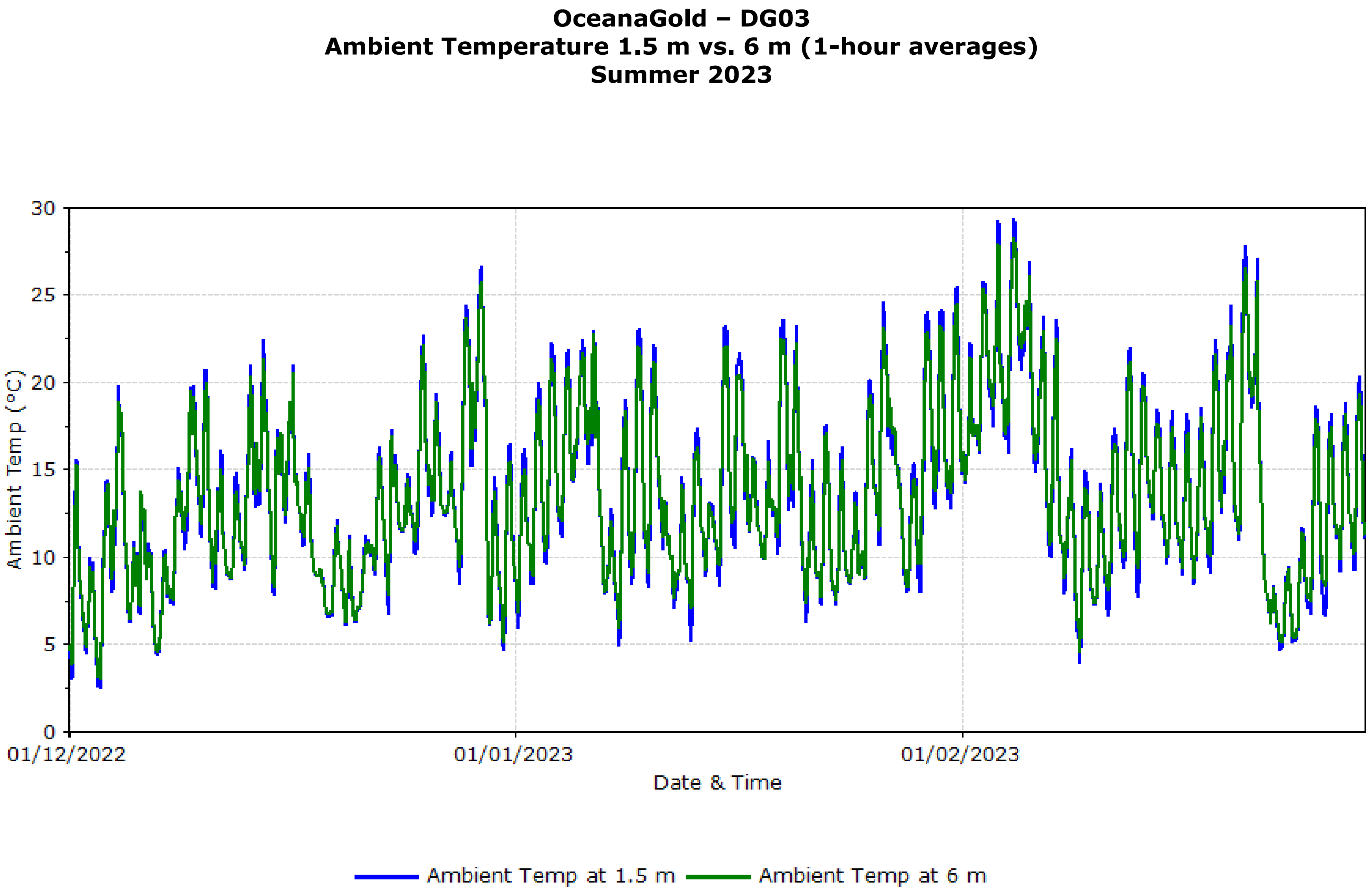

Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

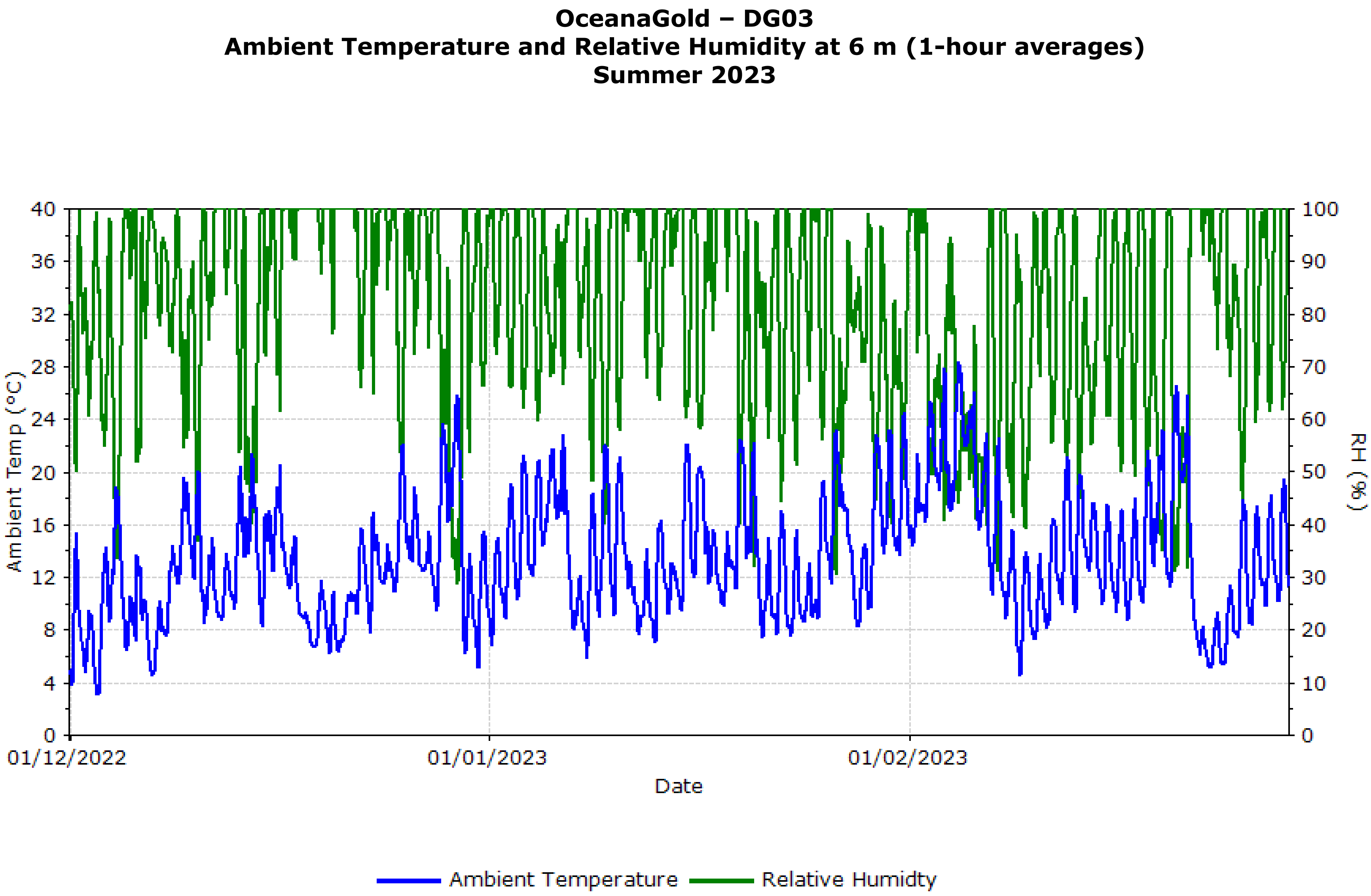

Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

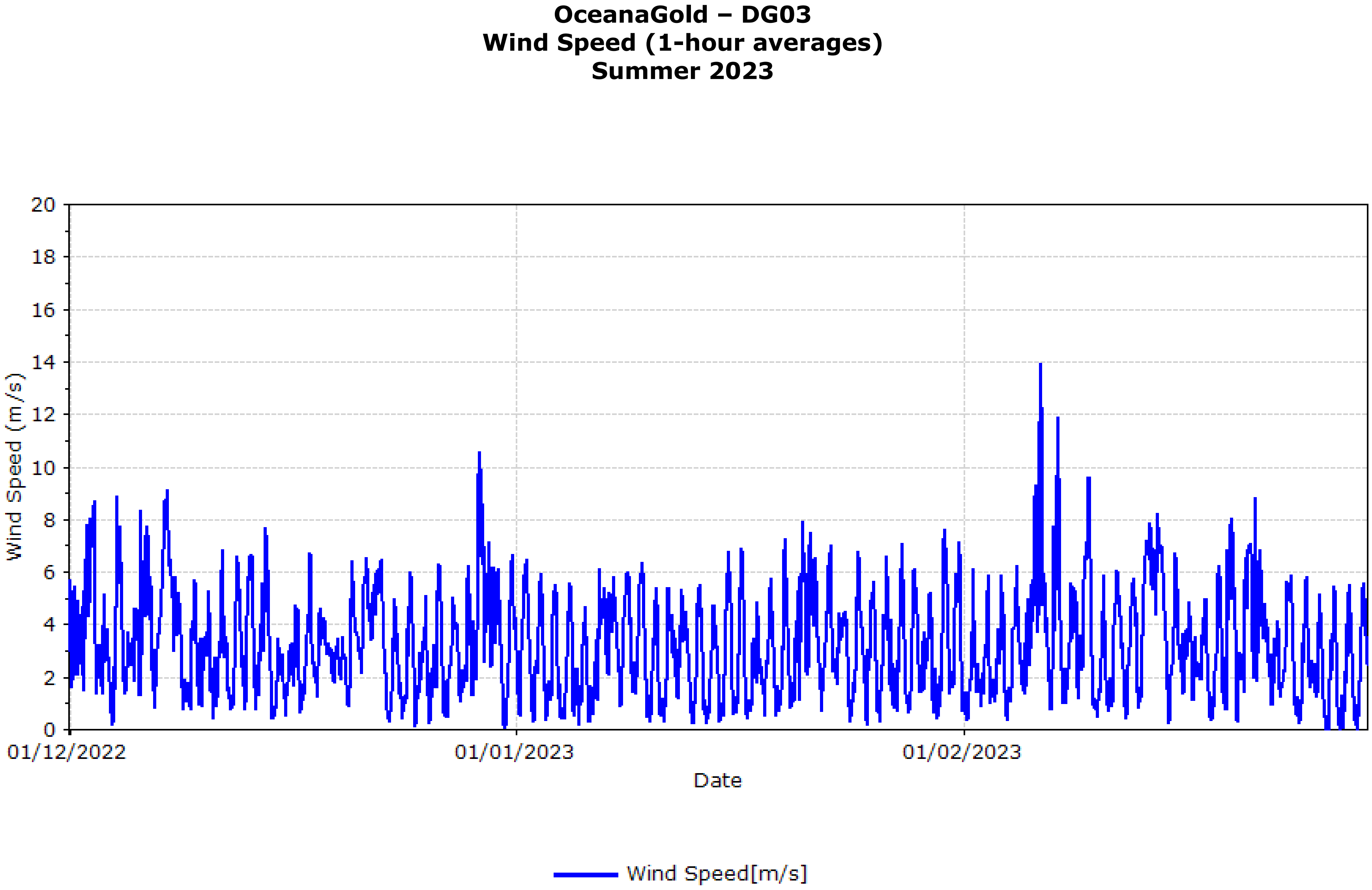

Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

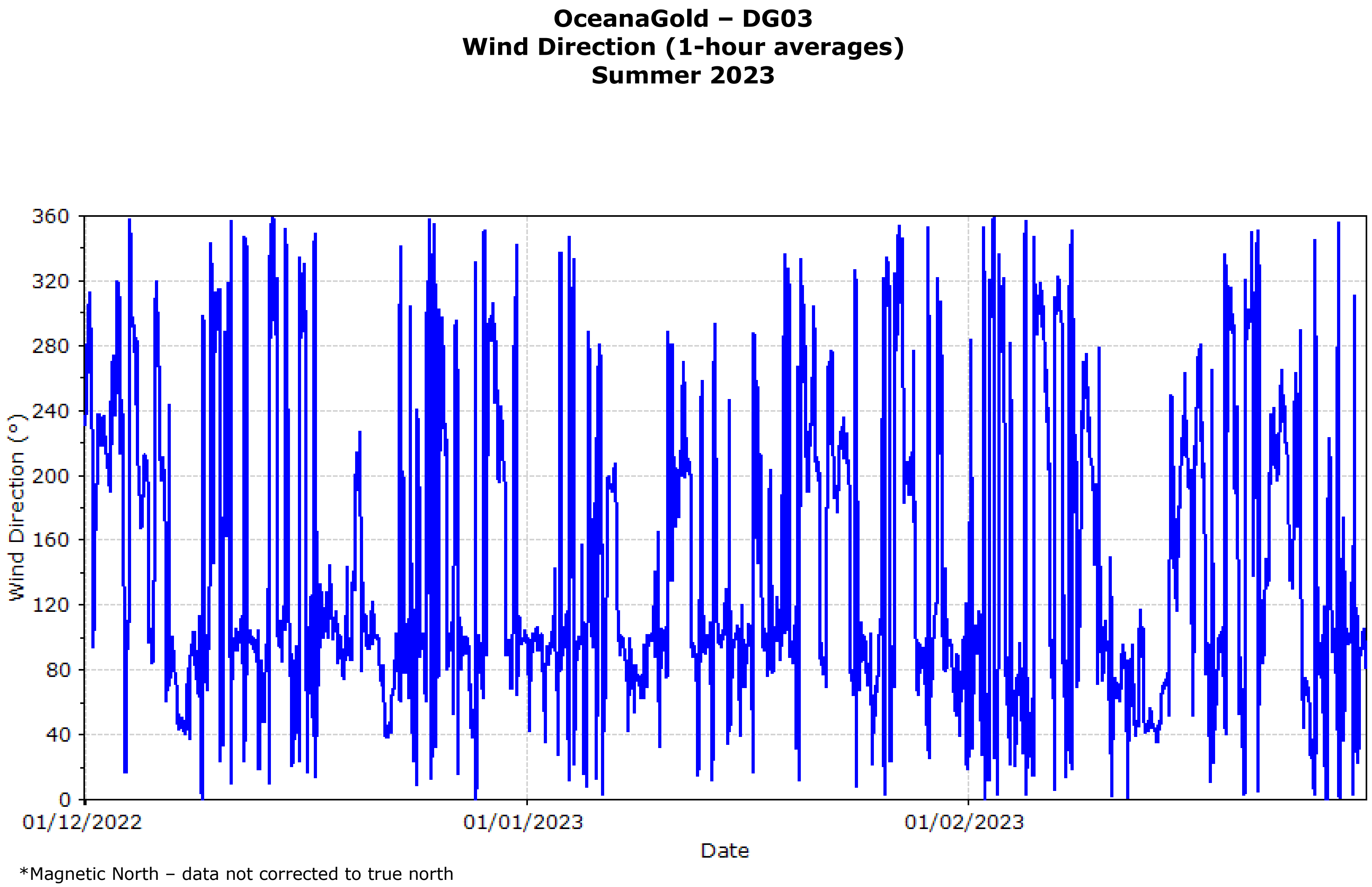

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

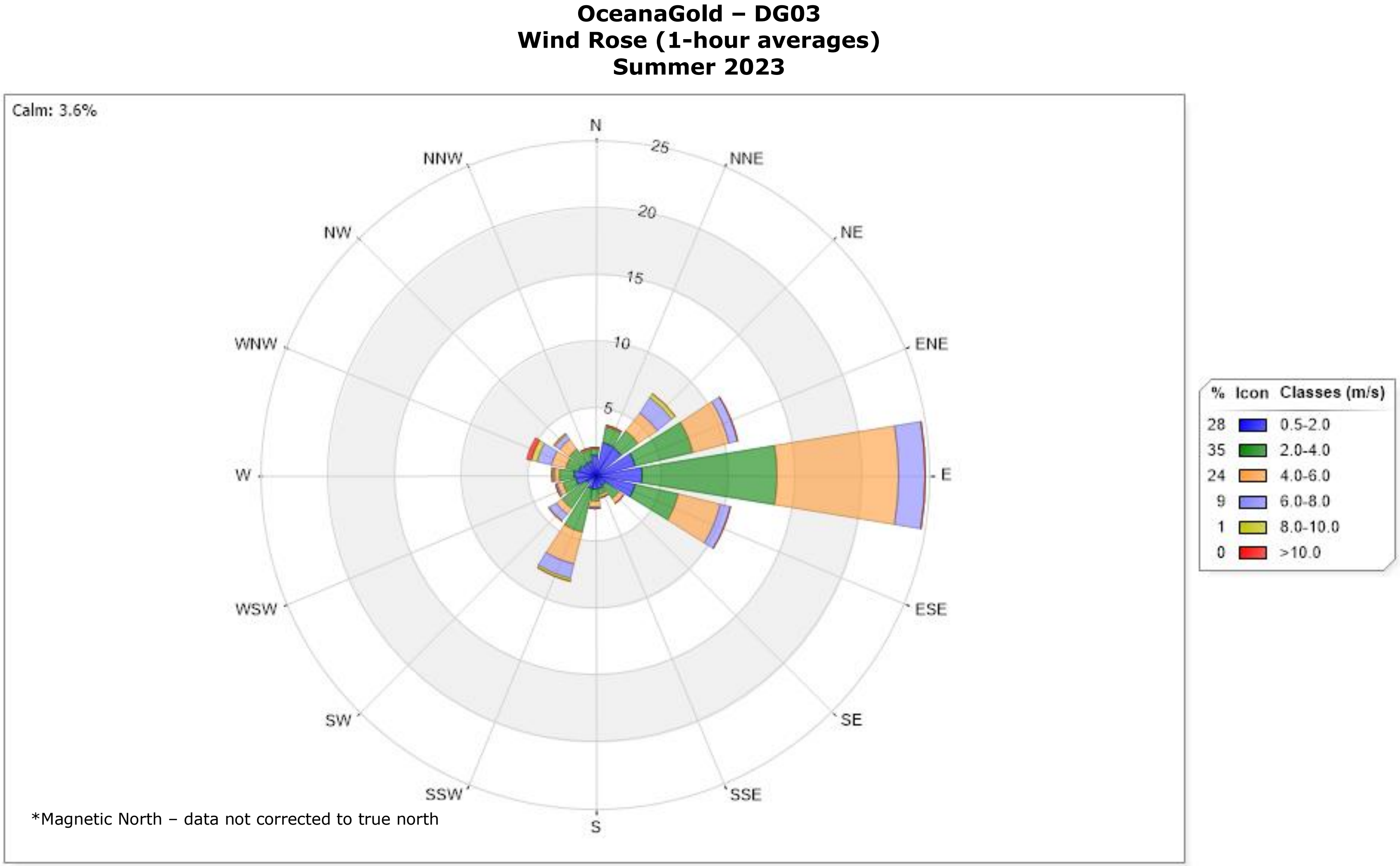

Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

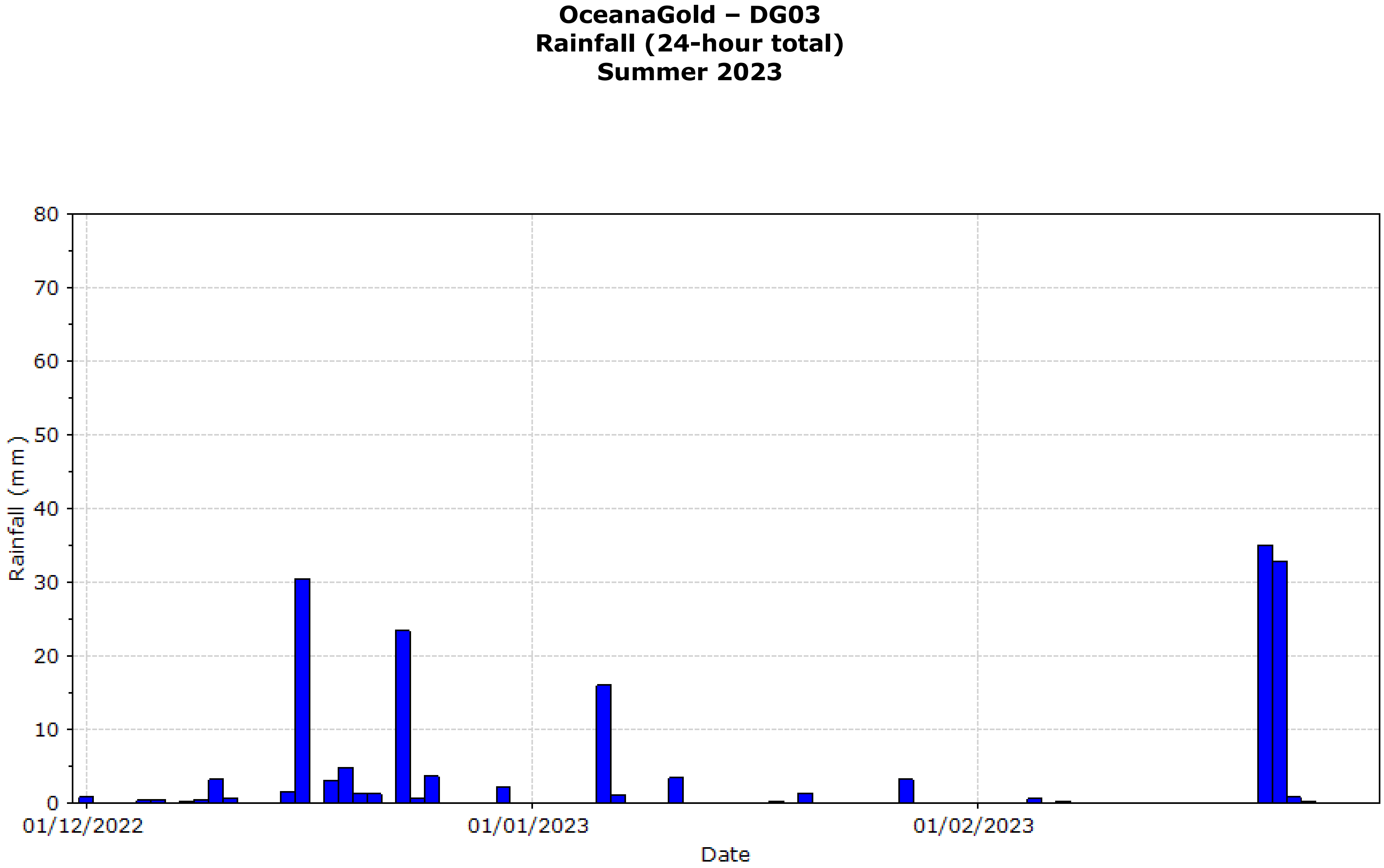

Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

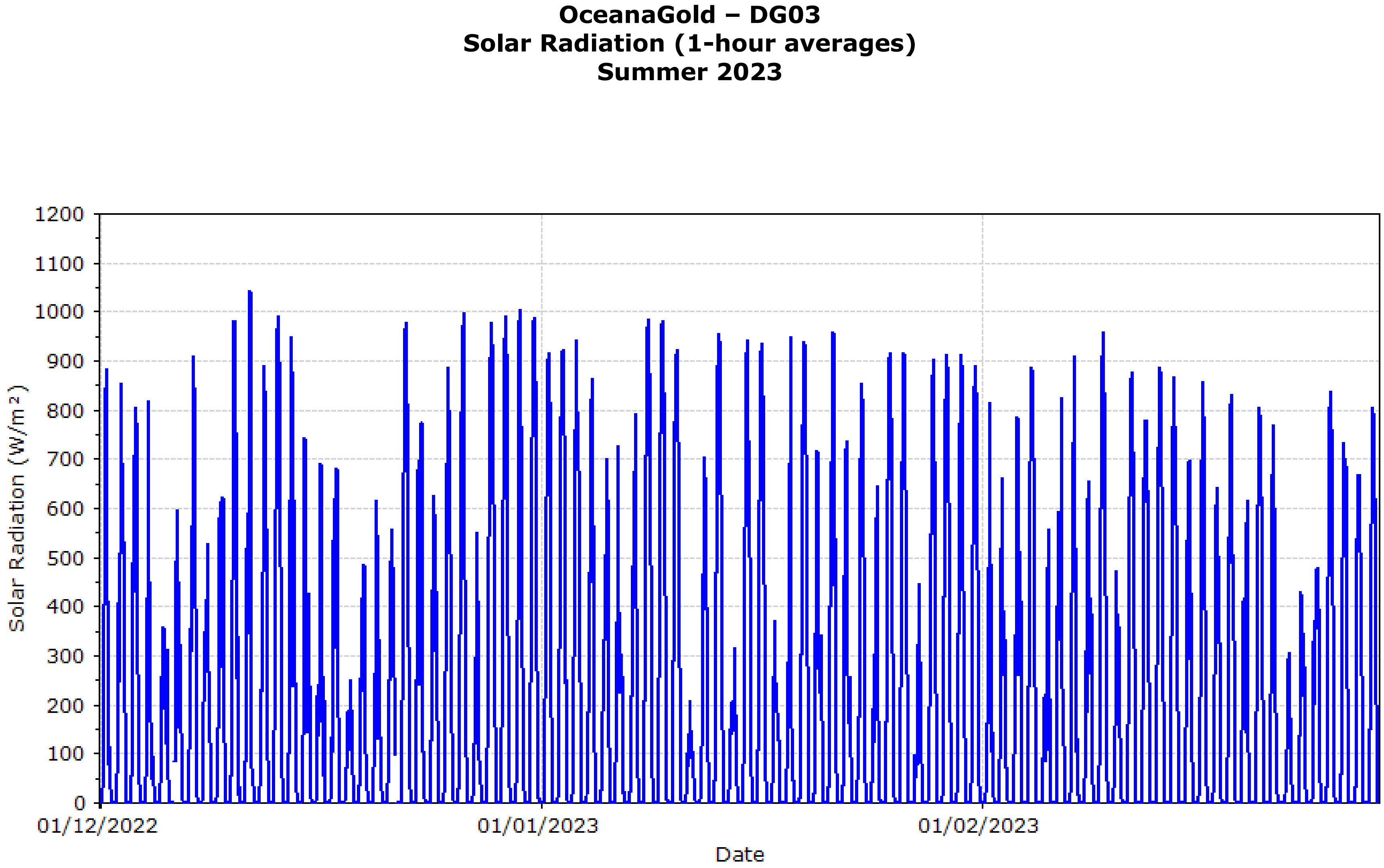

Figure 17: OceanaGold – DG03: Solar Radiation (1-hour averages)

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Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	15-12-21	2415	Callout	Installed	H MdAli
	19-04-22	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
	16-06-22	2415	Six-Monthly Maintenance	Parameter Check	B Kaushal
	14-09-22	2415	Quarterly Maintenance	Parameter Check	R Hodgkinson
	13-12-22	2415	Annual Maintenance	Audit Calibrations	R Hodgkinson
Temperature sensor – Campbell Scientific 107					
	19-04-22	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2418	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
Anemometer – Vector A101M					
	15-12-21	2417	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2417	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
Wind vane – Vector W200P					
	15-12-21	2416	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2416	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
Rain gauge – TB3-0.2/P					
	15-12-21	2419	Six-Monthly Maintenance	Parameter Check	H MdAli
	19-04-22	2419	Six-Monthly Maintenance	Parameter Check	J Abraham
	14-09-22	2419	Six-Monthly Maintenance	Parameter Check	R Hodgkinson

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Autumn 2023

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2023-097

Ambient Air Quality Monitoring
Quarterly Summary Report
Autumn 2023

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

15 June 2023

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

Watercare report number: AQ-2023-097
Watercare reference: 15-54681

Author

Kath McLeod
Senior Air Quality data Analyst
Data Management Team
Watercare Services Ltd

Peer Reviewer & Authoriser

Vilani Abeyratne
Ambient Data - Team Leader
Data Management Team
Watercare Services Ltd

Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Autumn 2023 (March 2023 to May 2023) showed:

At DG15:

- There were no exceedences of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 92%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 85 µg/m³ on 20 April 2023.
- There were higher (>250 µg/m³) TSP E-Sampler hourly concentrations from all directions direction except southeast, south and west to north.
- Elevated (>15 µg/m³) diurnal TSP hourly concentrations occurred from 01:00 to 04:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the north-northwest.

At DG03:

- Valid data captured for ambient temperature at 6 m, ambient temperature at 1.5 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%.
- The predominant wind direction was from the northwest.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Autumn 2023
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Autumn 2023.

Table 2: Site performance Autumn 2023

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	92	No valid data from 12/04/2023 09:10 to 19/04/2023 16:00 as the pump was not running.
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Autumn 2023. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there were no exceedences of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration was 85 µg/m³ on 20 April 2023. The 1-hour TSP concentrations greater than 250 µg/m³ (Figure 3) came from all direction except southeast, south and west to north (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred from 01:00 to 04:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
March 2023	0	6	74
April 2023	0	14	85
May 2023	0	6	67
Autumn 2023	**0**	**8**	**85 20/04/2023**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		Nil	
Wind direction (DG15)			
Hourly TSP >250 µg/m³		all except SE, S & W-N	
Diurnal variation			
Hourly Diurnal TSP >15 µg/m³		01:00 – 04:00	

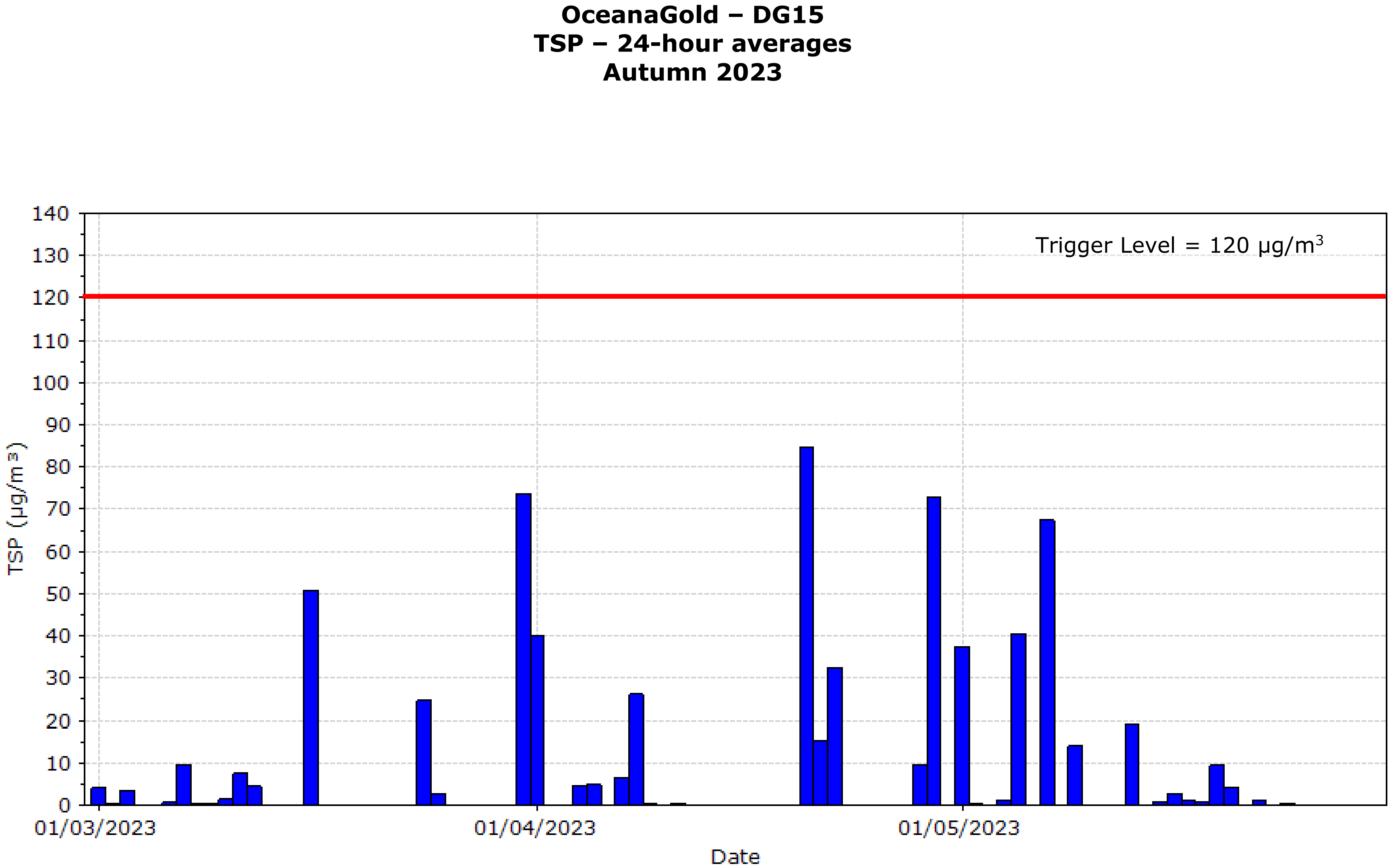

Figure 2: **OceanaGold – DG15: TSP E-Sampler (24-hour averages)**

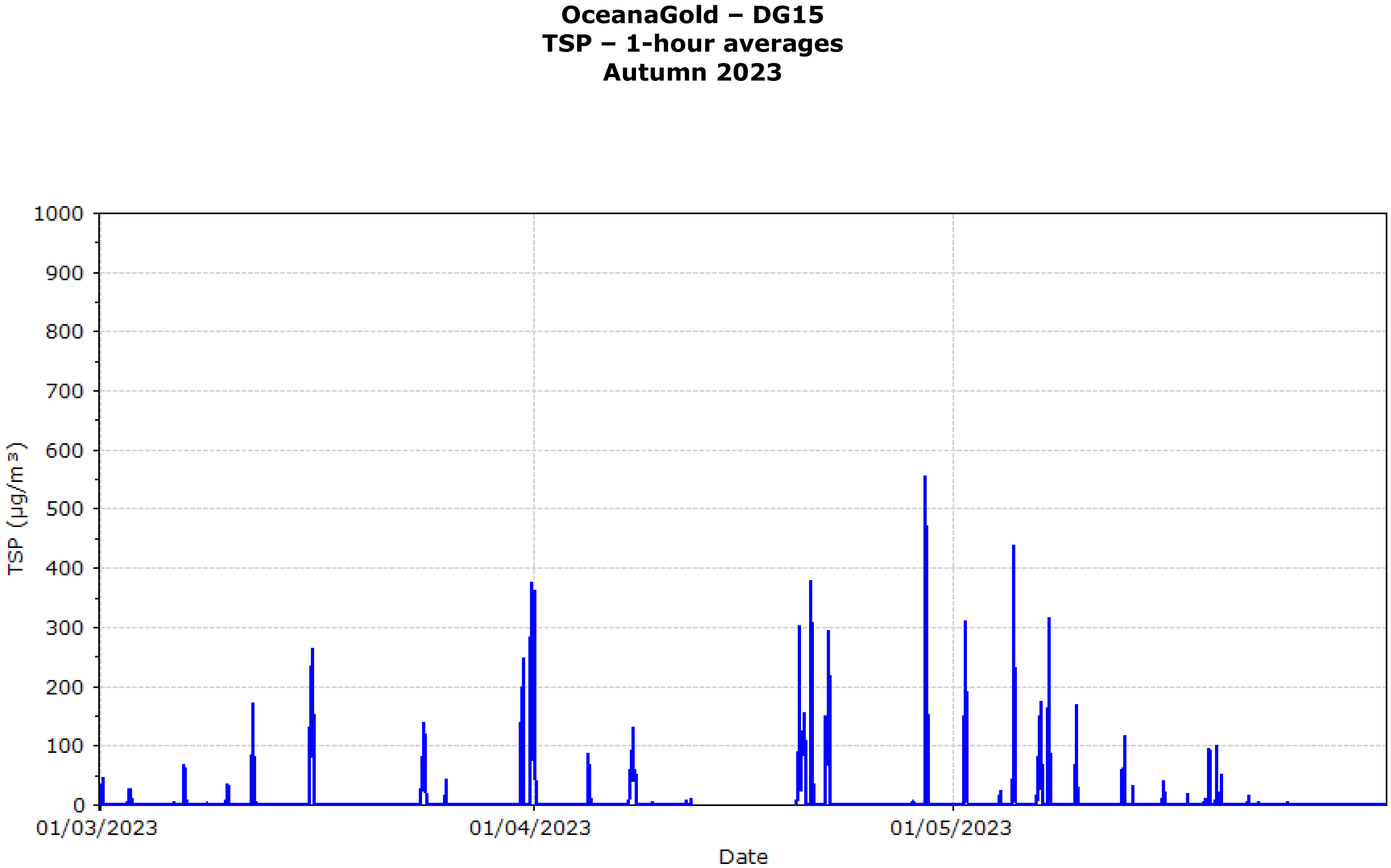

Figure 3: **OceanaGold – DG15: TSP E-Sampler (1-hour averages)**

OceanaGold – DG15

TSP Pollution Rose – 1-hour averages
Autumn 2023

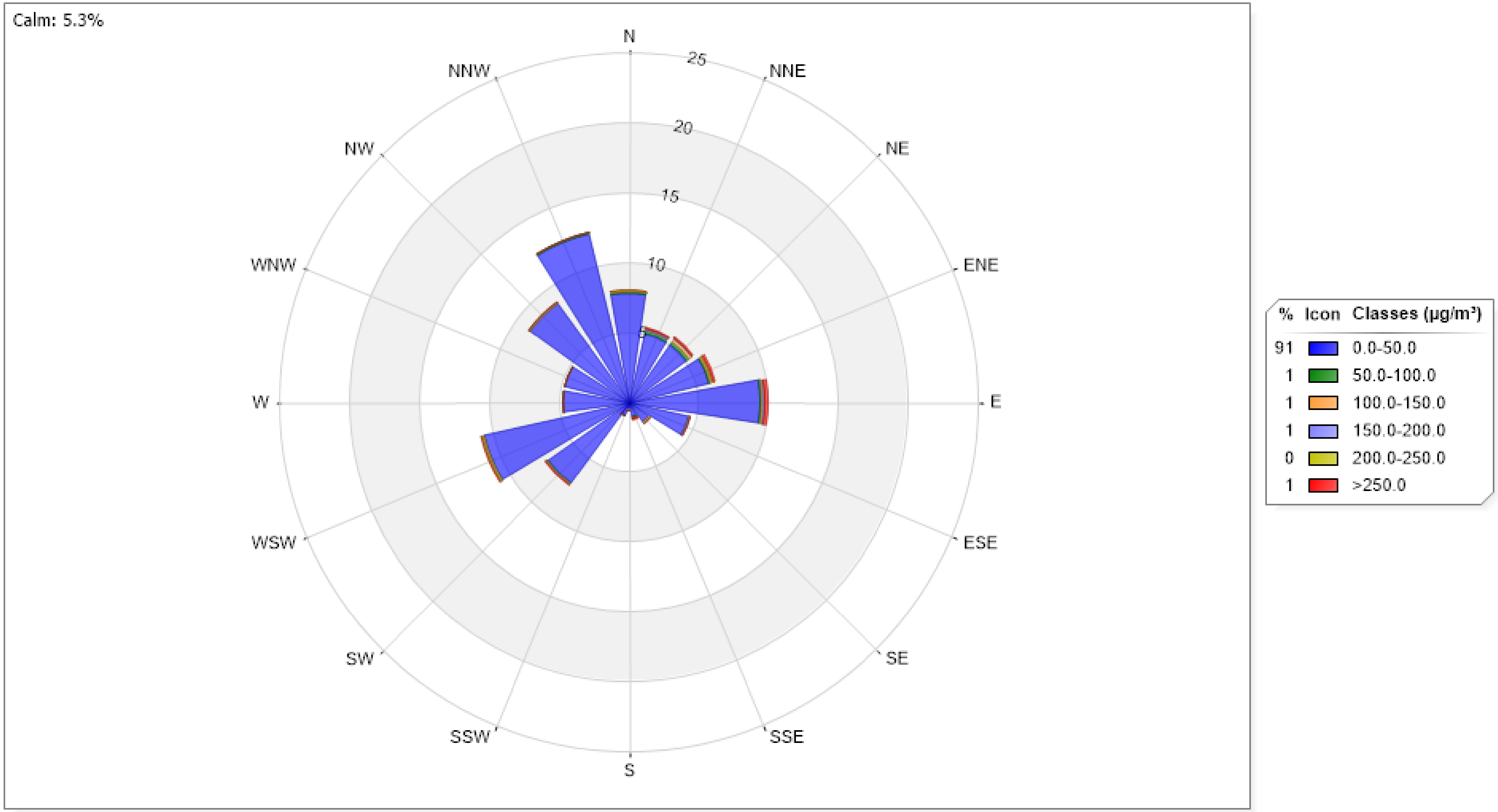

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

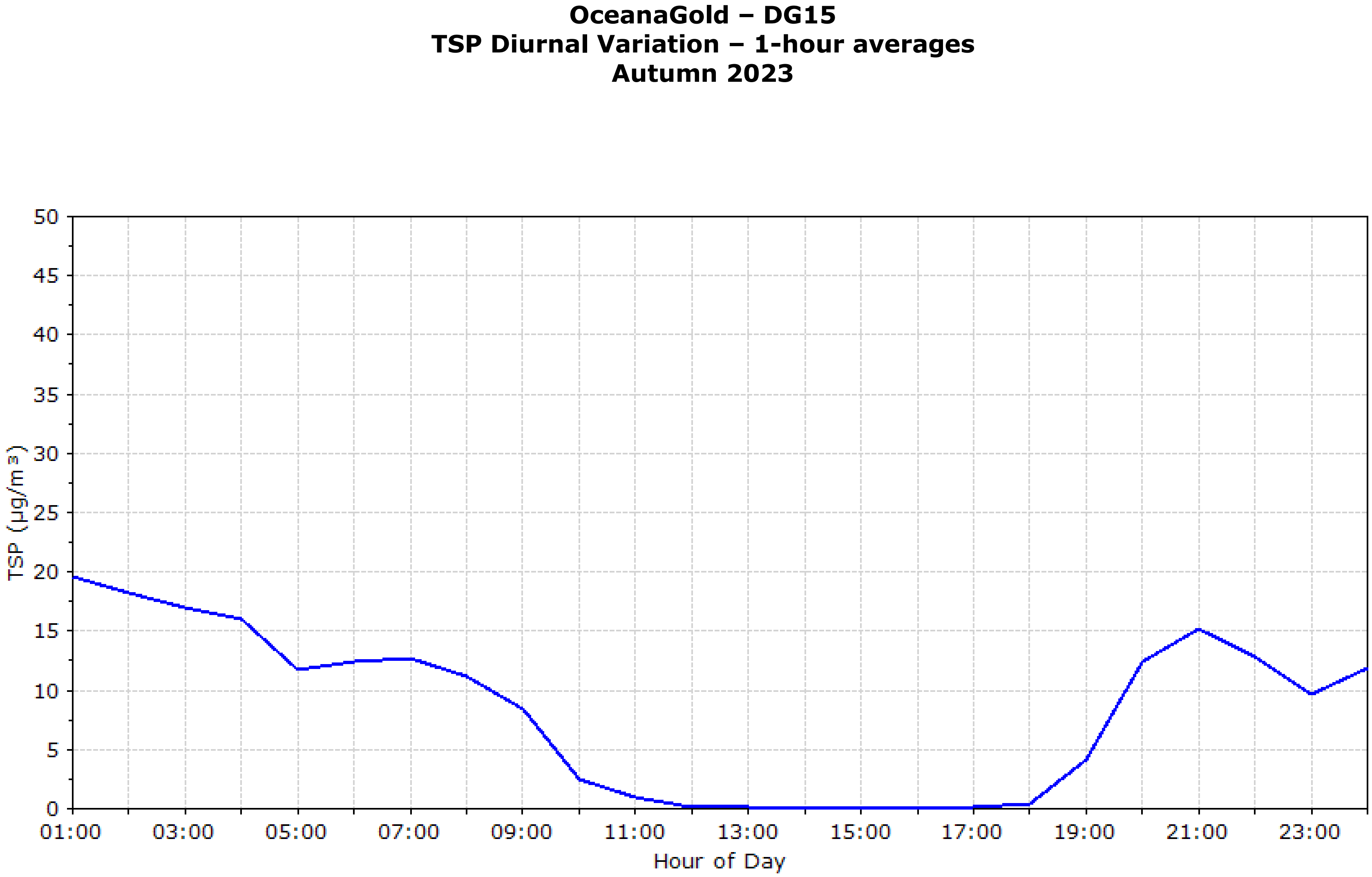

Figure 5: OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Autumn 2023 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	0.4	11.6	25.3
April 2023	-1.9	9.5	22.0
May 2023	-2.6	8.9	21.0
Autumn 2023	**-2.6 16/05/2023 05:00**	**10.0**	**25.3 08/03/2023 15:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	3.2	11.6	19.1
April 2023	4.6	9.5	16.1
May 2023	3.3	8.9	16.0
Autumn 2023	**3.2 30/03/2023**	**10.0**	**19.1 09/03/2023**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
March 2023	WSW	4.3	2.9	13.6
April 2023	NNW	7.1	2.6	11.9
May 2023	NNW	4.6	2.3	10.1
Autumn 2023	**NNW**	**5.3**	**2.6**	**13.6**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
March 2023	3.4	27.2	104.4	17
April 2023	1.9	25.0	55.8	13
May 2023	2.1	22.8	64.2	13
Autumn 2023	**2.4**	**27.2**	**224.4**	**43**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Autumn 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	130	50	4	0	0	0	184	8.3
NNE	92	22	2	0	0	0	116	5.3
NE	80	33	8	3	0	0	124	5.6
ENE	63	61	23	6	0	0	153	6.9
E	65	127	38	0	0	0	230	10.4
ESE	32	62	24	0	0	0	118	5.4
SE	24	18	2	0	0	0	44	2.0
SSE	27	11	1	0	0	0	39	1.8
S	14	4	0	0	0	0	18	0.8
SSW	18	5	1	0	0	0	24	1.1
SW	26	53	26	24	14	10	153	6.9
WSW	47	56	57	40	20	10	230	10.4
W	40	34	17	6	2	0	99	4.5
WNW	59	29	6	5	0	0	99	4.5
NW	83	78	25	5	0	0	191	8.7
NNW	137	107	21	4	0	0	269	**12.2**
All	**937**	**750**	**255**	**93**	**36**	**20**	**2091**	**95**
Calm	117						117	5.3

Table 8 shows the proportion of wind strengths at each wind direction. Stronger winds, greater than 8 m/s, were observed from the southwest to west-southwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the north-northwest.

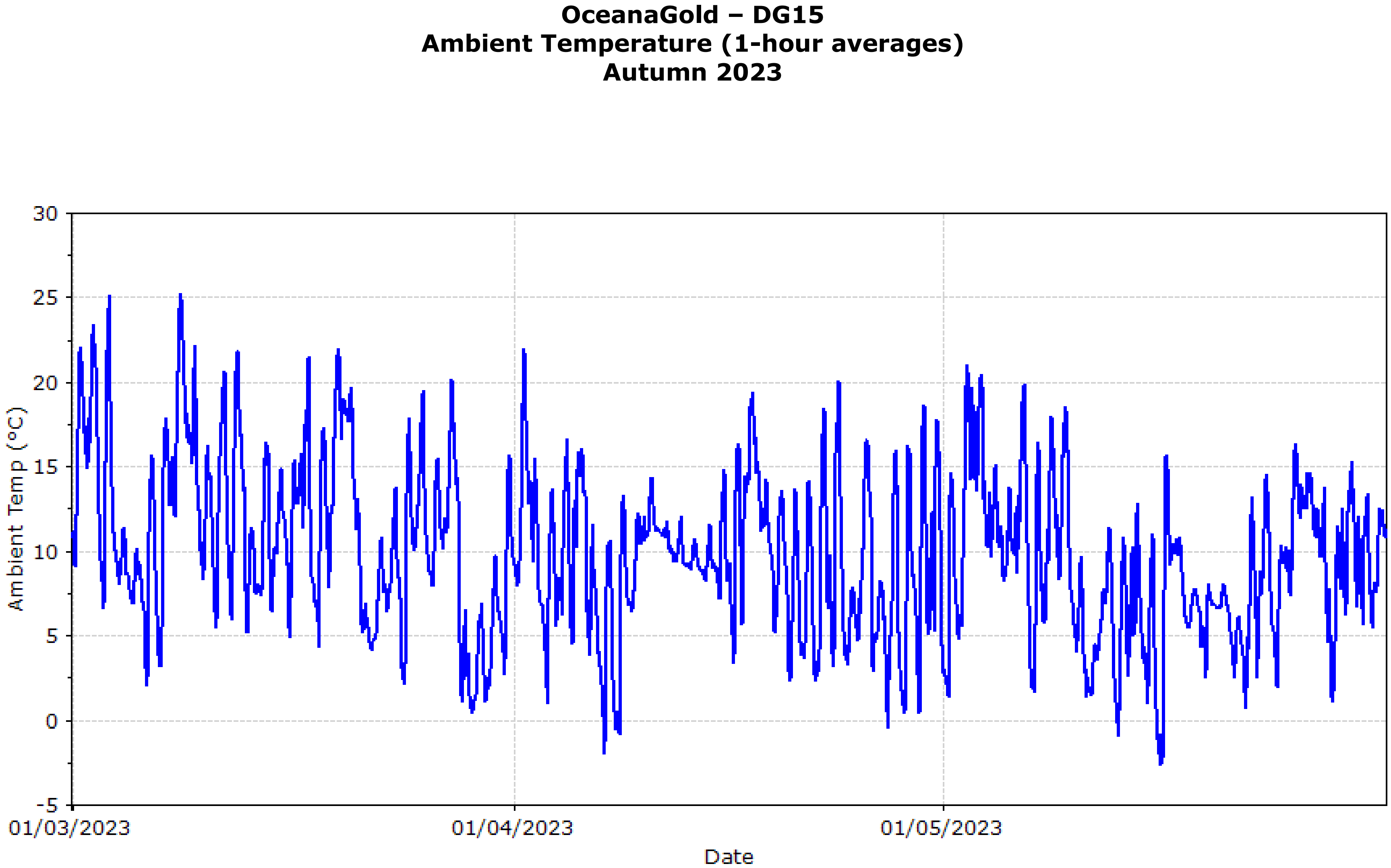

Figure 6: OceanaGold – DG15: Ambient Temperature (1-hour averages)

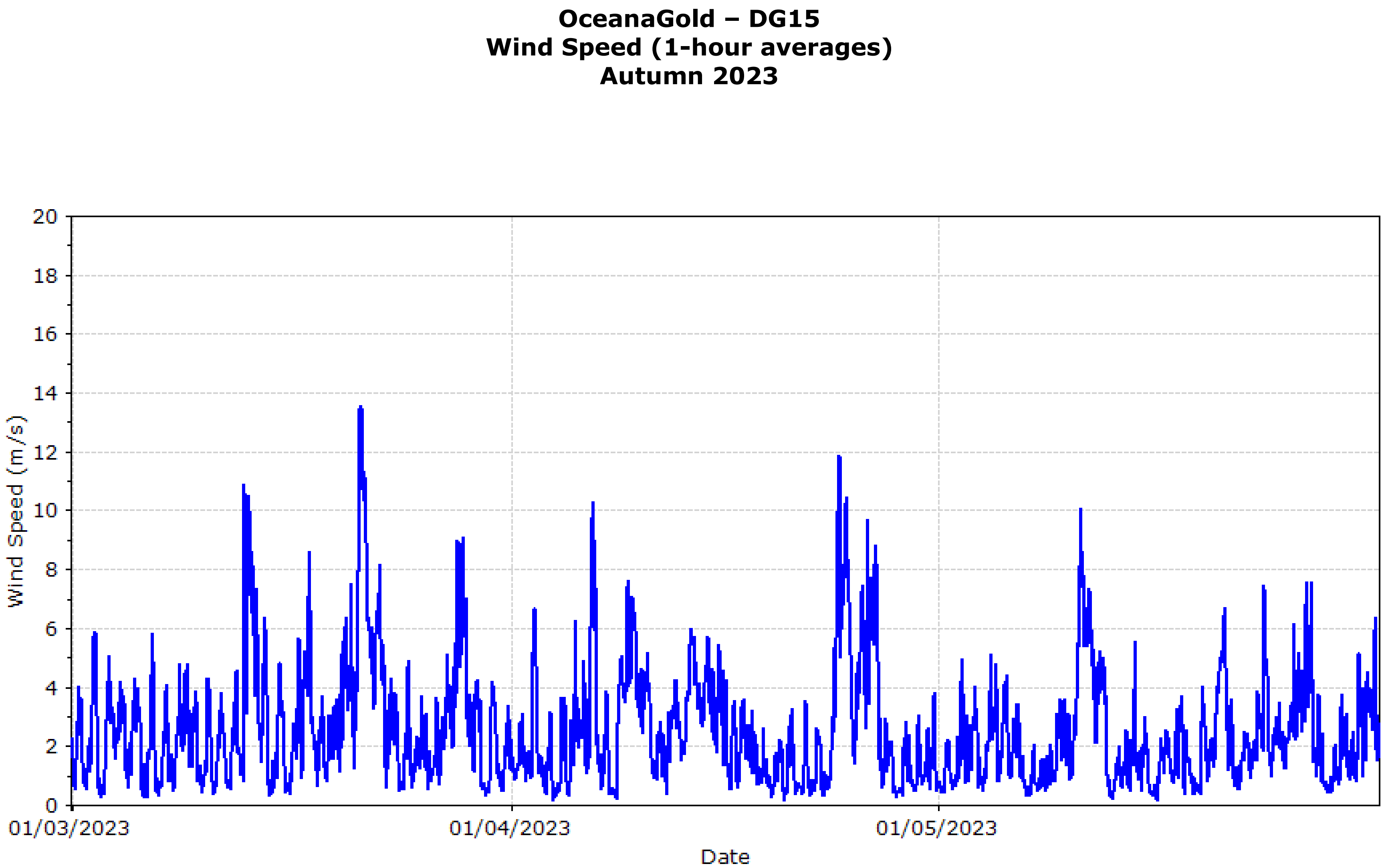

Figure 7: **OceanaGold – DG15: Wind Speed (1-hour averages)**

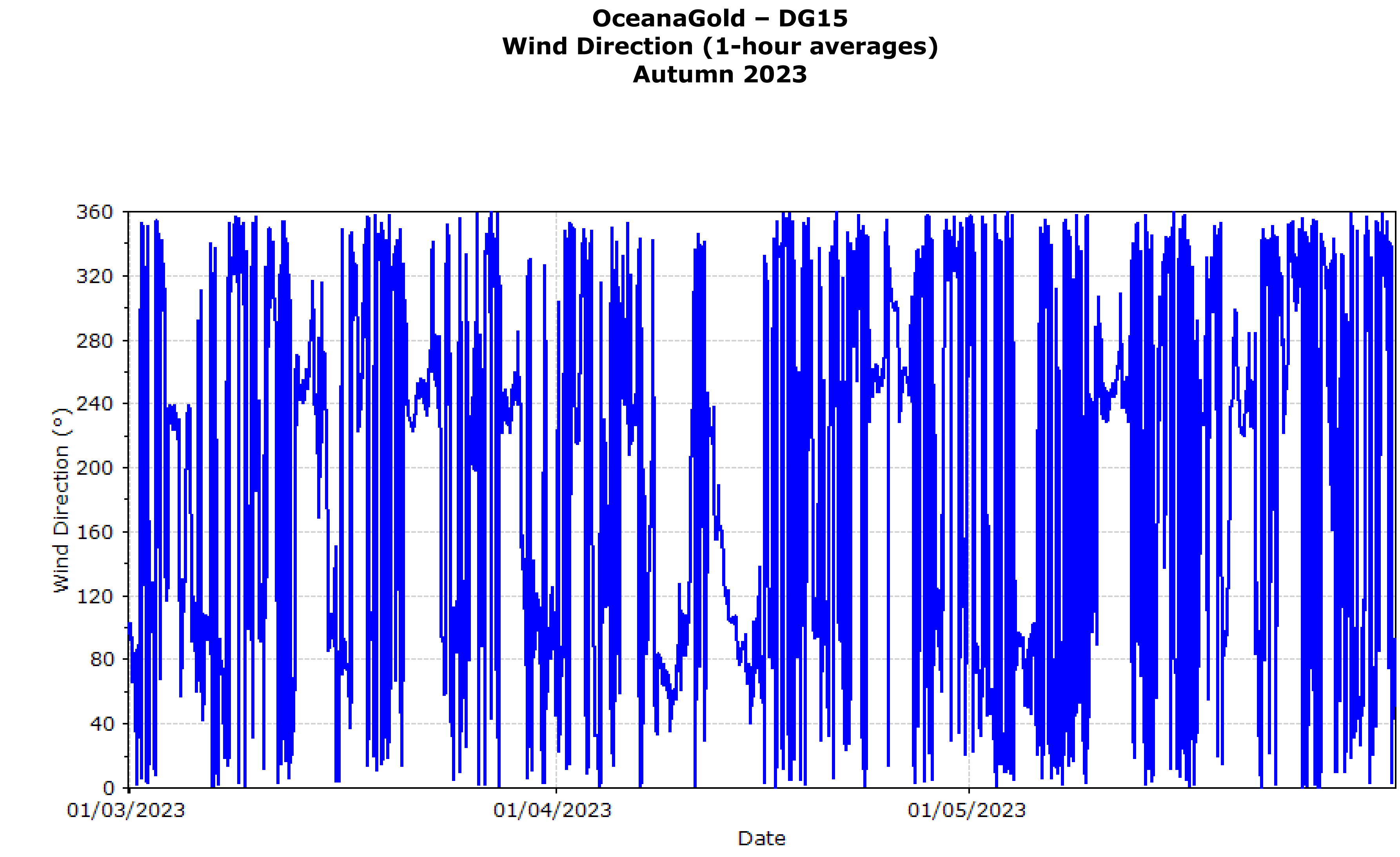

Figure 8: **OceanaGold – DG15: Wind Direction (1-hour averages)**

OceanaGold – DG15
Wind Rose (1-hour averages)
Autumn 2023

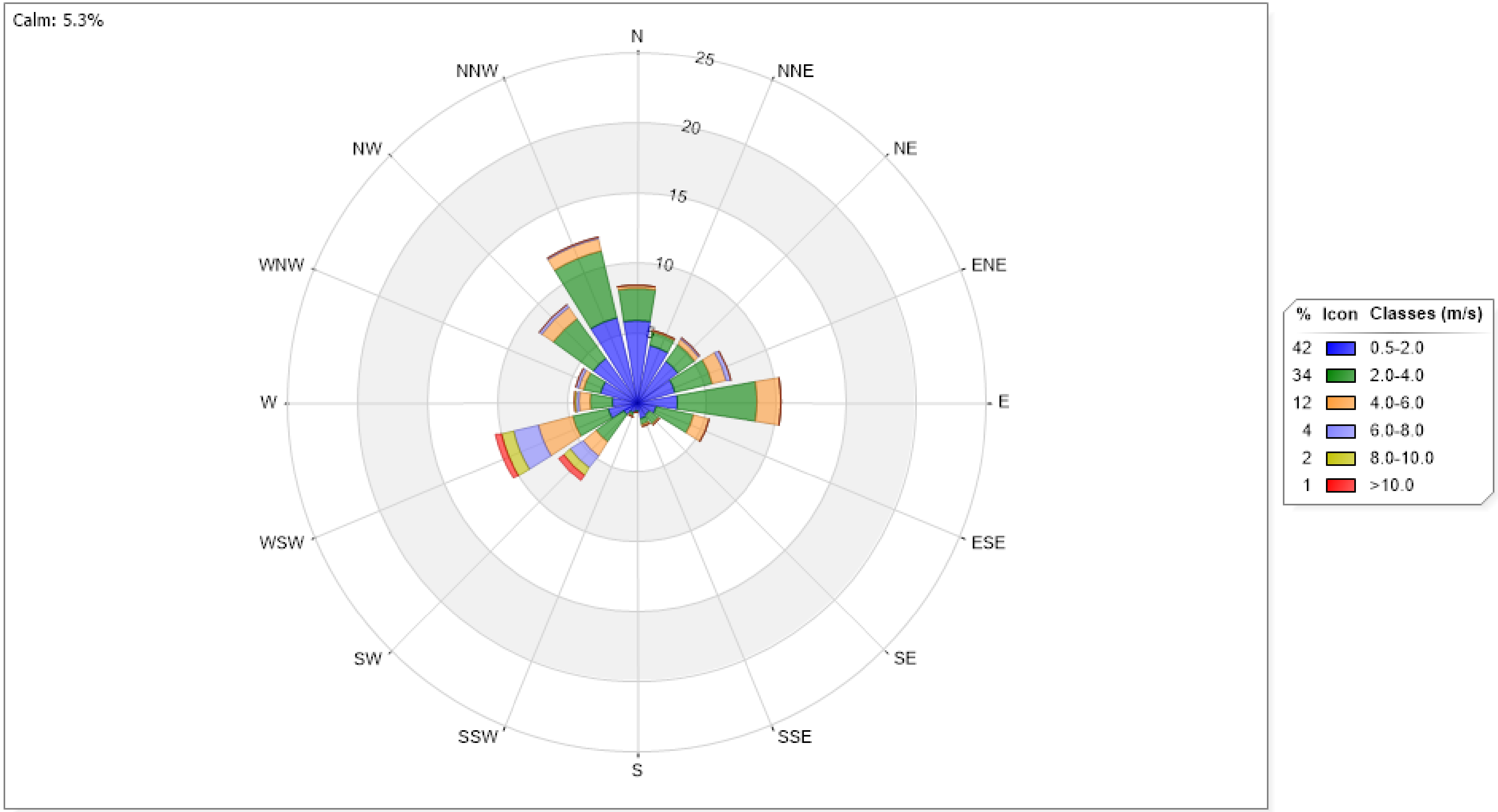

Figure 9: **OceanaGold – DG15: Wind Rose (1-hour averages)**

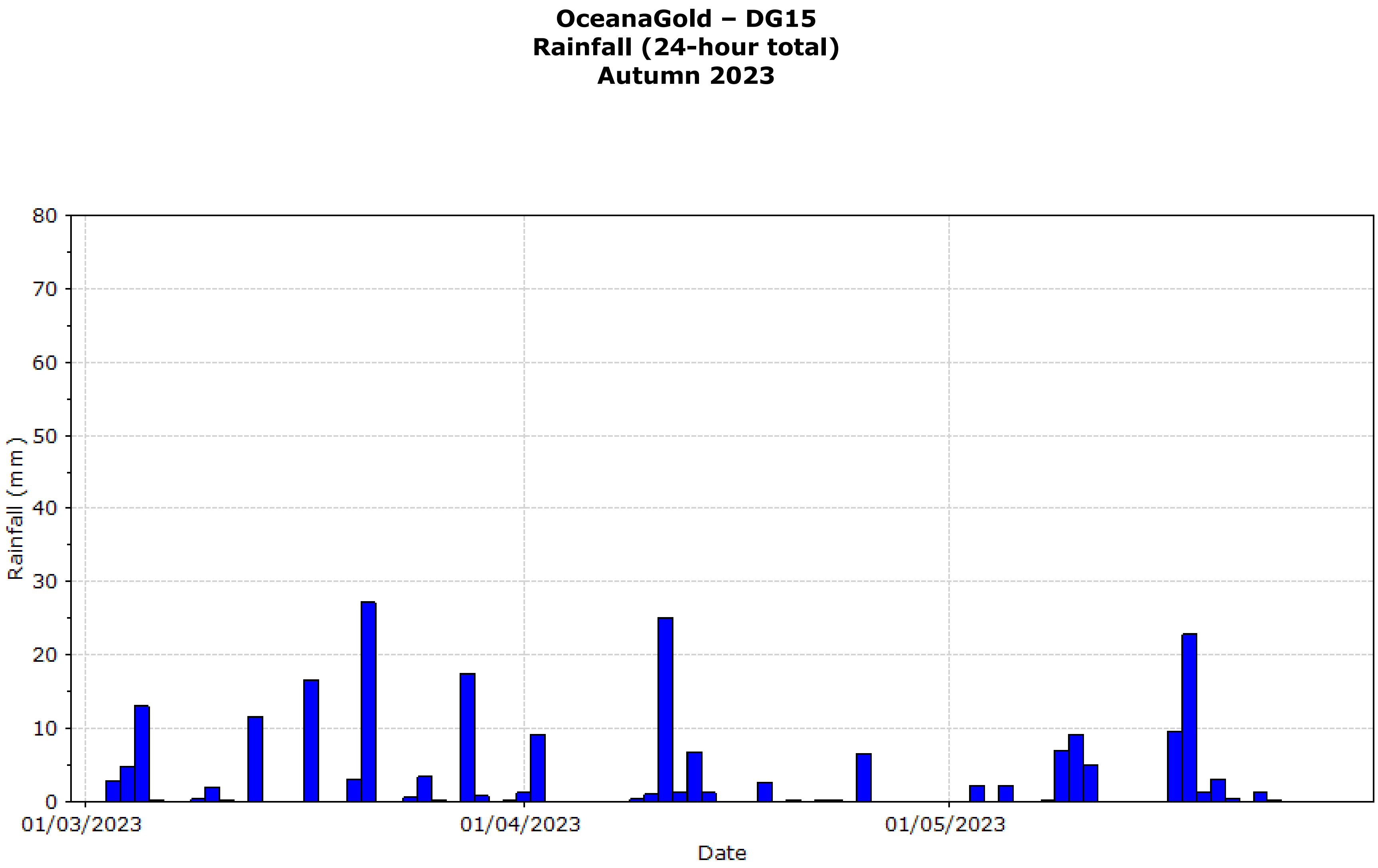

Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Autumn 2023 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	0.3	11.6	25.5
April 2023	0.7	9.8	21.9
May 2023	1.0	9.2	20.6
Autumn 2023	**0.3 29/03/2023 01:00**	**10.2**	**25.5 08/03/2023 14:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	0.6	11.8	24.6
April 2023	1.2	10.2	21.4
May 2023	1.1	9.7	20.8
Autumn 2023	**0.6 28/03/2023 24:00**	**10.6**	**24.6 08/03/2023 15:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
March 2023	30.8	80.0	100.0
April 2023	37.6	81.2	100.0
May 2023	42.7	79.2	100.0
Autumn 2023	**30.8**	**80.1**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	3.1	11.6	19.5
April 2023	4.9	9.8	15.6
May 2023	2.8	9.2	16.4
Autumn 2023	**2.8** **12/05/2023**	**10.2**	**19.5** **09/03/2023**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	3.2	11.8	19.7
April 2023	5.2	10.2	16.0
May 2023	3.0	9.7	17.2
Autumn 2023	**3.0** **12/05/2023**	**10.6**	**19.7** **09/03/2023**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
March 2023	54.0	80.0	96.5
April 2023	47.8	81.2	100.0
May 2023	56.6	79.2	100.0
Autumn 2023	**47.8**	**80.1**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)*	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
March 2023	E	4.2	3.7	15.3
April 2023	E	4.6	3.2	13.6
May 2023	NW	4.0	3.1	14.4
Autumn 2023	**NW**	**4.3**	**3.3**	**15.3**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
March 2023	3.8	33.2	118.0	17
April 2023	2.2	28.4	65.0	11
May 2023	2.4	27.4	73.4	13
Autumn 2023	**2.8**	**33.2**	**256.4**	**41**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m^2)	Average (W/m^2)	Maximum (W/m^2)
March 2023	39.3	147.2	256.7
April 2023	28.9	114.3	172.8
May 2023	18.3	63.2	112.7
Autumn 2023	**18.3 21/05/2023**	**108.2**	**256.7 07/03/2023**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Autumn 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	44	40	6	1	0	0	91	4.1
NNE	55	44	5	2	0	0	106	4.8
NE	61	52	17	15	8	0	153	6.9
ENE	76	71	34	1	0	0	182	8.3
E	57	125	53	7	0	0	242	11.0
ESE	36	35	13	2	0	0	86	3.9
SE	22	13	5	0	0	0	40	1.8
SSE	23	6	1	0	0	0	30	1.4
S	20	7	1	0	0	0	28	1.3
SSW	30	46	30	16	14	10	146	6.6
SW	12	60	73	47	12	7	211	9.6
WSW	29	38	6	2	0	0	75	3.4
W	49	32	6	3	0	0	90	4.1
WNW	46	68	40	28	16	20	218	9.9
NW	44	86	81	34	12	9	266	**12.0**
NNW	46	65	28	10	1	0	150	6.8
All	**650**	**788**	**399**	**168**	**63**	**46**	**2114**	**96**
Calm	94						94	4.3

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from south-southwest to southwest and from west-northwest to northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the northwest.

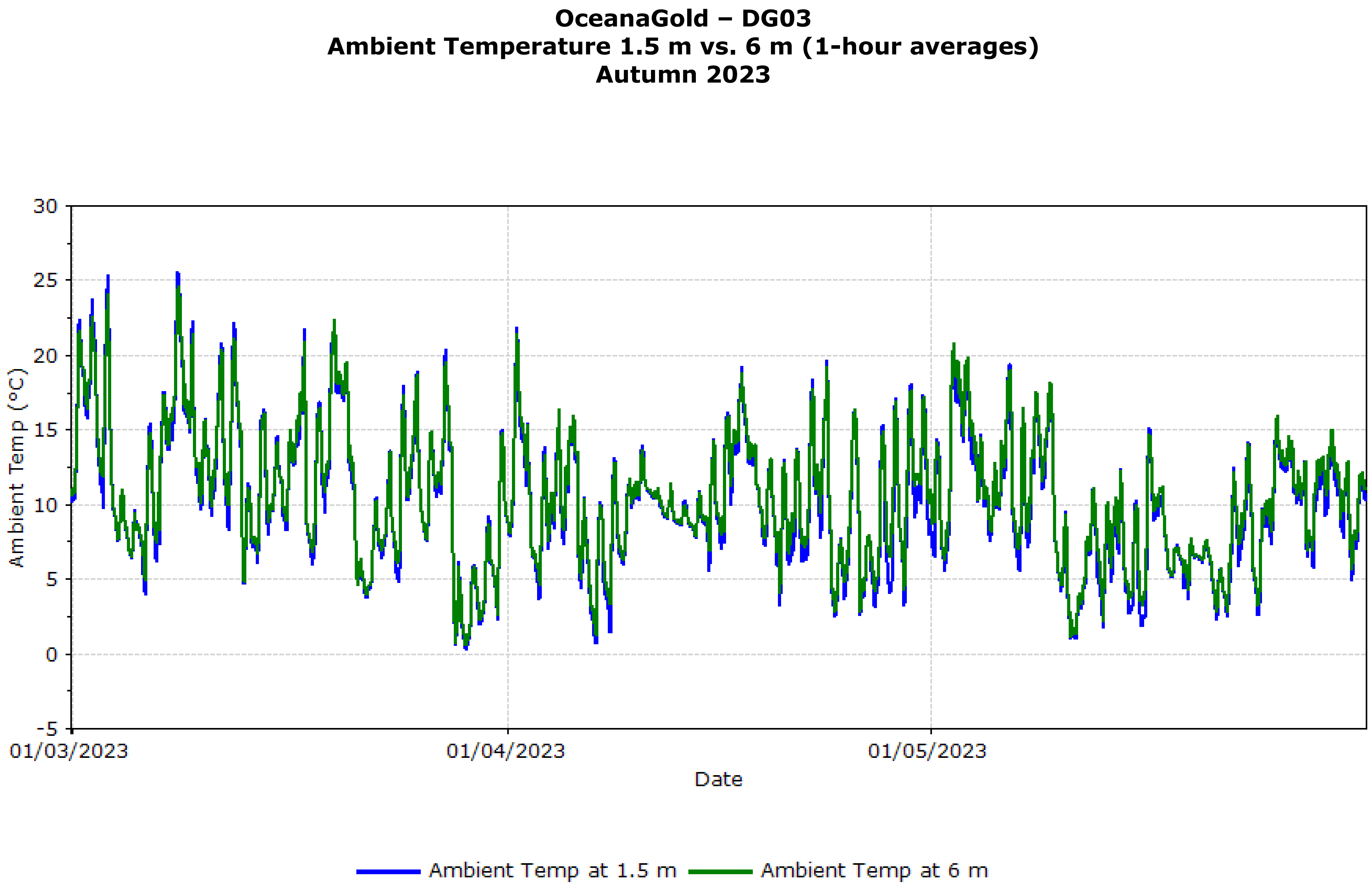

Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

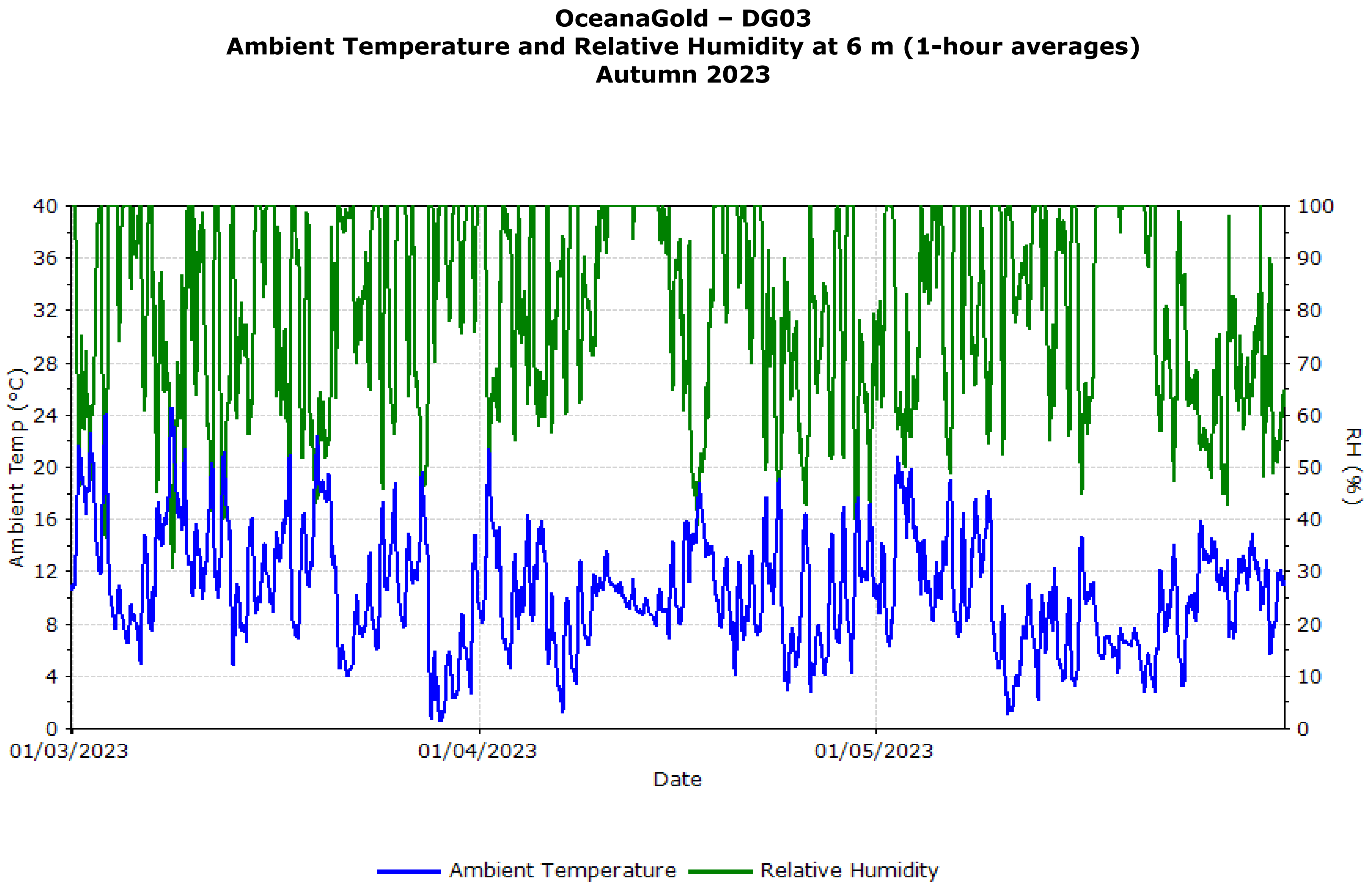

Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

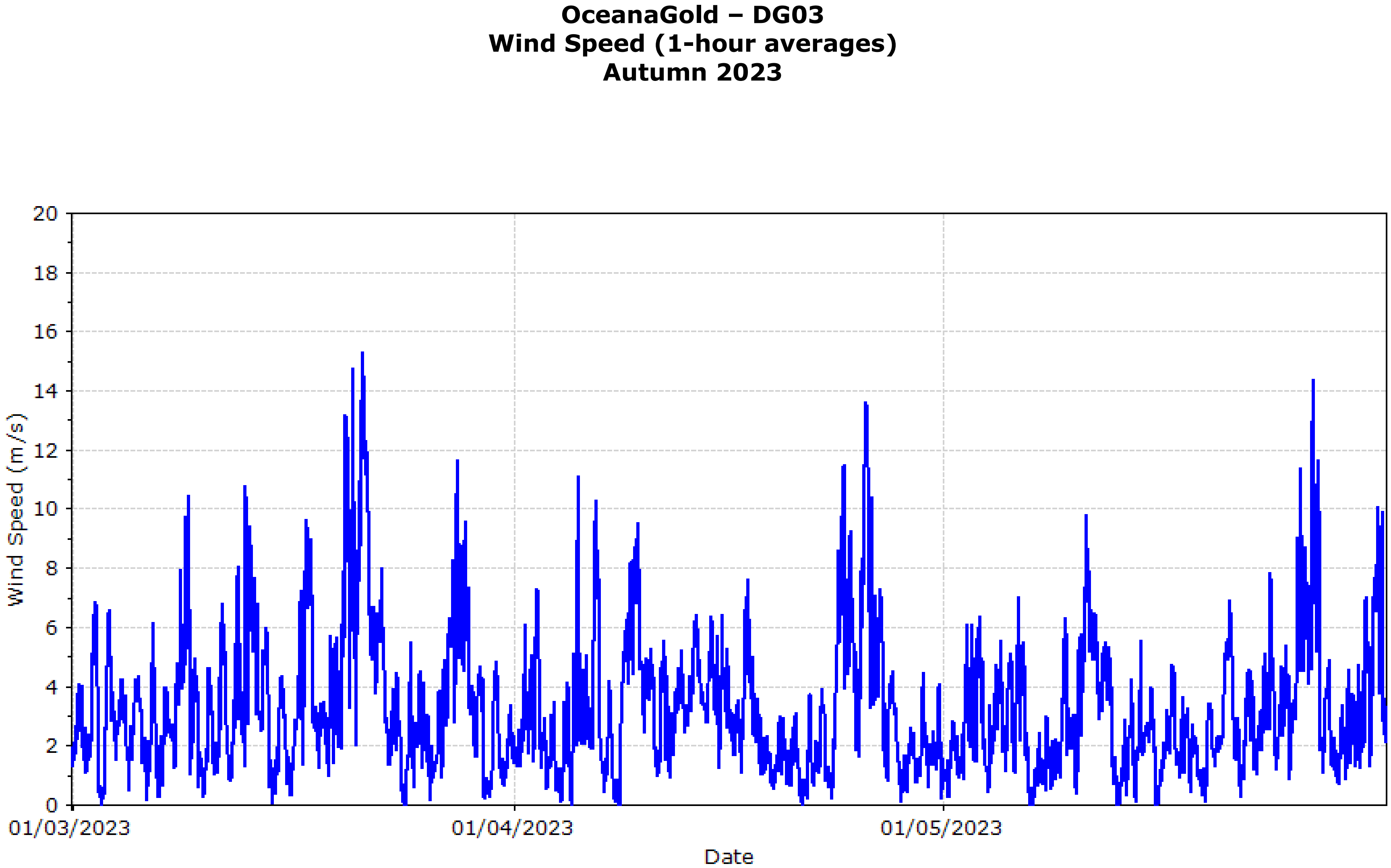

Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

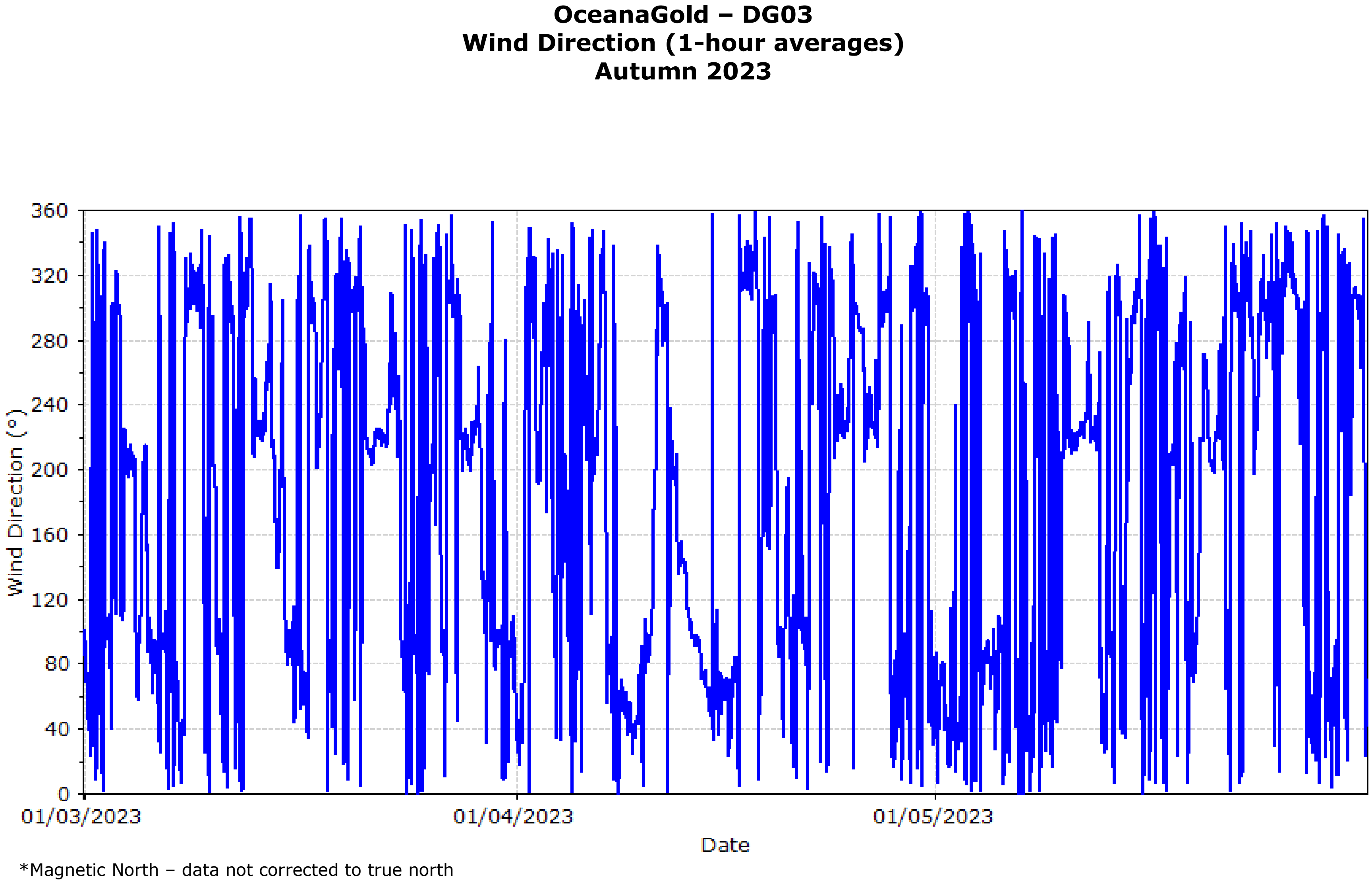

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

OceanaGold – DG03
Wind Rose (1-hour averages)
Autumn 2023

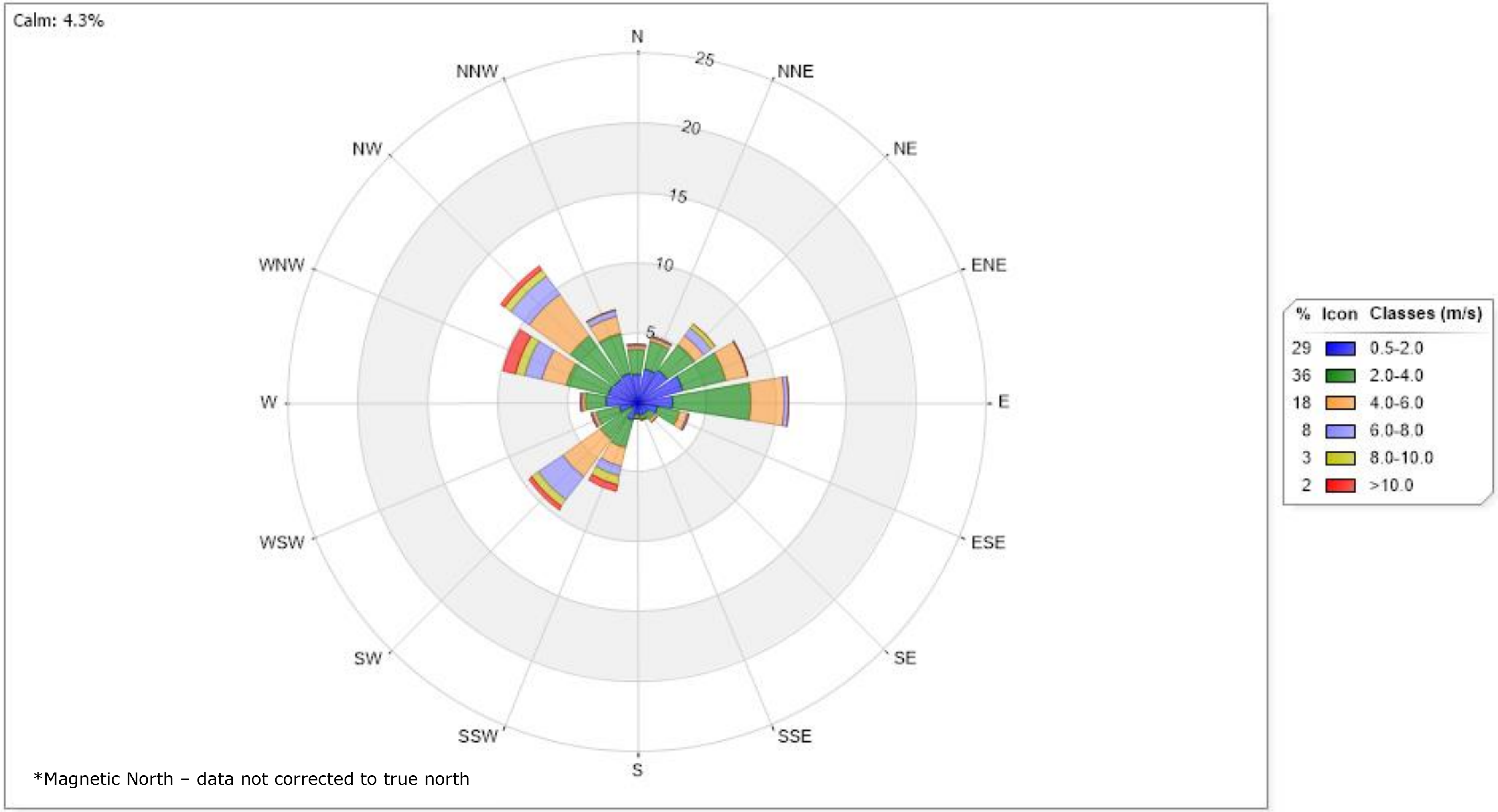

Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

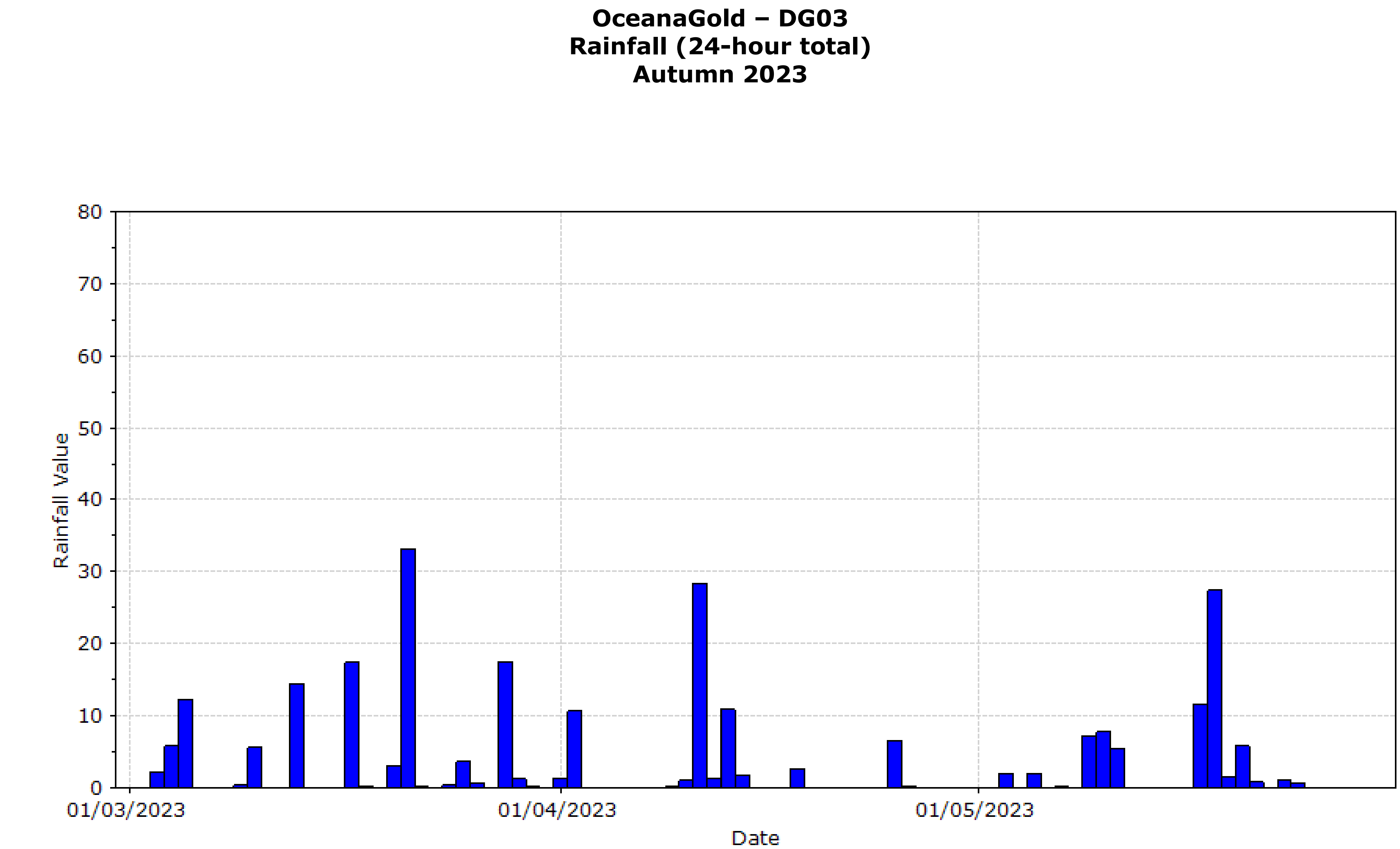

Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

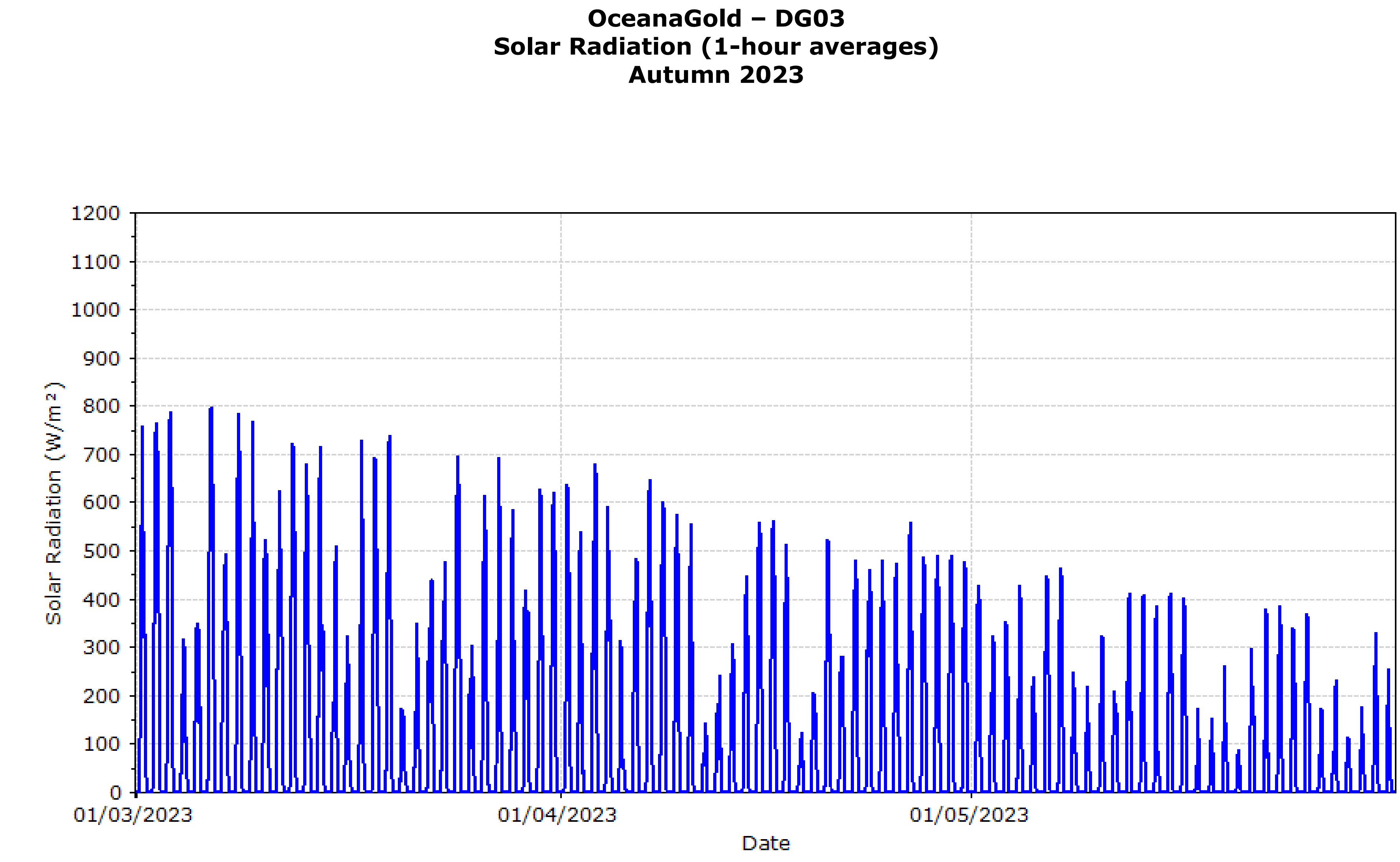

Figure 17: OceanaGold – DG03: Solar Radiation (1-hour averages)

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Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	16-06-22	2415	Six-Monthly Maintenance	Parameter Check	B Kaushal
	14-09-22	2415	Quarterly Maintenance	Parameter Check	R Hodgkinson
	13-12-22	2415	Annual Maintenance	Audit Calibrations	R Hodgkinson
	23-03-23	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
	19-04-23	2415	Maintenance & Repair	Callout	J Abraham
Temperature sensor – Campbell Scientific 107					
	14-09-22	2418	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
Anemometer – Vector A101M					
	14-09-22	2417	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
Wind vane – Vector W200P					
	14-09-22	2416	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
Rain gauge – TB3-0.2/P					
	14-09-22	2419	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2419	Six-Monthly Maintenance	Parameter Check	J Abraham

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Winter 2023

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2023-172

Ambient Air Quality Monitoring
Quarterly Summary Report
Winter 2023

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

15 June 2023

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

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Watercare reference: 15-54681

Author

Kath McLeod
Senior Air Quality data Analyst
Data Management Team
Watercare Services Ltd

Peer Reviewer & Authoriser

Vilani Abeyratne
Ambient Data - Team Leader
Data Management Team
Watercare Services Ltd

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Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Winter 2023 (June 2023 to August 2023) showed:

At DG15:

- There were no exceedences of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 100%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 87 µg/m³ on 09 July 2023.
- There were higher (>250 µg/m³) TSP E-Sampler hourly concentrations from north to east-northeast, east-southeast, south and west-northwest.
- Elevated (>15 µg/m³) diurnal TSP hourly concentrations occurred at 21:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the west-southwest.

At DG03:

- Valid data captured for ambient temperature at 6 m, ambient temperature at 1.5 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%.
- The predominant wind direction was from the southwest.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Winter 2023
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Winter 2023.

Table 2: Site performance Winter 2023

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	100	-
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Winter 2023. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there were no exceedences of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration was 87 µg/m³ on 09 July 2023. The 1-hour TSP concentrations greater than 250 µg/m³ (Figure 3) came from north to east-northeast, east-southeast, south and west-northwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred at 21:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
June 2023	0	7	68
July 2023	0	7	87
August 2023	0	1	7
Winter 2023	**0**	**5**	**87 09/07/2023**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		Nil	
Wind direction (DG15)			
Hourly TSP >250 µg/m³		N-ENE, ESE, S, WNW	
Diurnal variation			
Hourly Diurnal TSP >15 µg/m³		21:00	

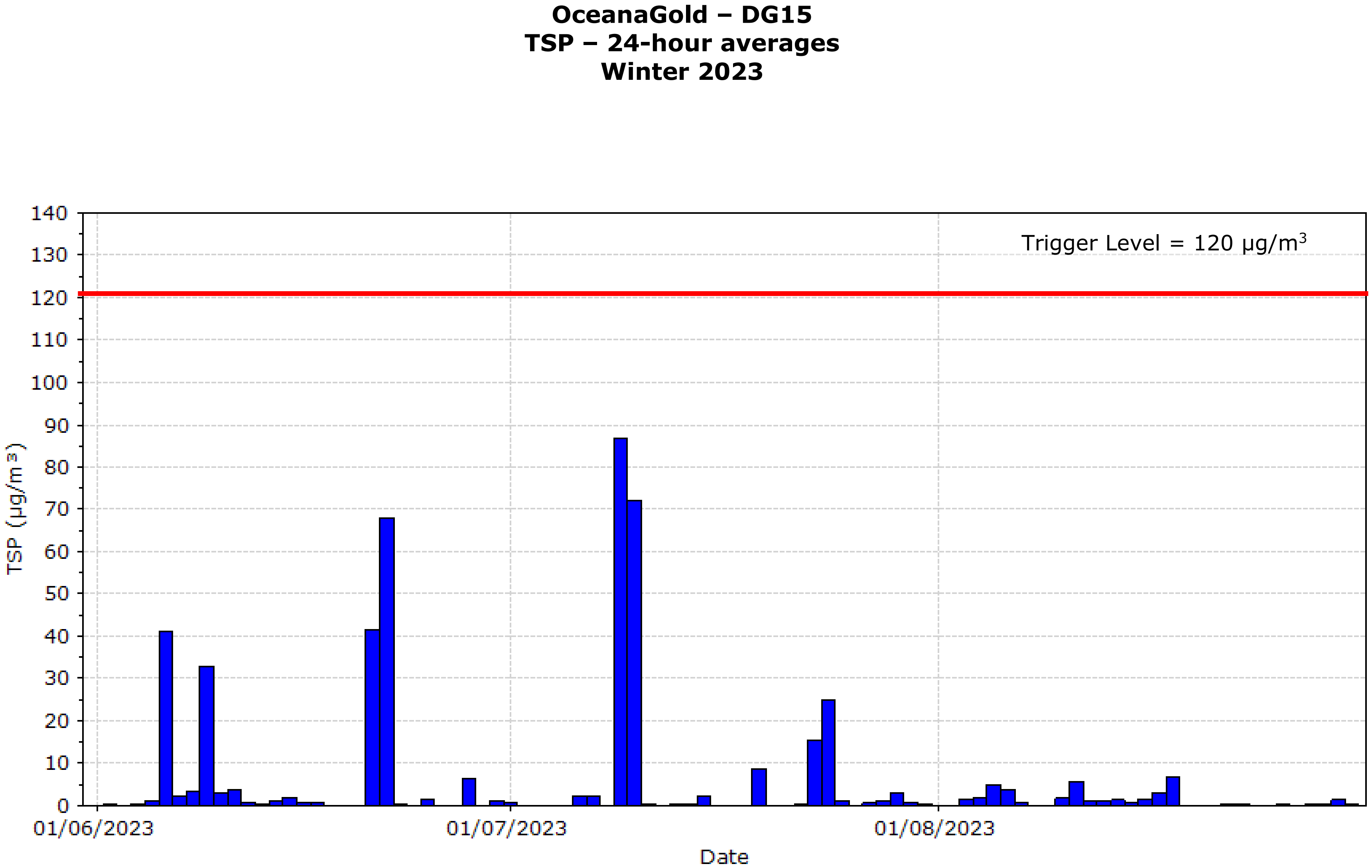


Figure 2: **OceanaGold – DG15: TSP E-Sampler (24-hour averages)**

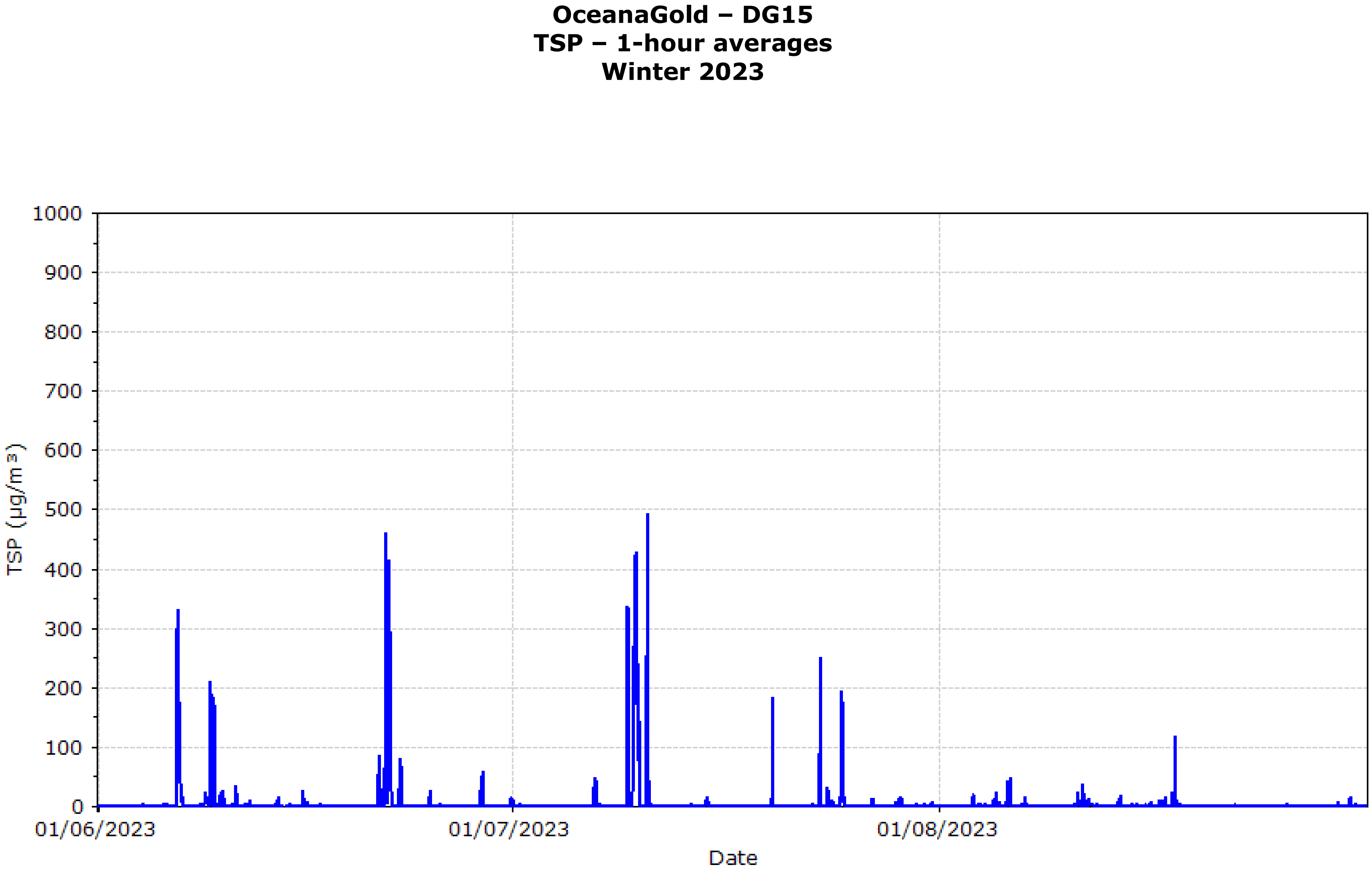
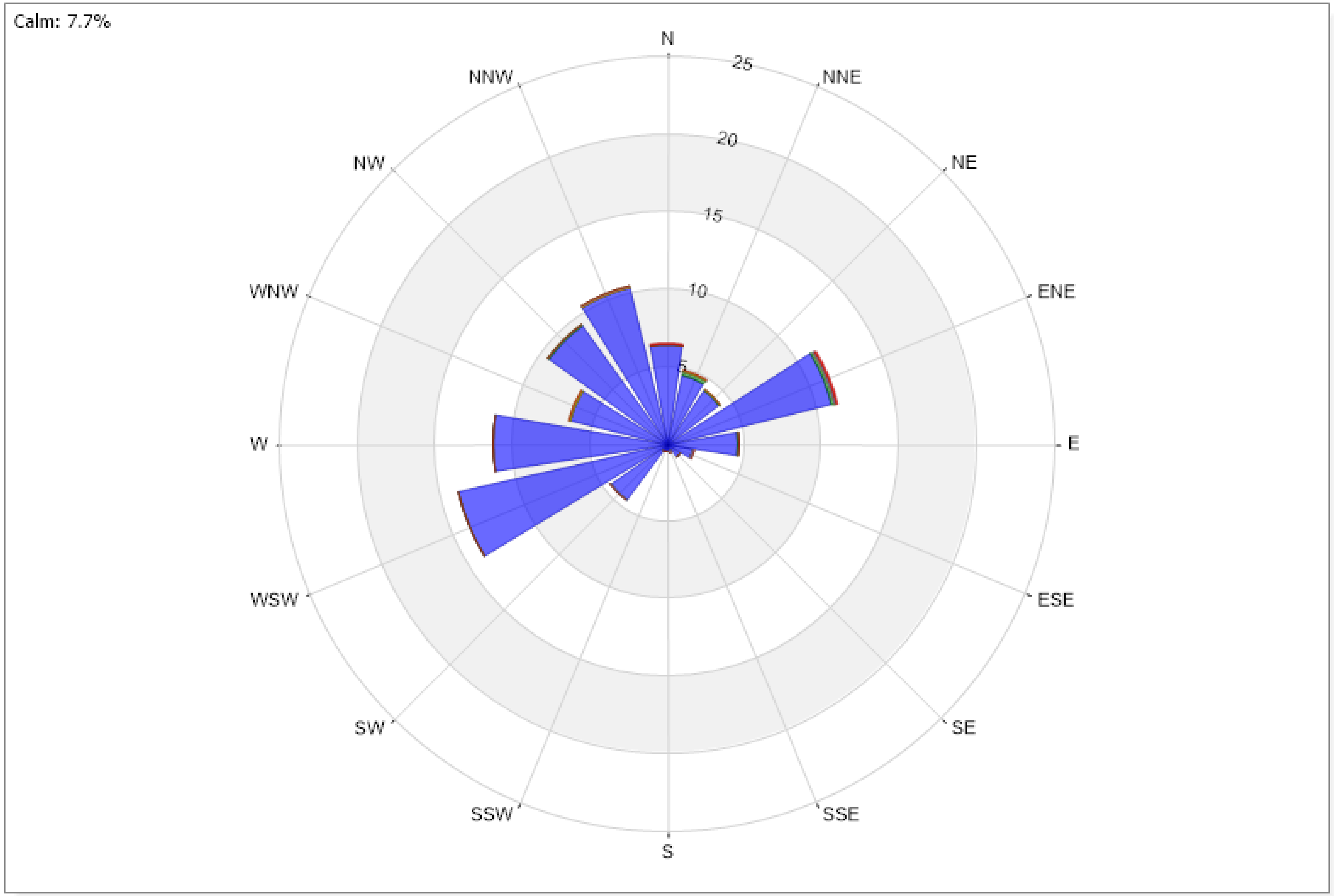


Figure 3: **OceanaGold – DG15: TSP E-Sampler (1-hour averages)**

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Winter 2023



%	Icon	Classes (μg/m³)
91		0.0-50.0
1		50.0-100.0
0		100.0-150.0
0		150.0-200.0
0		200.0-250.0
0		>250.0

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

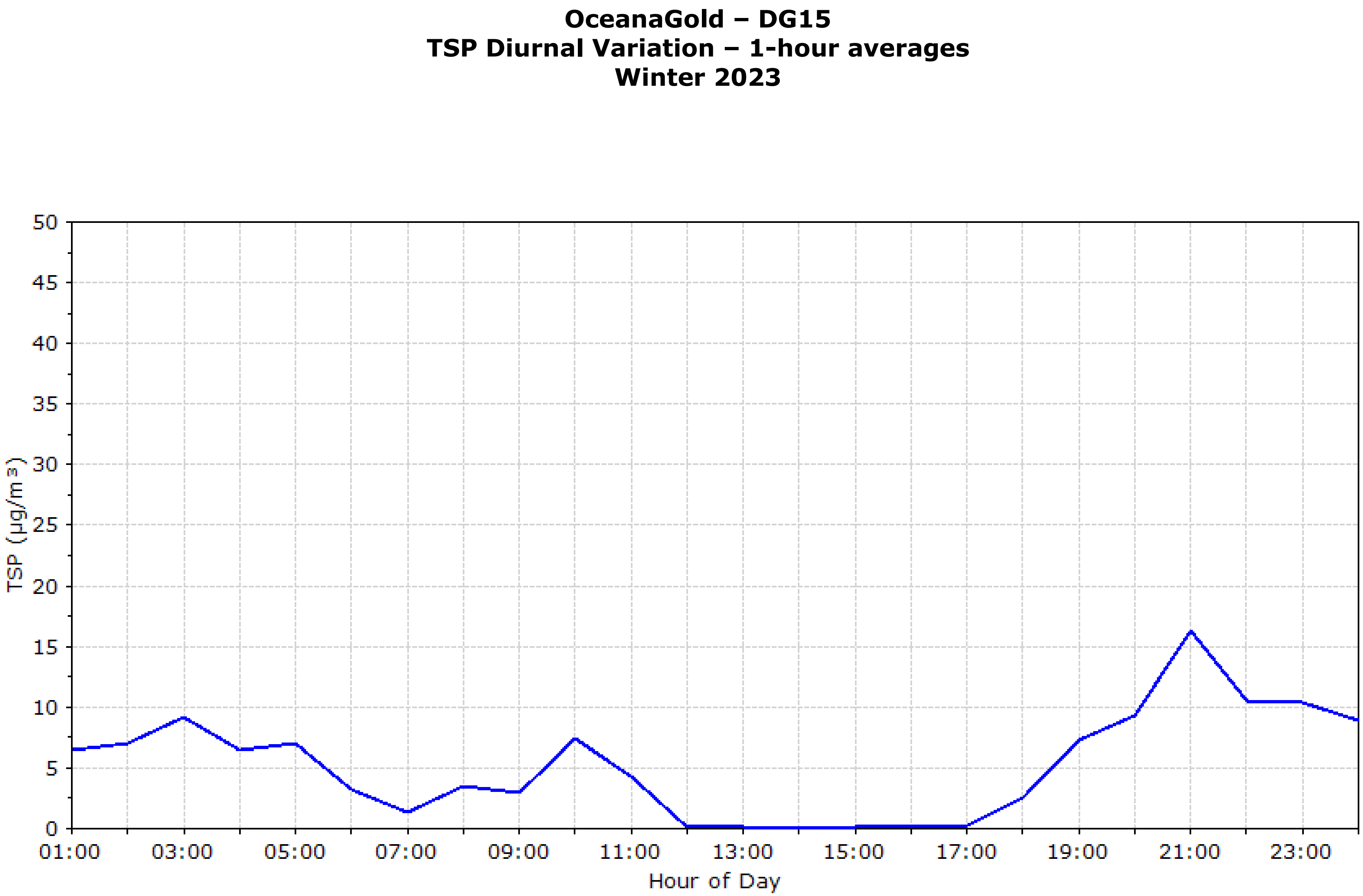


Figure 5: OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Winter 2023 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	-6.6	5.3	17.7
July 2023	-4.5	5.4	15.4
August 2023	-4.1	4.5	14.9
Winter 2023	**-6.6 10/06/2023 06:00**	**5.1**	**17.7 01/06/2023 13:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	-1.3	5.3	13.5
July 2023	0.4	5.4	11.8
August 2023	-0.5	4.5	9.9
Winter 2023	**-1.3 11/06/2023**	**5.1**	**13.5 02/06/2023**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
June 2023	ENE	9.3	2.1	8.7
July 2023	WSW	5.7	3.6	16.1
August 2023	WSW	8.1	2.7	11.8
Winter 2023	**WSW**	**7.7**	**2.8**	**16.1**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
June 2023	1.0	9.4	28.8	13
July 2023	1.3	18.6	40.0	13
August 2023	0.6	5.2	18.6	12
Winter 2023	**1.0**	**18.6**	**87.4**	**38**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Winter 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	119	20	3	1	0	0	143	6.5
NNE	91	15	1	0	0	0	107	4.9
NE	54	30	10	1	0	0	95	4.3
ENE	82	108	55	5	0	0	250	11.3
E	32	59	12	0	0	0	103	4.7
ESE	26	14	1	0	0	0	41	1.9
SE	12	8	4	0	0	0	24	1.1
SSE	13	1	0	0	0	0	14	0.6
S	9	3	1	0	0	0	13	0.6
SSW	6	4	2	0	0	0	12	0.5
SW	24	32	25	6	9	3	99	4.5
WSW	37	59	77	62	35	34	**304**	13.8
W	75	72	61	31	9	0	248	11.2
WNW	74	52	15	2	1	0	144	6.5
NW	91	83	26	7	2	0	209	9.5
NNW	115	93	13	8	3	1	233	10.6
All	**860**	**653**	**306**	**123**	**59**	**38**	**2040**	**92**
Calm	168						168	7.6

Table 8 shows the proportion of wind strengths at each wind direction. Stronger winds, greater than 8 m/s, were observed from the southwest to north-northwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the west-southwest.

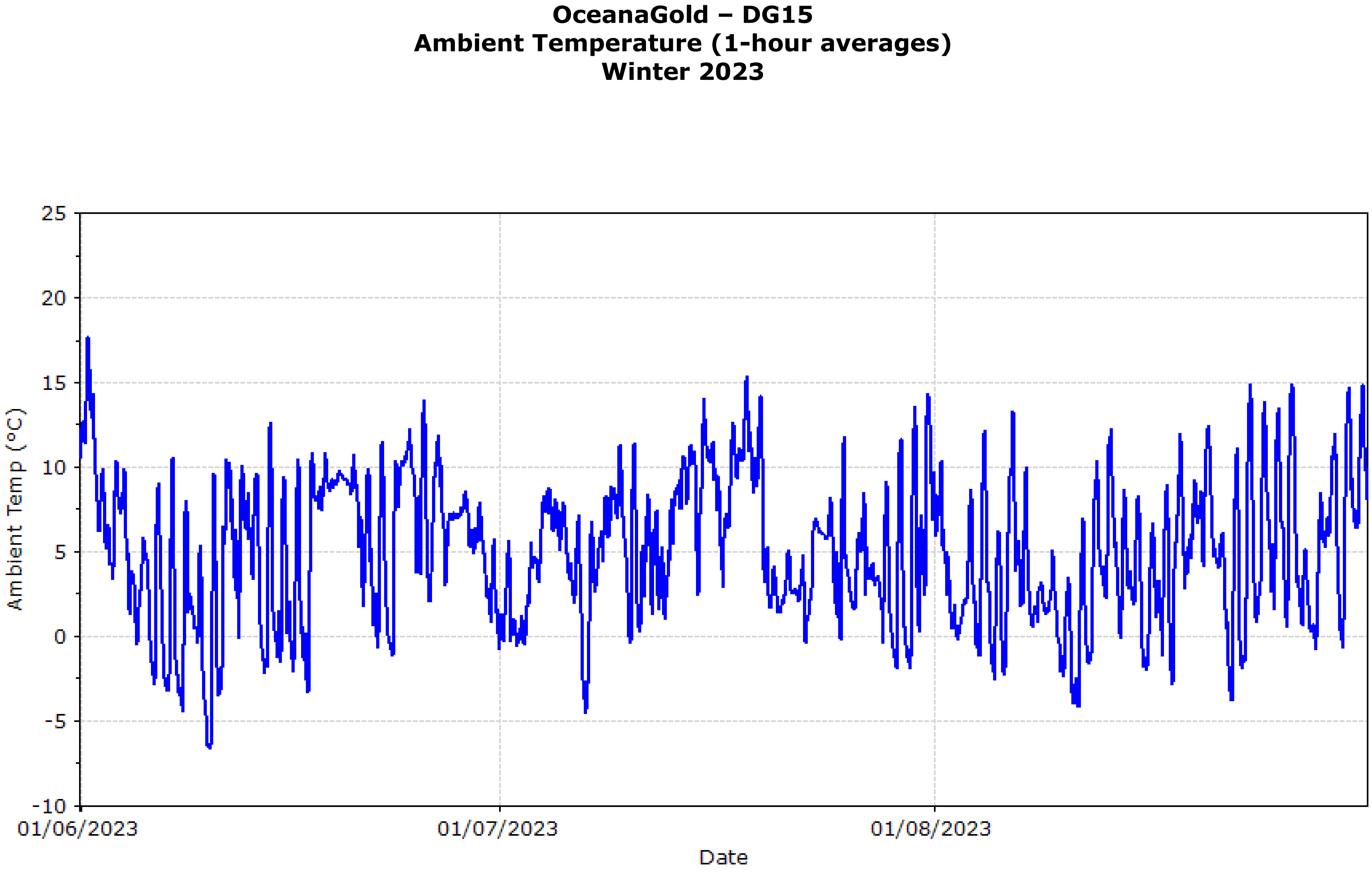


Figure 6: **OceanaGold – DG15: Ambient Temperature (1-hour averages)**

OceanaGold – DG15
Wind Speed (1-hour averages)
Winter 2023

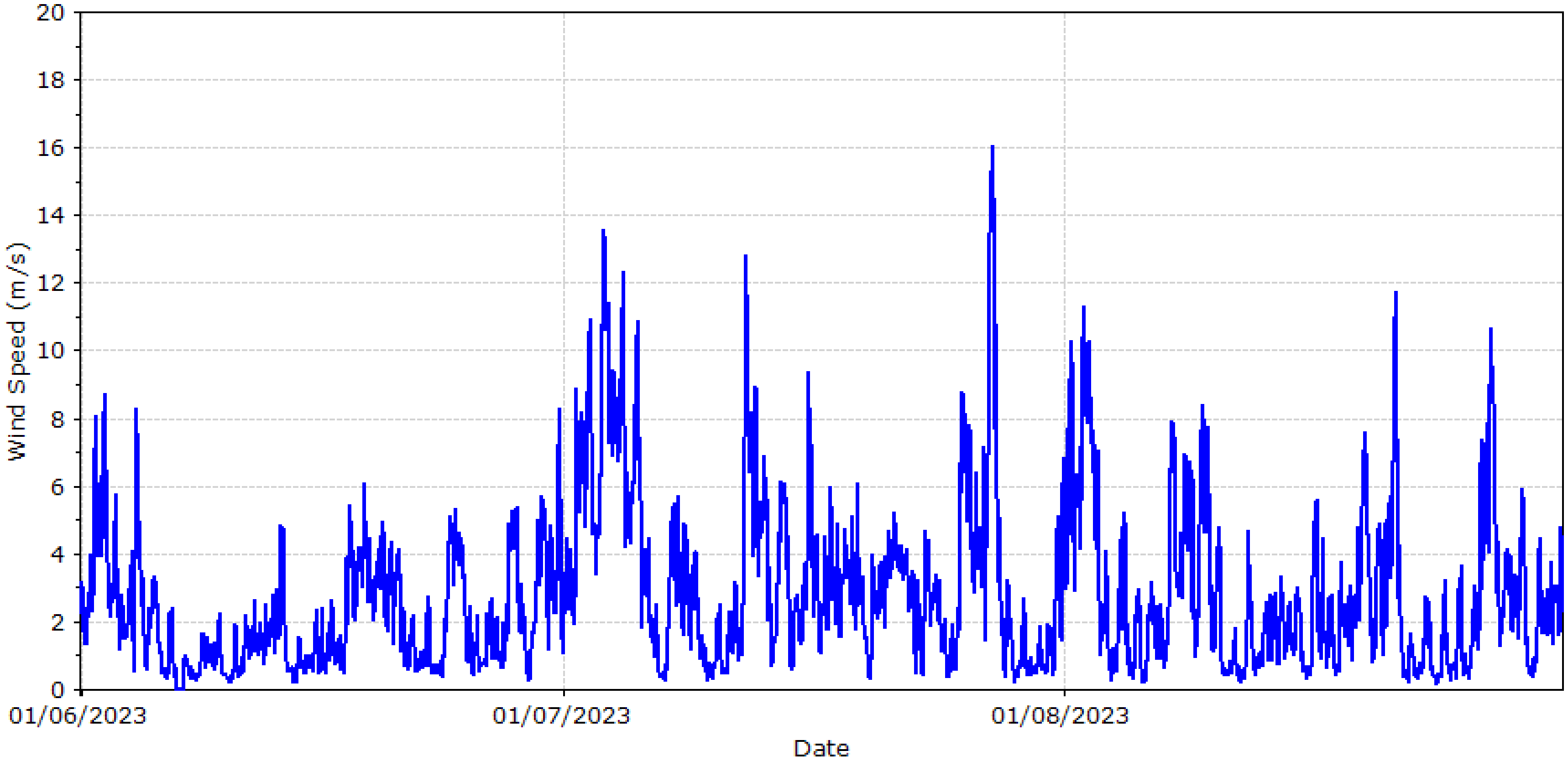


Figure 7: OceanaGold – DG15: Wind Speed (1-hour averages)

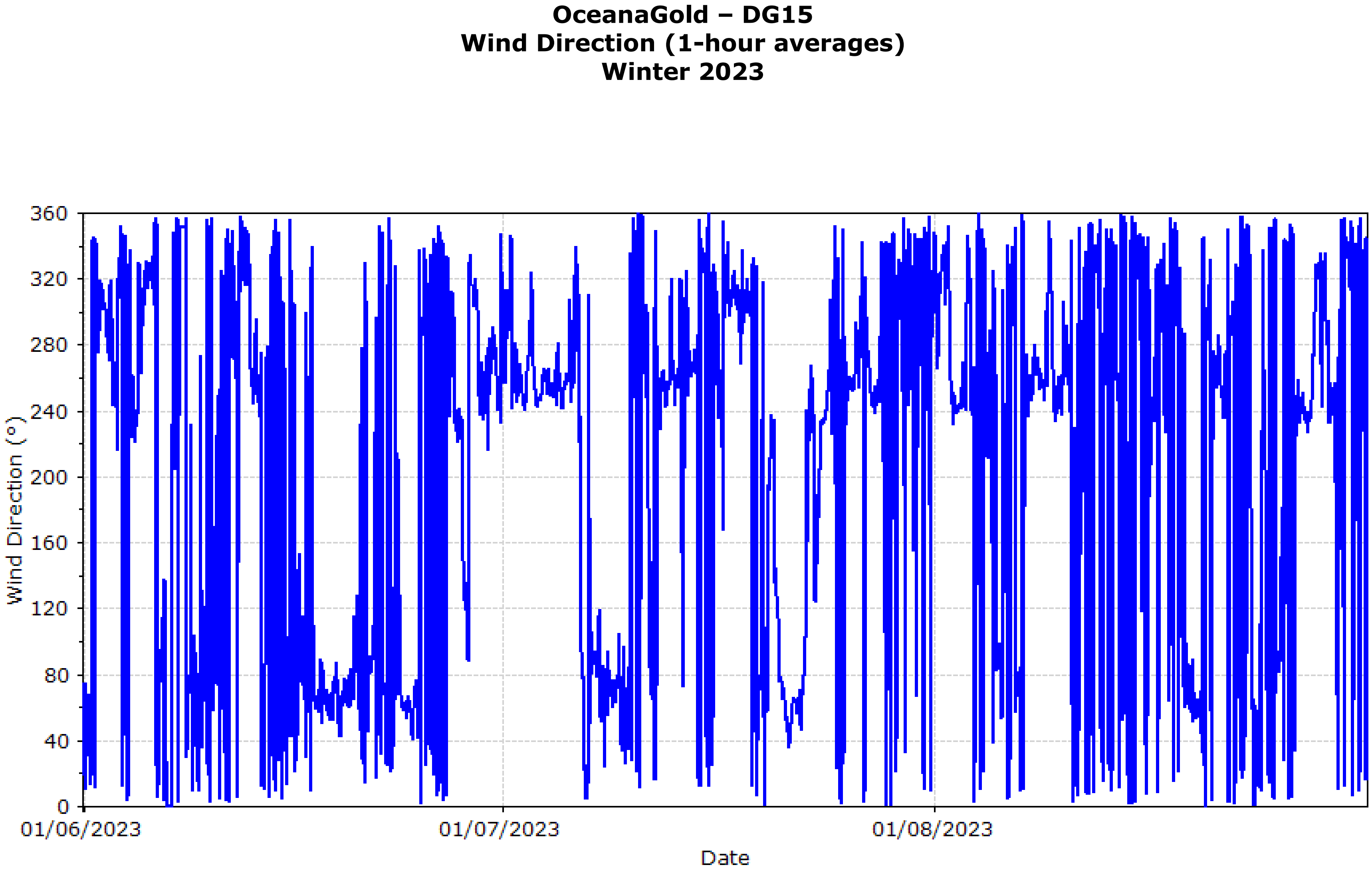


Figure 8: OceanaGold – DG15: Wind Direction (1-hour averages)

OceanaGold – DG15
Wind Rose (1-hour averages)
Winter 2023

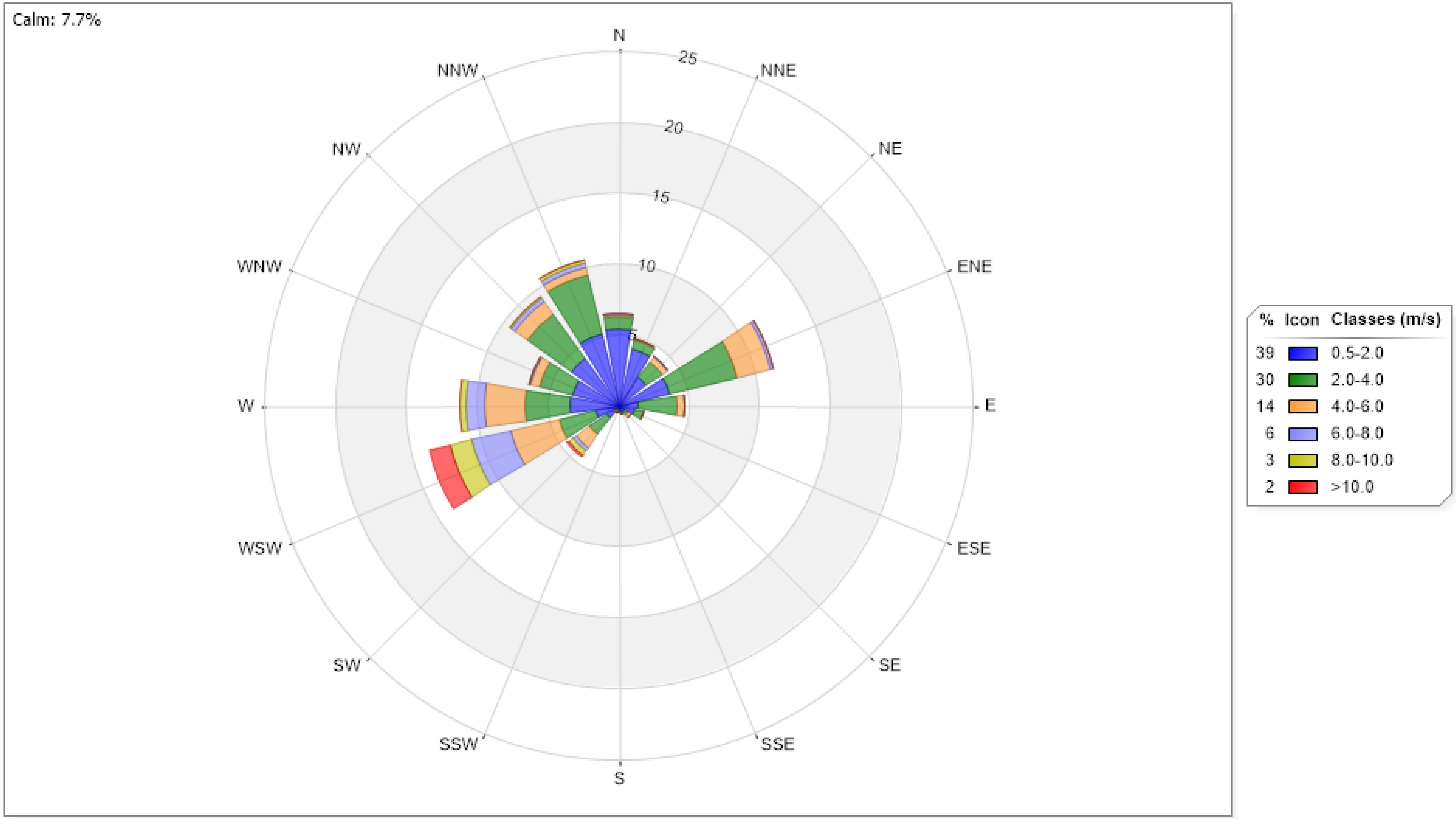


Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

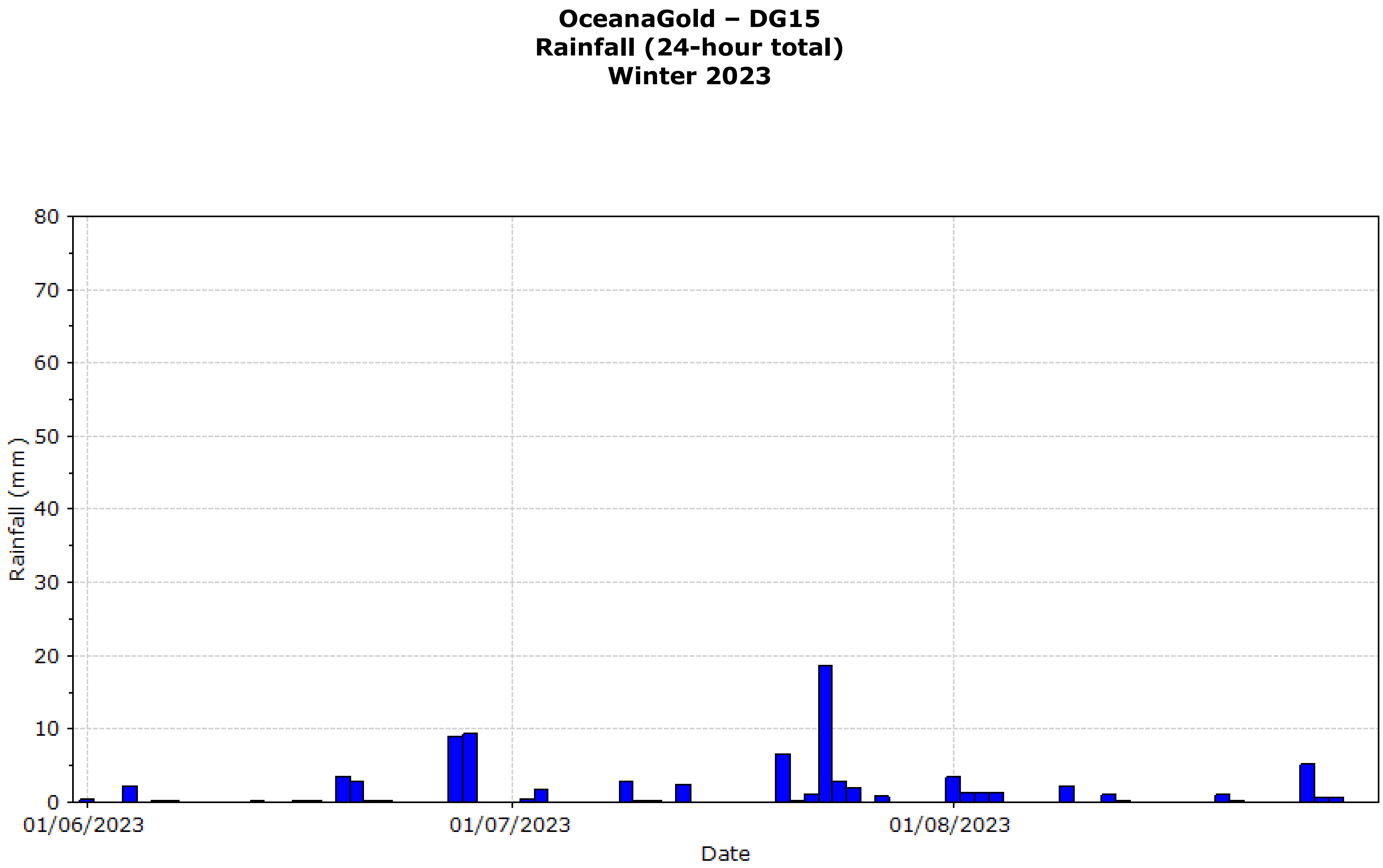


Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Winter 2023 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	-2.9	6.0	16.8
July 2023	-1.2	5.5	15.2
August 2023	-2.4	5.0	14.8
Winter 2023	**-2.9 10/06/2023 06:00**	**5.5**	**16.8 01/06/2023 14:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	-1.2	6.6	16.7
July 2023	-0.8	5.9	14.7
August 2023	-1.9	5.4	14.6
Winter 2023	**-1.9 10/08/2023 05:00**	**6.0**	**16.7 01/06/2023 14:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
June 2023	42.6	83.0	100.0
July 2023	39.6	75.5	100.0
August 2023	35.5	75.3	100.0
Winter 2023	**35.5**	**77.9**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	0.6	6.0	13.1
July 2023	-0.1	5.5	11.2
August 2023	-0.3	5.0	9.4
Winter 2023	**-0.3 11/08/2023**	**5.5**	**13.1 02/06/2023**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	1.1	6.6	13.6
July 2023	0.2	5.9	11.6
August 2023	0.2	5.4	9.7
Winter 2023	**0.2 11/08/2023**	**6.0**	**13.6 02/06/2023**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
June 2023	54.0	83.0	100.0
July 2023	54.0	75.5	100.0
August 2023	50.9	75.3	97.3
Winter 2023	**50.9**	**77.9**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)*	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
June 2023	NE	7.1	2.7	14.3
July 2023	SW	4.4	4.1	14.6
August 2023	SW	10.4	3.2	17.7
Winter 2023	**SW**	**7.3**	**3.4**	**17.7**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
June 2023	1.3	14.0	38.0	10
July 2023	1.8	30.4	56.6	13
August 2023	0.6	4.8	18.2	12
Winter 2023	**1.2**	**30.4**	**112.8**	**35**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
June 2023	11.2	57.8	80.1
July 2023	23.3	66.3	100.8
August 2023	27.1	92.3	160.2
Winter 2023	**11.2 05/06/2023**	**72.3**	**160.2 01/09/2023**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Winter 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	42	38	2	0	0	0	82	3.7
NNE	50	33	8	0	0	0	91	4.1
NE	61	68	71	11	7	0	218	9.9
ENE	76	67	44	1	0	0	188	8.5
E	61	53	6	0	0	0	120	5.4
ESE	19	9	5	0	0	0	33	1.5
SE	15	5	4	0	0	0	24	1.1
SSE	9	3	3	0	0	0	15	0.7
S	12	4	4	0	0	0	20	0.9
SSW	12	26	25	5	6	2	76	3.4
SW	16	79	89	52	29	22	**287**	13.0
WSW	30	71	41	7	0	0	149	6.8
W	42	63	29	9	3	4	150	6.8
WNW	57	101	56	36	9	13	272	12.3
NW	49	100	39	20	10	12	230	10.4
NNW	23	40	24	2	1	1	91	4.1
All	**574**	**761**	**450**	**144**	**65**	**54**	**2047**	**93**
Calm	161						161	7.3

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from south-southwest to southwest and from west-northwest to north-northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the southwest.

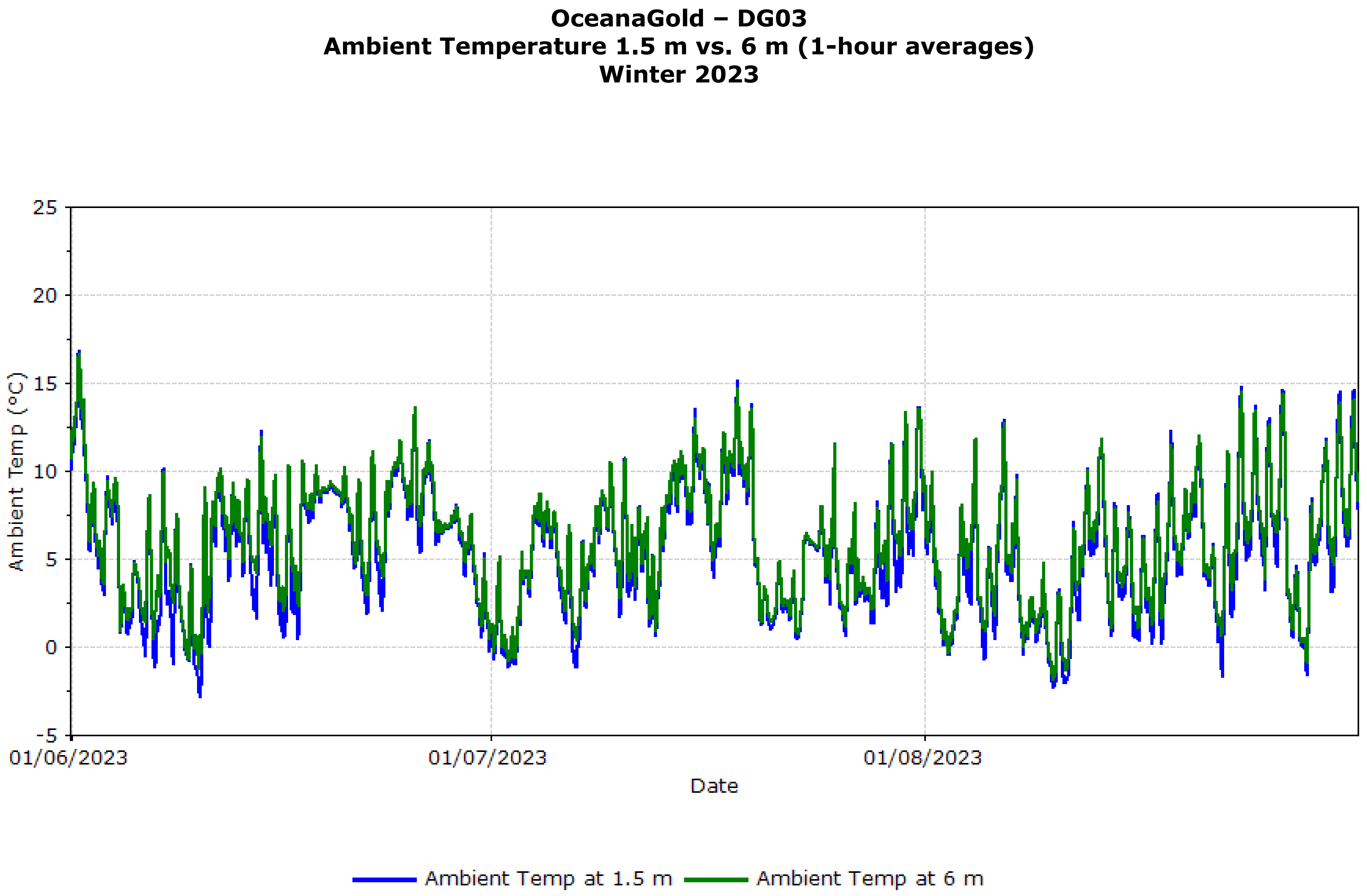


Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

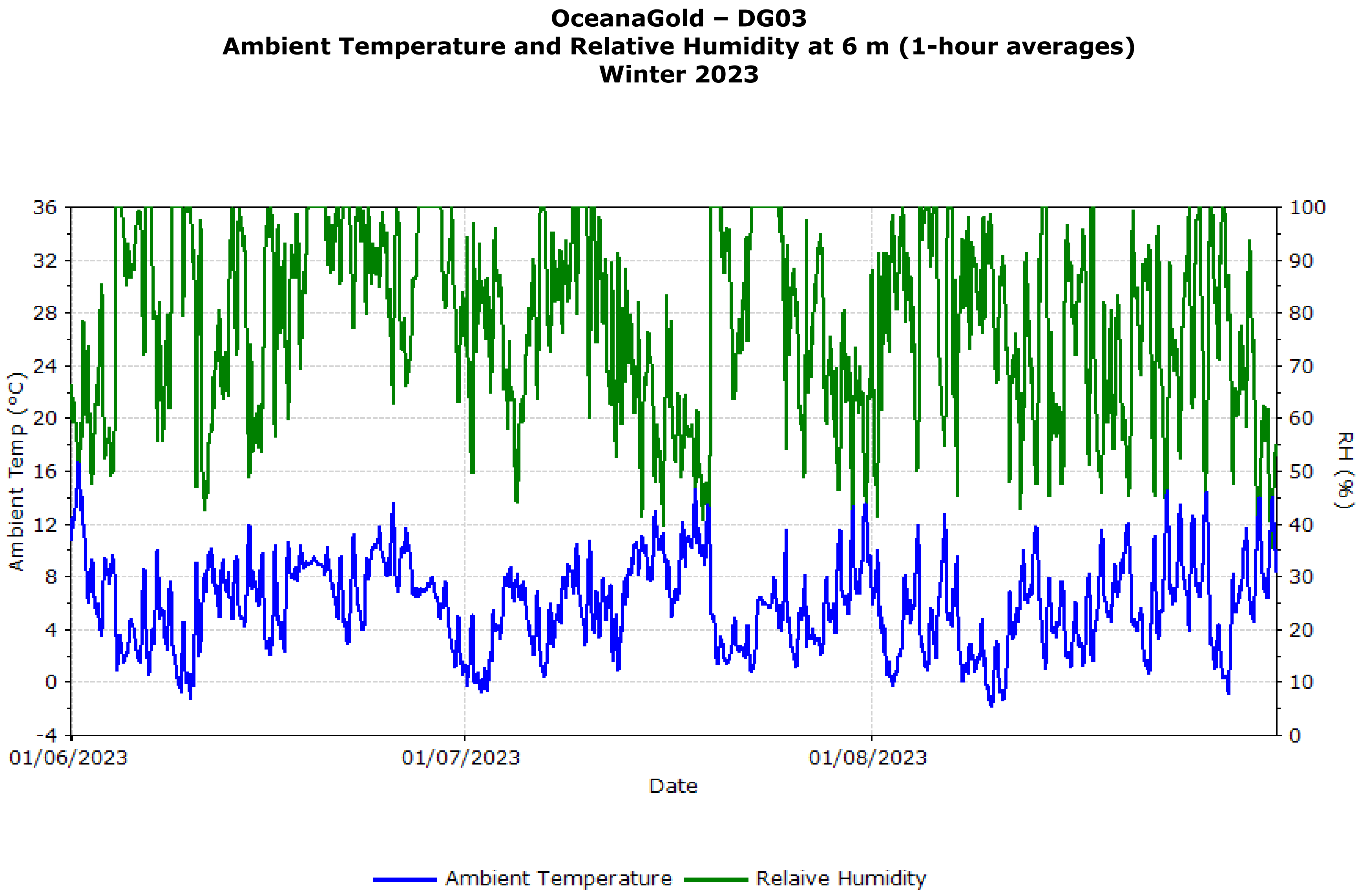


Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

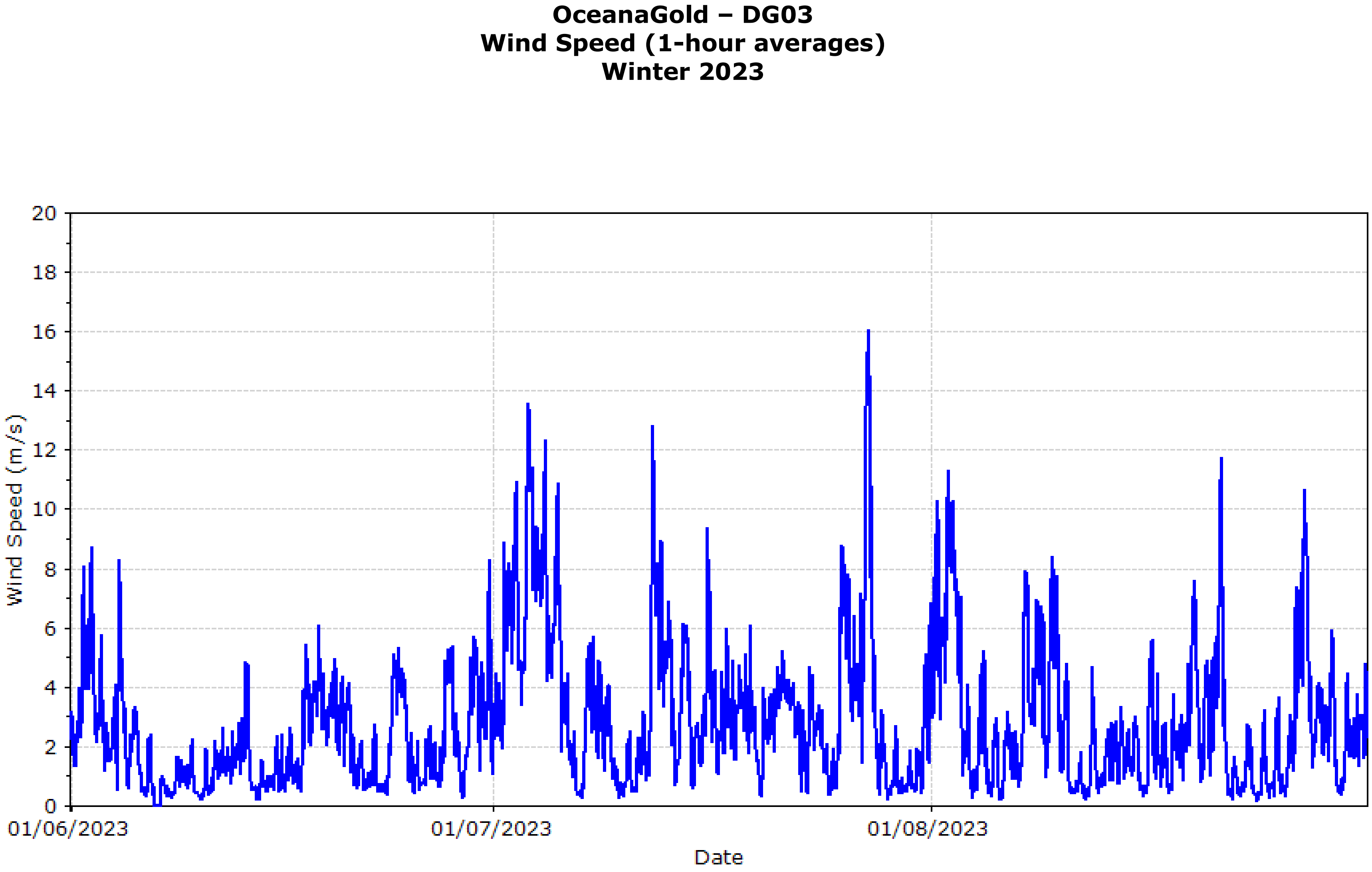


Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

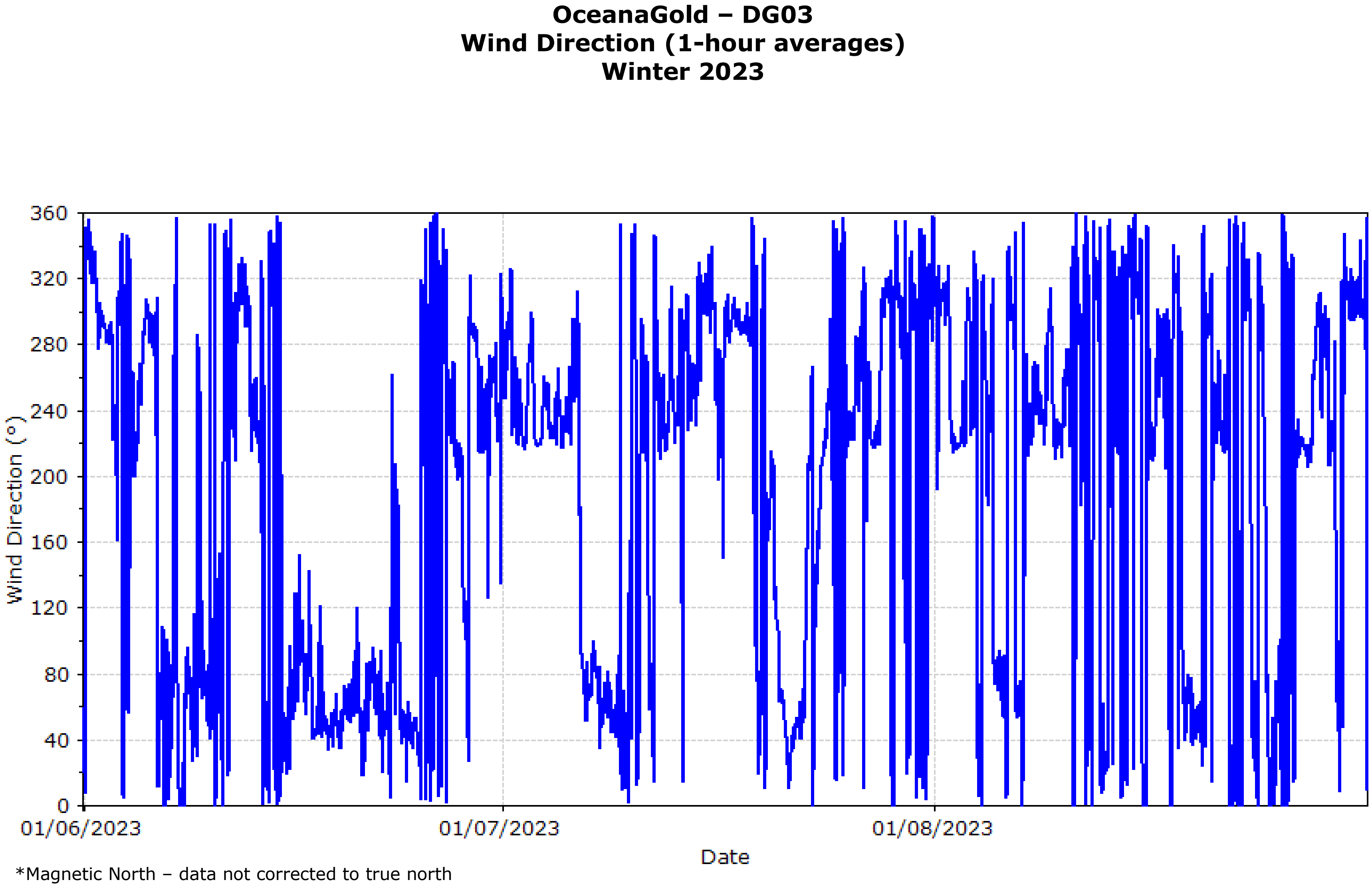


Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

OceanaGold – DG03
Wind Rose (1-hour averages)
Winter 2023

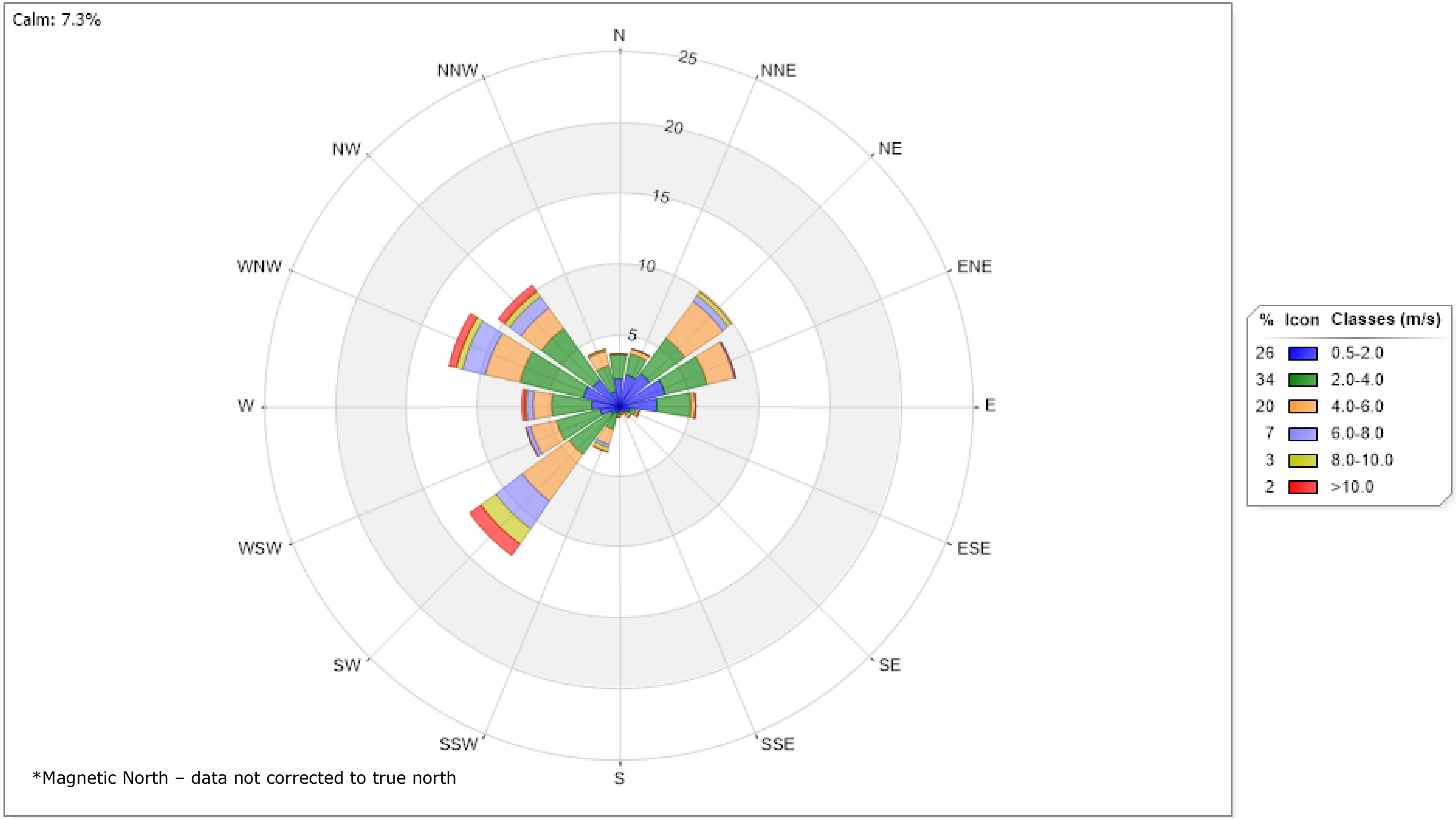


Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

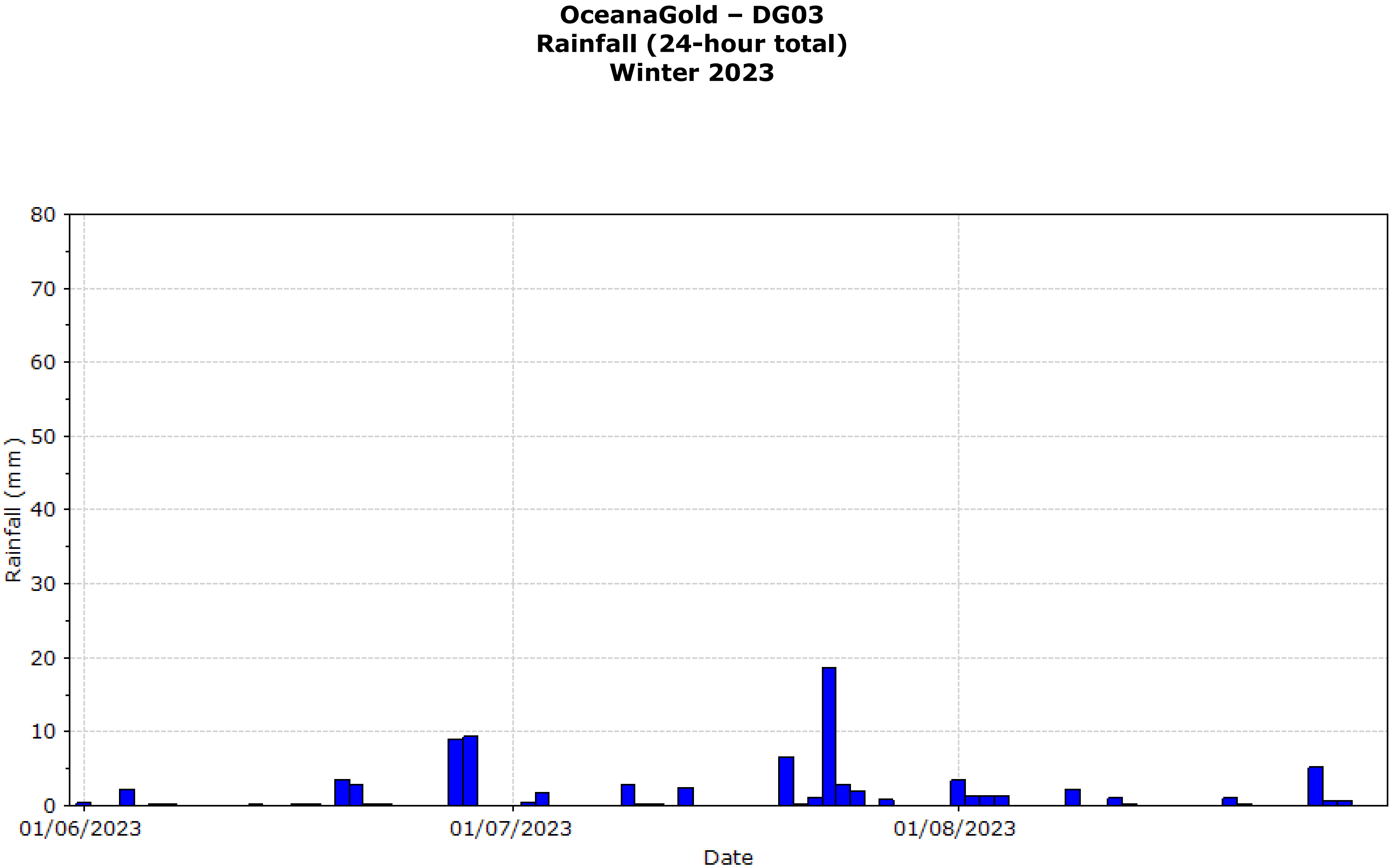


Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

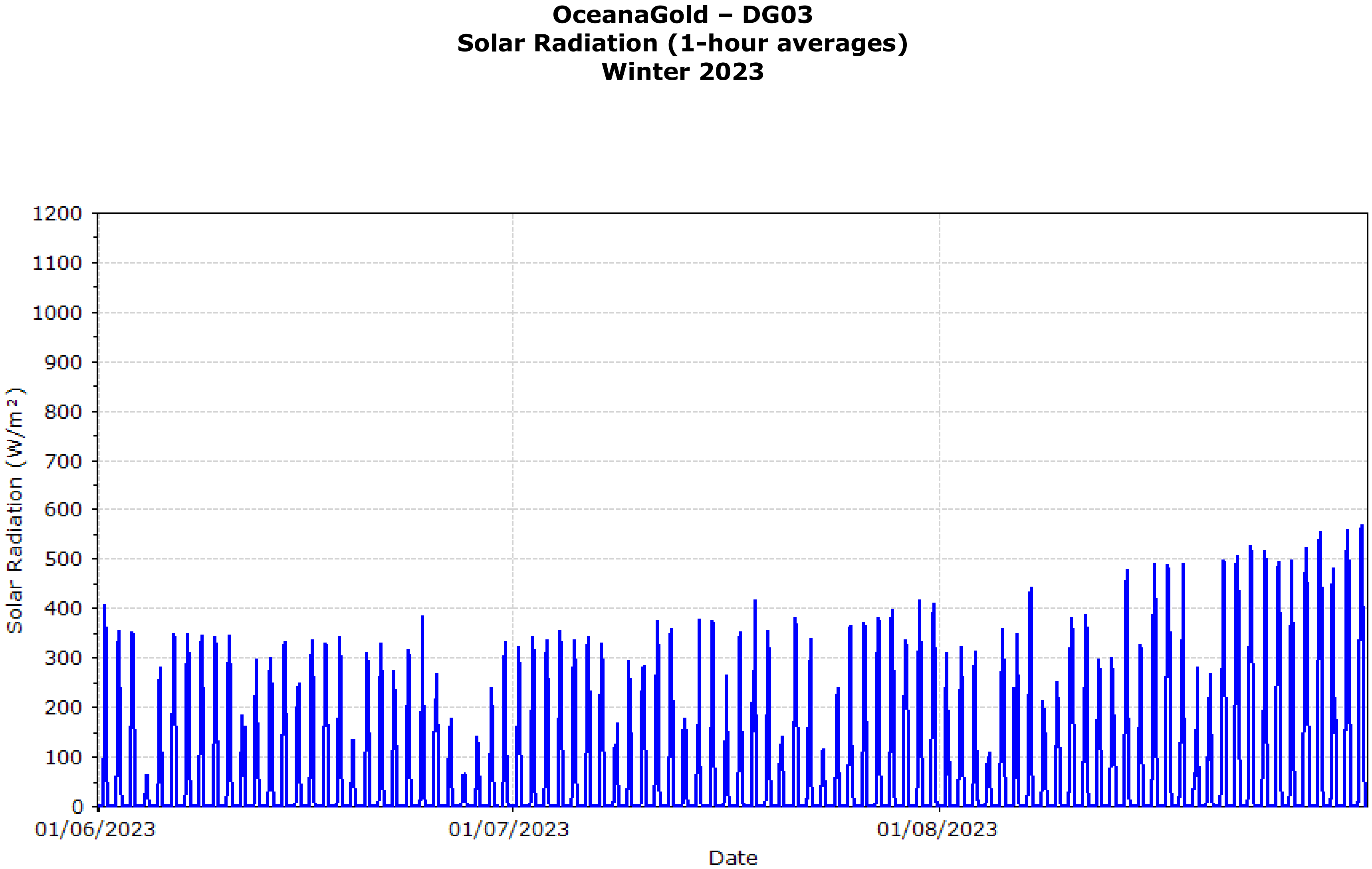


Figure 17: OceanaGold – DG03: Solar Radiation (1-hour averages)

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Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	16-06-22	2415	Six-Monthly Maintenance	Parameter Check	B Kaushal
	14-09-22	2415	Quarterly Maintenance	Parameter Check	R Hodgkinson
	13-12-22	2415	Annual Maintenance	Audit Calibrations	R Hodgkinson
	23-03-23	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
	19-04-23	2415	Maintenance & Repair	Callout	J Abraham
	14-06-23	2415	Quarterly Maintenance	Parameter Check	J Abraham
Temperature sensor – Campbell Scientific 107					
	14-09-22	2418	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
Anemometer – Vector A101M					
	14-09-22	2417	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
Wind vane – Vector W200P					
	14-09-22	2416	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
Rain gauge – TB3-0.2/P					
	14-09-22	2419	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2419	Six-Monthly Maintenance	Parameter Check	J Abraham

OceanaGold NZ Limited

Ambient Air Quality Monitoring
Quarterly Summary Report
Spring 2023

Prepared for
OceanaGold New Zealand Limited

By

Watercare
Laboratory Services

AQ-2023-237

Ambient Air Quality Monitoring
Quarterly Summary Report
Spring 2023

A report for
OceanaGold Corporation
RD3, Macraes Flat 9483
East Otago
New Zealand

14 December 2023

Prepared by
Watercare Services Limited
Laboratory Services – Air Quality Department
52 Aintree Avenue, Airport Oaks, Auckland 2022
PO Box 107 028, Auckland Airport 2150
Ph +64 09 539 7600
Fax +64 09 539 7601
www.watercarelabs.co.nz

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Author	Peer Reviewer & Authoriser
Kath McLeod	Vilani Abeyratne
Senior Air Quality data Analyst	Ambient Data - Team Leader
Data Management Team	Data Management Team
Watercare Services Ltd	Watercare Services Ltd

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Table of Contents

Page

Tables

Figures

1. Summary

Ambient air quality monitoring at OceanaGold, East Otago for Spring 2023 (September 2023 to November 2023) showed:

At DG15:

- There was one exceedence of the 24-hour TSP Trigger Levels recorded by the by E-Sampler.
- Valid data captured for TSP E-Sampler was 100%.
- The highest TSP 24-hour concentration measured by the E-Sampler was 145 µg/m³ on 03 September 2023.
- There were higher (>300 µg/m³) TSP E-Sampler hourly concentrations from various directions.
- Elevated (>20 µg/m³) diurnal TSP hourly concentrations occurred at 06:00 (New Zealand standard time).
- Valid data captured for wind speed and direction was 100%.
- Valid data captured for ambient temperature and rainfall was 100%.
- The predominant wind direction was from the east.

At DG03:

- Valid data captured for ambient temperature at 6 m, ambient temperature at 1.5 m, relative humidity, rainfall and solar radiation were 100%. Wind speed and wind direction valid data were also 100%.
- The predominant wind direction was from the northwest.

2. Introduction

In October 2012, OceanaGold commissioned Watercare to conduct monitoring of continuous total suspended particulates (TSP) and continuous meteorological parameters. There is one air quality station monitoring TSP and meteorological parameters and other monitoring only meteorological parameters. TSP data collected from the instrument was used to validate the report data. The monitoring was carried out as part of a resource consent requirement.

In this report we provide:

- summary of results for monitoring during Spring 2023
- overview of the relevant exceedence limits
- description of the monitoring site
- overview of the methods used to monitor selected parameters
- comparisons with limits and statistics
- results of validated data
- maintenance records.

3. Ambient Air Quality Levels

There is no standard value for Total Suspended Particulates (TSP) in the National Environmental Standards (NES). TSP monitoring in New Zealand was initially used to assess nuisance effects and was not generally associated with serious health effects. In 2001, Ministry for the Environment (MfE) produced the recommended trigger levels (Table 1) for assessing dust emissions. These limits and the relative surrounding areas are applied in the absence of current national guidelines and are commonly used in resource consents. The appropriate classification for OceanaGold is an insensitive area with a 24-hour trigger level of 120 µg/m³.

Table 1: MfE trigger levels

Parameter	Averaging Period	Trigger Levels and Areas
TSP	24-hour	80 µg/m³ – sensitive areas 100 µg/m³ – moderate sensitivity 120 µg/m³ – insensitive

4. Site Descriptions

4.1. Site Area

Site Area	OceanaGold RD3, Macraes Flat 9483 East Otago	**Site Class**	Industrial Peak
Air Quality Stations	OceanaGold – DG15	OceanaGold – DG03	

OceanaGold operates the Macraes Gold mine in Macraes Flat located 55 km north of Dunedin in East Otago. The mine is mainly surrounded by rural farm land (Figure 1).

The main mining operation is 1-2 km to the east of the Macraes Flat township. The local topography has rolling hills with man-made hills bordering the mine.

During the monitoring period two air quality stations were situated in the vicinity of Macraes mine. The equipment was owned by OceanaGold and operated by Watercare at DG15. The positions of the air quality stations are detail below. The monitoring stations and sample inlet were sited in accordance with *AS/NZ 3580.1.1 – 2016 Ambient Air – Guide for the Siting of Sampling Units*.

Figure 1: Aerial map of OceanaGold air quality monitoring locations

4.2. OceanaGold – DG15

The OceanaGold – DG15 air quality station monitors TSP, ambient temperature, wind speed, wind direction and rainfall. The site was commissioned on 23 January 2013 and Watercare reported valid data since 24 January 2013.

DG15 was sited in a paddock 95 m southeast of Macraes Road and 65 m east-northeast of Red Bank Road (Figure 1). Macraes Road is the main road with rural farmland to the west and Fraser's mine 1.2 km to the east-southeast. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG15 and the mine embankment.

OceanaGold – DG15		
Address	Behind 1757 Macraes Road, Macraes Flat	
Site coordinates (NZTM)	E1398815	N4971316
Time base	Continuous 10-minute data	
Parameters	TSP at 1.8 m – E-Sampler TSP at 1.5 m – HiVol (monitoring completed Mar-15) Ambient Temperature at 1.5 m Wind Speed and Direction at 6 m Rainfall at ground level (from 11 Apr-13)	

4.3. OceanaGold – DG03

The OceanaGold – DG03 air quality station monitors ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity, wind speed, wind direction, rainfall and solar radiation. The equipment was operated by OceanaGold suppliers. Watercare reported valid data from 24 January 2013. Calibration and maintenance were performed by OceanaGold contractors.

DG03 was sited in a paddock 20 m north of Golden Point Road and 1 km north of Macraes Township (Figure 1). There is rural farmland to the south and the Mixed Tailings Impoundment (MTI) 200 m to the north. There are no neighbouring trees that may affect the site's monitoring. There is a clear line of sight between DG03 and the mine embankment.

OceanaGold – DG03		
Address	South of MTI Golden Point Road	
Site coordinates (NZTM)	E1398844	N4972539
Time base	Continuous 10-minute data from 27/09/2017 Previously continuous 1-hour data	
Parameters	Ambient Temperature at 1.5 m Ambient Temperature at 6 m Relative Humidity at 6 m Wind Speed and Direction at 6 m Rainfall at ground level Solar Radiation at 1.5 m	

5. Methods

This section provides the methodology and processes used in the measurement of TSP and the meteorological parameters. The instrument maintenance history is recorded in Appendix A.

5.1. Total Suspended Particulates – E-Sampler

TSP was continuously monitored using a Met One E-Sampler-9800. The E-Sampler is a type of nephelometer that measures suspended particulates using a forward laser light scatter system with a gravimetric filter system.

The sample air is drawn into the E-Sampler at 2 litres per minute and passes through the laser light. The suspended particulates in the sample scatter a portion of the laser light. This scattered light detected by the sensor is proportional to the particulate mass. The exiting sample air is deposited onto a 47 mm filter. The mass on the filter is used to calculate the gravimetric K-factor to correct the E-Sampler light scattering signal. For this monitoring period the TSP concentrations were corrected by the calculated K-factor of 1.0. The E-Sampler operates with a full-scale measurement range of 0 – 65,530 µg/m^3.

5.1.1. Quality Assurance

The instrument was operated by Watercare in accordance with the manufacturer's instructions. This means that the instrument was installed, configured, calibrated and maintained in accordance with the manufacturer's operational manual.

Maintenance checks, including operational parameter examinations, are conducted, quarterly and 6-monthly. Instrument performance and data checks are carried out daily.

Every hour the E-Sampler operates an automatic self-test for 2-3 minutes. This span/zero test period was excluded from the total flow over the sample period. Particulate matter concentrations have been calculated to standard temperature (0°C) and pressure (1atm).

5.2. Meteorological Parameters

Measurements of meteorology were made with reference to Standards Australia and Standards New Zealand AS/NZS 3580.14–2014 *Meteorological monitoring for ambient air quality monitoring applications* and Watercare's quality system. The make and model of each meteorological sensor at the DG15 site is in Appendix A.

5.2.1. Quality Assurance

To ensure compliance with the above method, all meteorological sensors at the DG15 site must meet the method performance specifications as well as being installed, configured, calibrated and maintained in accordance with the method's requirements and the manufacturer's instructions. This includes:

- Instrument meets AS/NZS 3580.14–2014 performance specifications, including precision and accuracy, and is configured accordingly.
- Daily instrument performance and data checks.
- Six monthly calibration and maintenance including cable and system integrity checks; wind speed and direction sensor sensitivity checks; calibration of ambient temperature and rain gauge checks.

- Annual calibration and maintenance as per every six months plus calibration of sensor signal conditioning unit and bearing friction checks of wind speed and wind direction sensors.

All meteorological sensors at the DG03 site were operated, calibrated and maintained by OceanaGold contractors.

5.3. Data Collection

Continuous data from the instruments were logged on-site by a Campbell Scientific datalogger every ten minutes at both DG15 and DG03. The DG15 data were collected using Watercare's automatic data logging system. The DG03 data were collected by OceanaGold contractors using a web based system. These data sources were automatically downloading from the sites every day and were checked every weekday at Watercare.

All data, were entered into Watercare's air quality database, Envista, which is used to validate and report all parameters. All data are stored as time ending averages and at New Zealand Standard Time (NZST).

6. Results

This section provides the site performance and an overview of the results for TSP and the meteorological parameters.

6.1. Site Performance

The MfE Good Practice Guide for Air Quality Monitoring and Data Management suggests that it is difficult to reach anything close to 100% valid data for long-term monitoring. For this report, site performance has been compared against a target of 95% for continuously monitored parameters. Table 2 describes overall site performance from Spring 2023.

Table 2: Site performance Spring 2023

Parameters	Averaging period	Valid data (%)	Site notes
DG15			
TSP – E-Sampler	10-minute	100	-
Ambient Temperature	10-minute	100	-
Wind Speed	10-minute	100	-
Wind Direction	10-minute	100	-
Rainfall	10-minute	100	-
DG03			
Ambient Temperature (1.5 m)	10-minute	100	-
Ambient Temperature (6 m)	10-minute	100	-
Relative Humidity	10-minute	100	During high humidity levels, the data flatlines at 100%.
Wind Speed	10-minute	100	Magnetic north alignment instead of a true north alignment (-25°). Data not corrected.
Wind Direction	10-minute	100	
Rainfall	10-minute	100	-
Solar Radiation	10-minute	100	-

6.2. Total Suspended Particulates

The E-Sampler TSP characteristics are tabulated in Table 3 showing the 24-hour summary statistics, the possible exceedences, a pollution rose summary and the elevated TSP times for Spring 2023. Figure 2 to Figure 5 graphically displays the 24-hour bar graph, 1-hour line graph, 1-hour pollution rose, and 1-hour diurnal line graph for TSP E-Sampler during the monitoring period.

As listed in Table 3 and displayed in Figure 2 there was one exceedence of the TSP trigger level measured by the E-Sampler. The highest TSP 24-hour concentration was 145 µg/m³ on 03 September 2023. The 1-hour TSP concentrations greater than 300 µg/m³ (Figure 3) came from northeast, east-southeast to southeast, southwest to west-southwest and west-northwest (Figure 4). Elevated diurnal 1-hour TSP concentrations occurred at 06:00 (Figure 5).

Table 3: TSP characteristics – E-Sampler

24-hour results	Minimum (µg/m³)	Average (µg/m³)	Maximum (µg/m³)
September 2023	0	9	145
October 2023	0	8	102
November 2023	0	7	88
Spring 2023	**0**	**8**	**145 03/09/2023**
Exceedences			
MfE Trigger Level – Daily TSP >120 µg/m³		145 µg/m³ on 03/09/2023	
Wind direction (DG15)			
Hourly TSP >300 µg/m³		NE, ESE-SE, SW-WSW, WNW	
Diurnal variation			
Hourly Diurnal TSP >20 µg/m³		06:00	

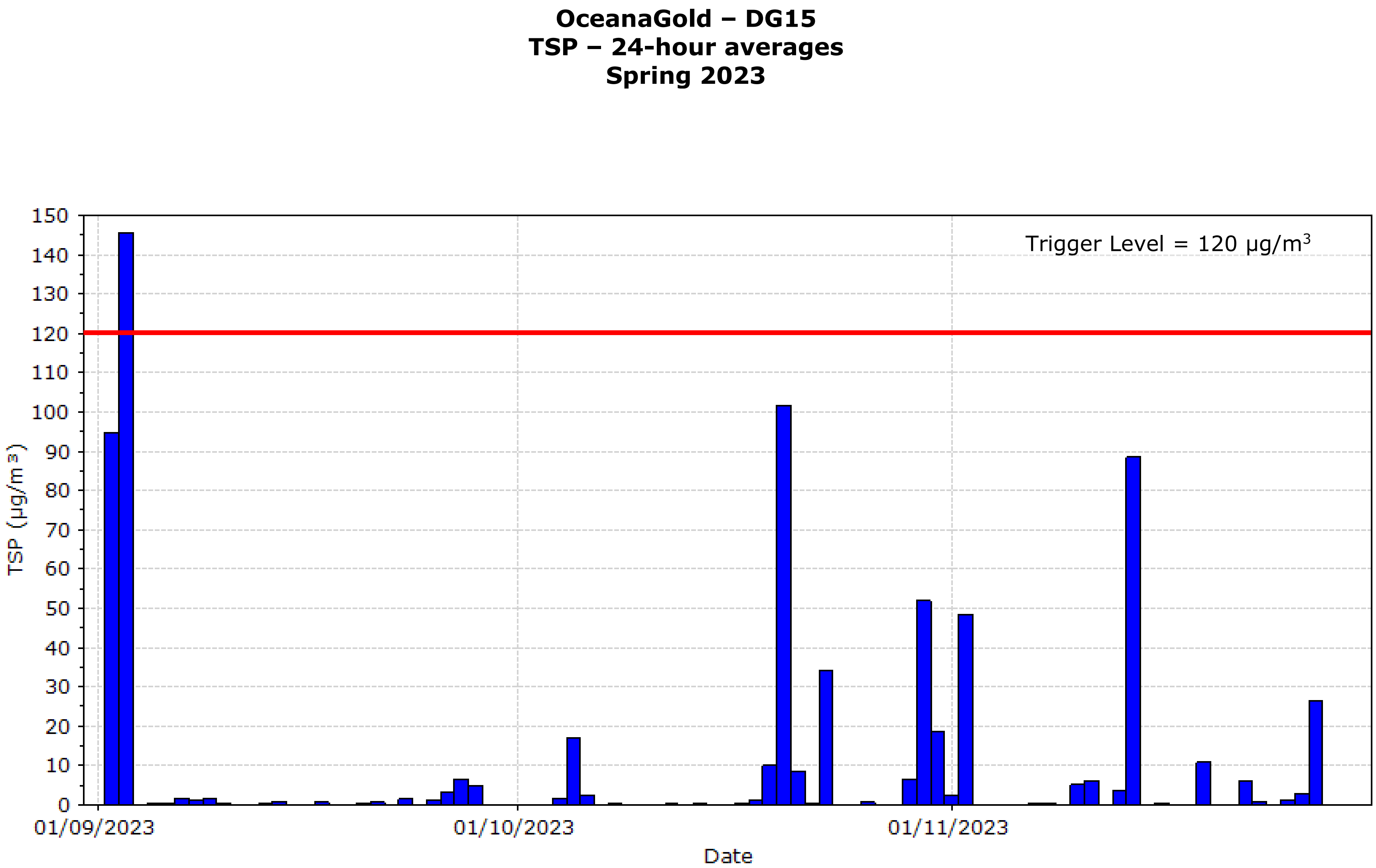

Figure 2: OceanaGold – DG15: TSP E-Sampler (24-hour averages)

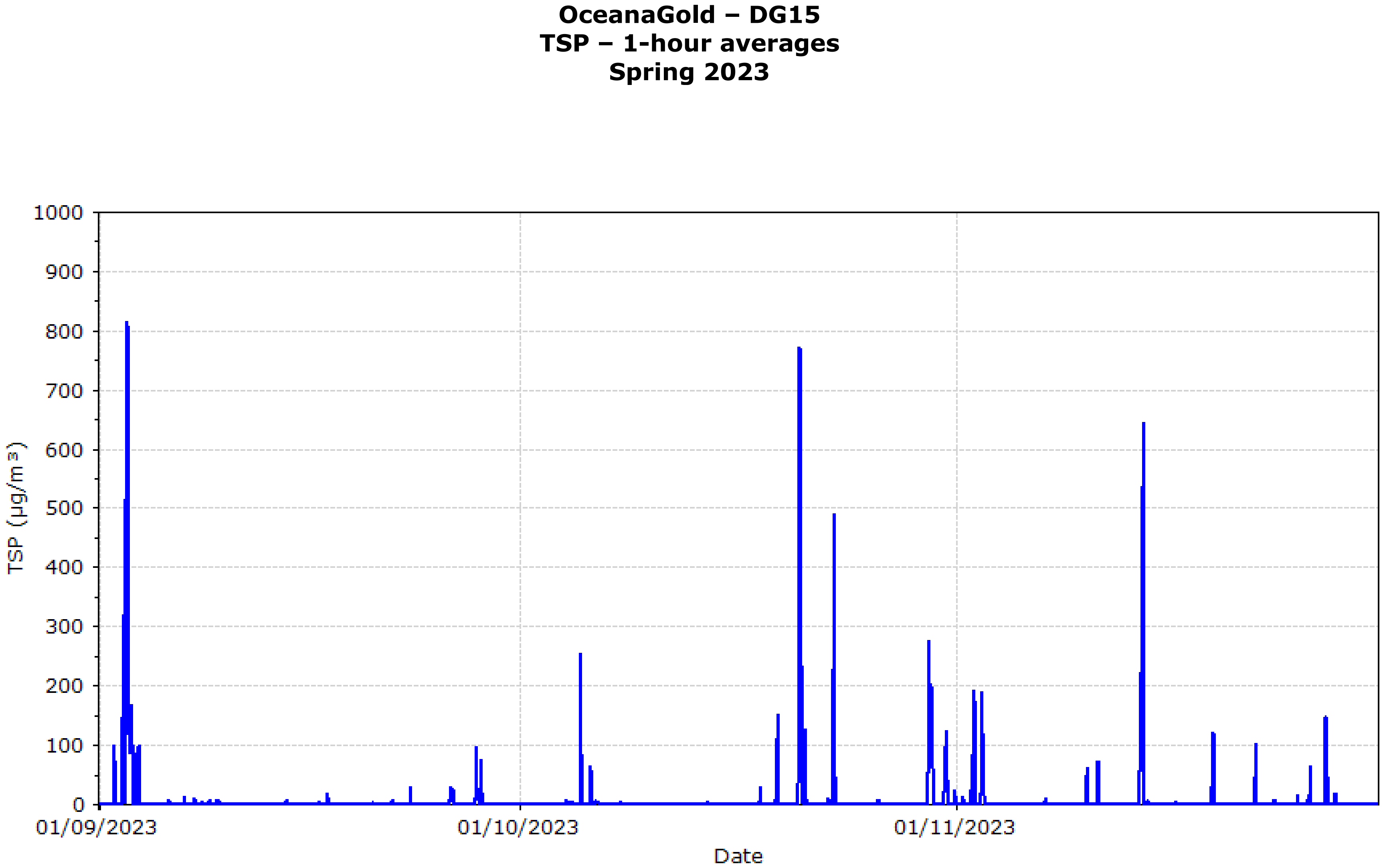

Figure 3: OceanaGold – DG15: TSP E-Sampler (1-hour averages)

OceanaGold – DG15
TSP Pollution Rose – 1-hour averages
Spring 2023

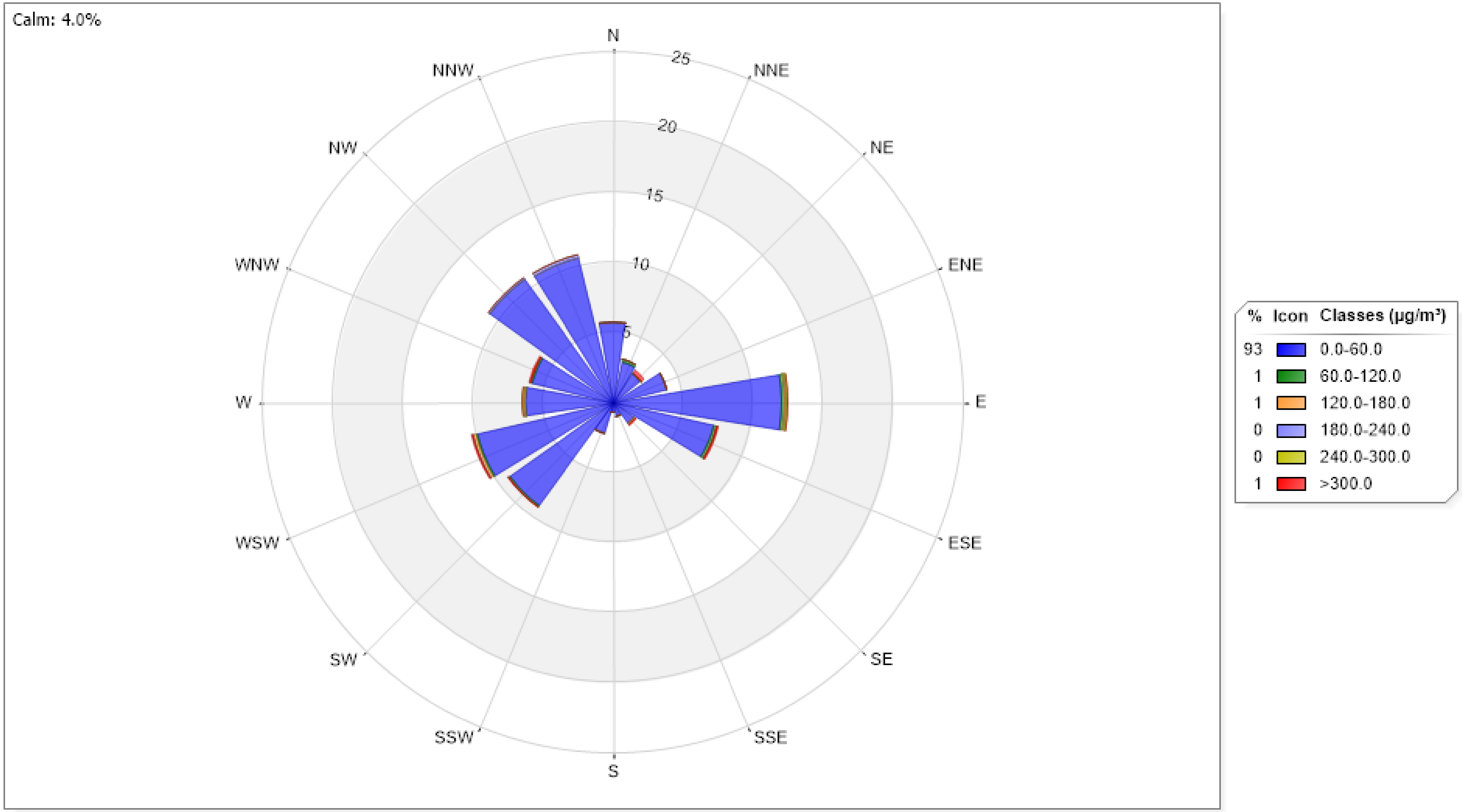

Figure 4: OceanaGold –DG15: TSP E-Sampler Pollution Rose (1-hour averages)

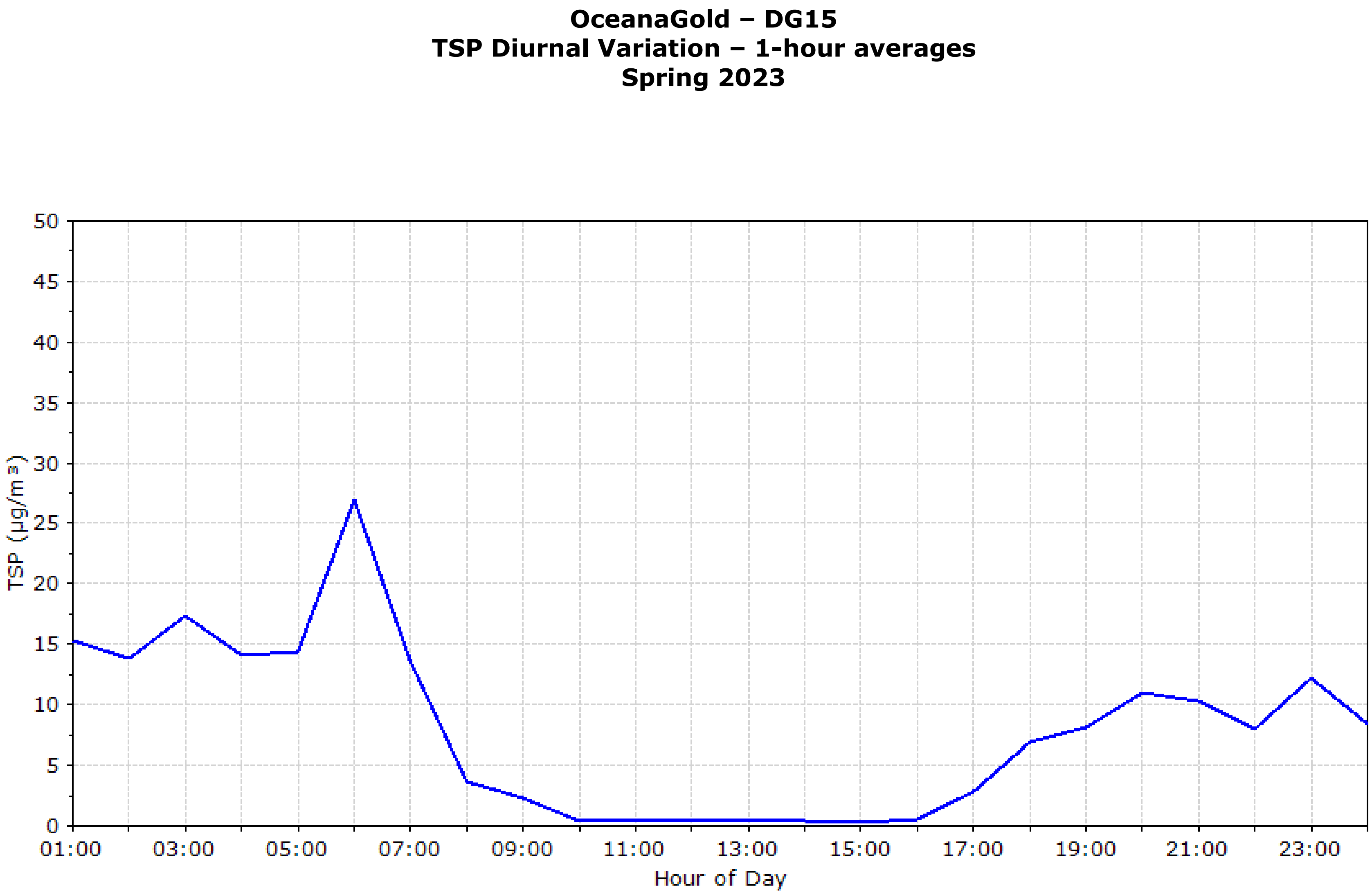

Figure 5: **OceanaGold – DG15: TSP E-Sampler diurnal variation (1-hour averages)**

6.3. Meteorological Parameters

6.3.1. OceanaGold – DG15

Ambient temperature, wind and rainfall from Spring 2023 at the OceanaGold station DG15 are summarised below in Table 4 to Table 8. Meteorological parameters are graphically displayed in Figure 6 to Figure 10.

Table 4: Hourly Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	-3.6	7.9	20.7
October 2023	-1.2	9.0	19.9
November 2023	-1.3	9.6	22.0
Spring 2023	**-3.6 25/09/2023 07:00**	**8.8**	**22.0 22/11/2023 15:00**

Table 5: Daily Ambient Temperature statistics – DG15

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	2.3	7.9	17.5
October 2023	1.3	9.0	16.2
November 2023	5.4	9.6	15.0
Spring 2023	**1.3 28/10/2023**	**8.8**	**17.5 21/09/2023**

Table 6: Hourly Wind characteristics – DG15

Period	Predominate Wind Directions	Wind Calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
September 2023	NW	3.5	3.5	11.7
October 2023	NNW	3.0	3.6	14.0
November 2023	E	5.6	2.8	12.2
Spring 2023	**E**	**4.0**	**3.3**	**14.0**

Table 7: Daily Rainfall statistics – DG15

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
September 2023	1.8	28.0	52.8	7
October 2023	1.2	7.8	36.2	10
November 2023	2.0	29.0	60.6	13
Spring 2023	**1.6**	**29.0**	**149.6**	**30**

Table 8: Wind Speed and Wind Direction summary – DG15 (1-hour average based on 10 minute averages, Spring 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	79	39	7	0	0	0	125	5.7
NNE	44	22	2	0	0	0	68	3.1
NE	37	22	2	0	0	0	61	2.8
ENE	34	37	16	0	0	0	87	4.0
E	60	156	53	4	0	0	273	**12.5**
ESE	29	80	60	1	0	0	170	7.8
SE	18	19	9	0	0	0	46	2.1
SSE	14	11	0	0	0	0	25	1.1
S	11	3	3	0	0	0	17	0.8
SSW	24	15	9	4	0	0	52	2.4
SW	37	49	55	39	12	9	201	9.2
WSW	52	38	38	41	41	15	225	10.3
W	47	38	33	16	6	1	141	6.5
WNW	41	37	48	6	1	0	133	6.1
NW	44	58	78	41	15	2	238	10.9
NNW	85	90	39	16	4	1	235	10.8
All	**656**	**714**	**452**	**168**	**79**	**28**	**2097**	**96**
Calm	87						87	4.0

Table 8 shows the proportion of wind strengths at each wind direction. Stronger winds, greater than 8 m/s, were observed from the southwest to north-northwest. The majority of the wind speed was between 0.5 to 4.0 m/s. The predominant wind direction was from the east.

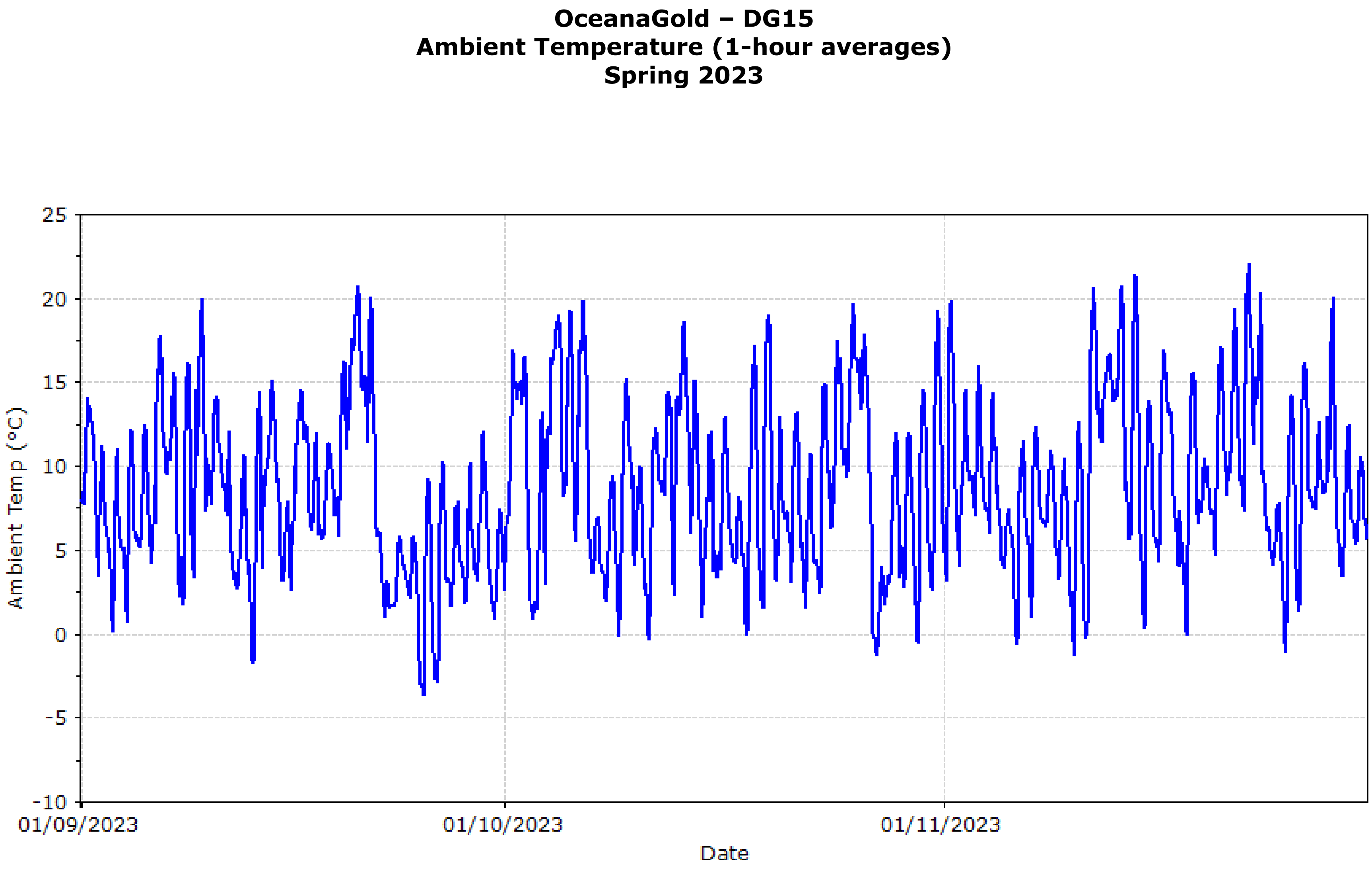

Figure 6: **OceanaGold – DG15: Ambient Temperature (1-hour averages)**

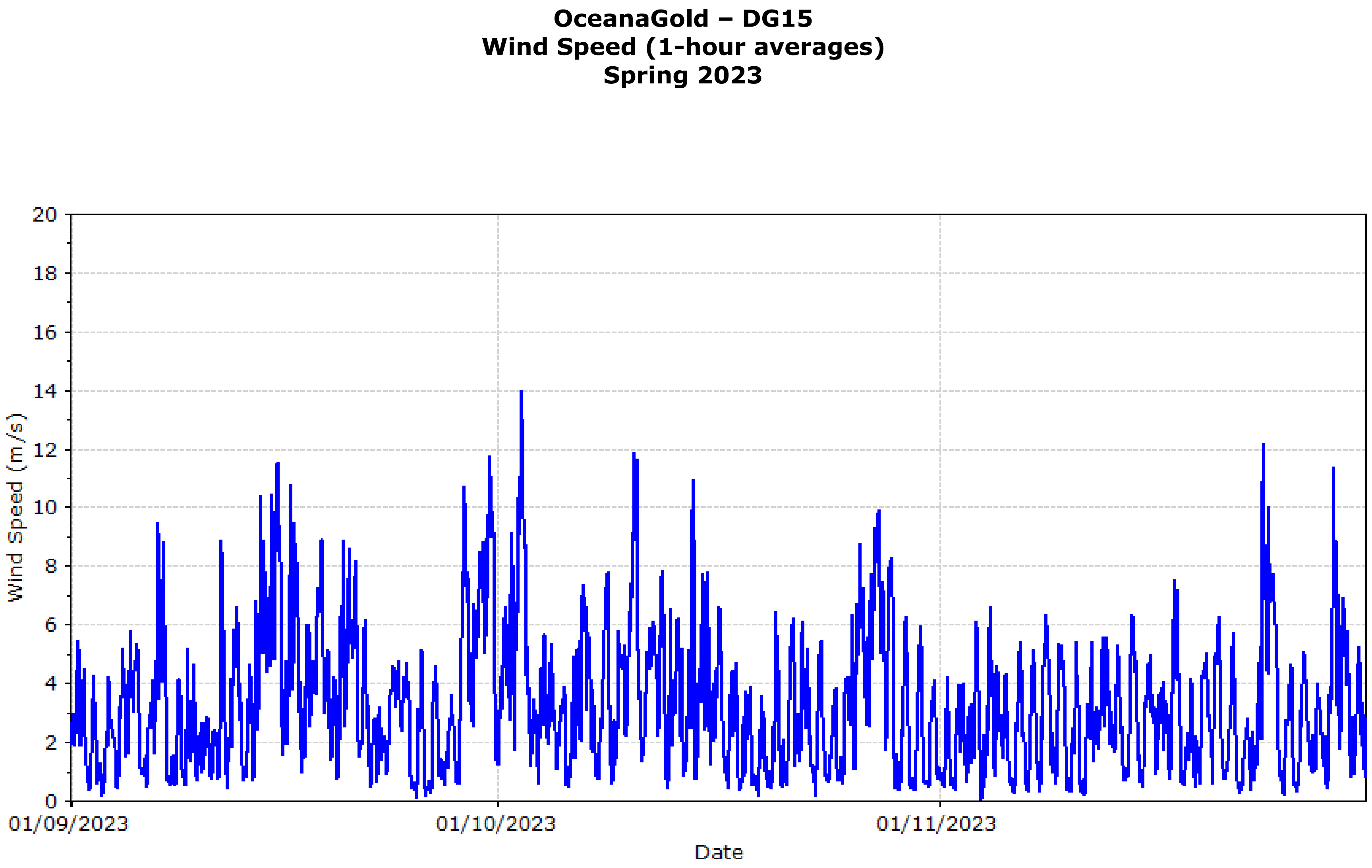

Figure 7: OceanaGold – DG15: Wind Speed (1-hour averages)

OceanaGold – DG15
Wind Direction (1-hour averages)
Spring 2023

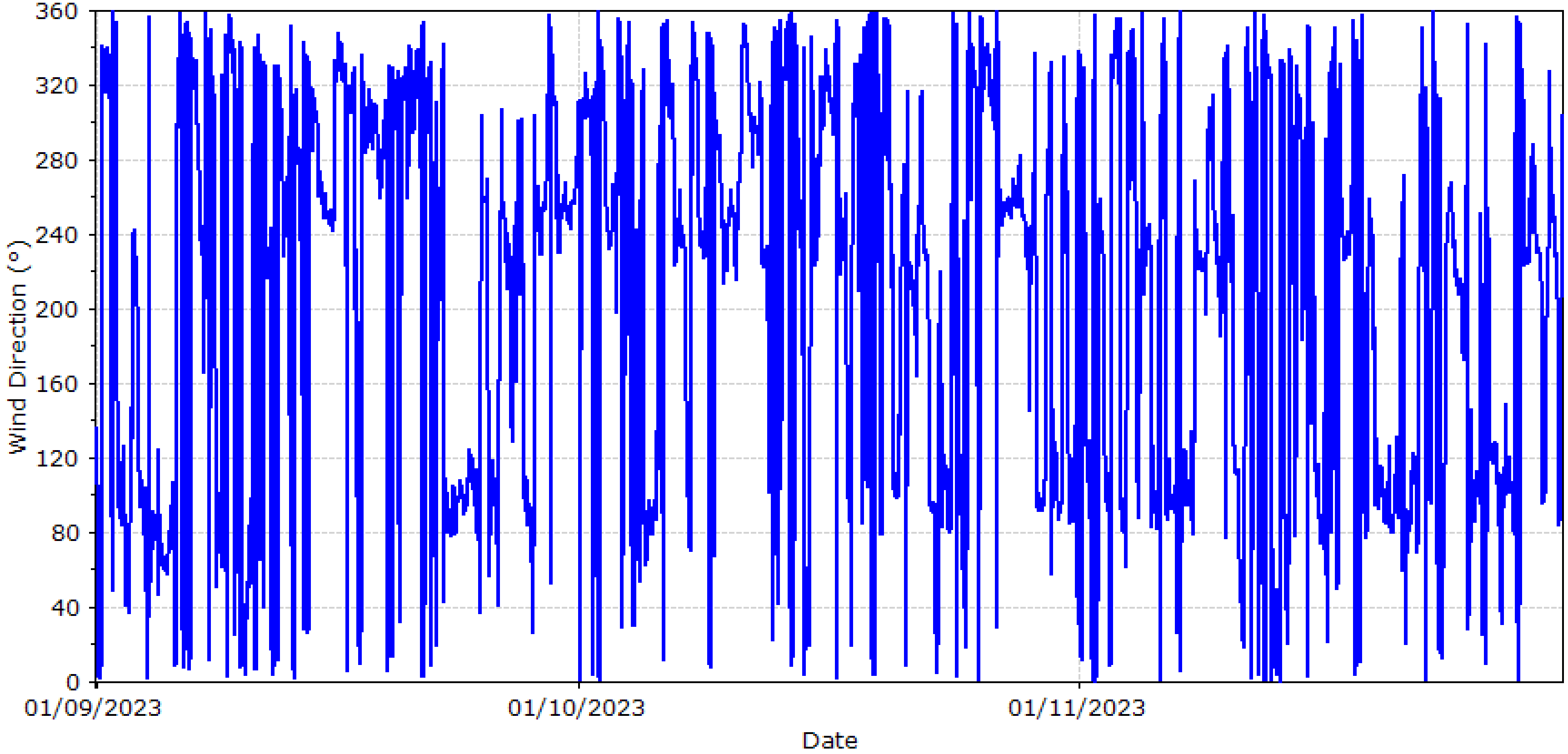

Figure 8: OceanaGold – DG15: Wind Direction (1-hour averages)

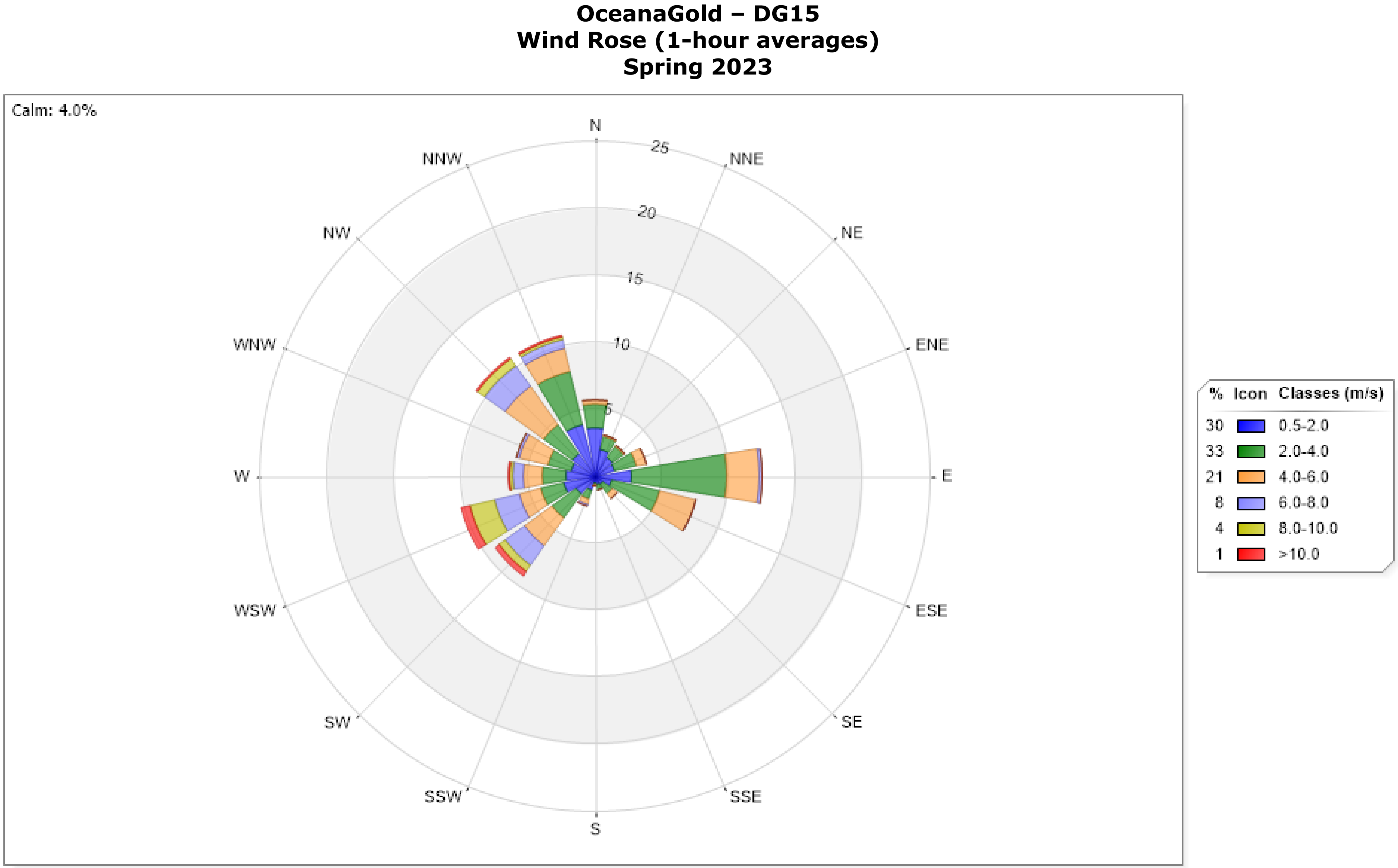

Figure 9: OceanaGold – DG15: Wind Rose (1-hour averages)

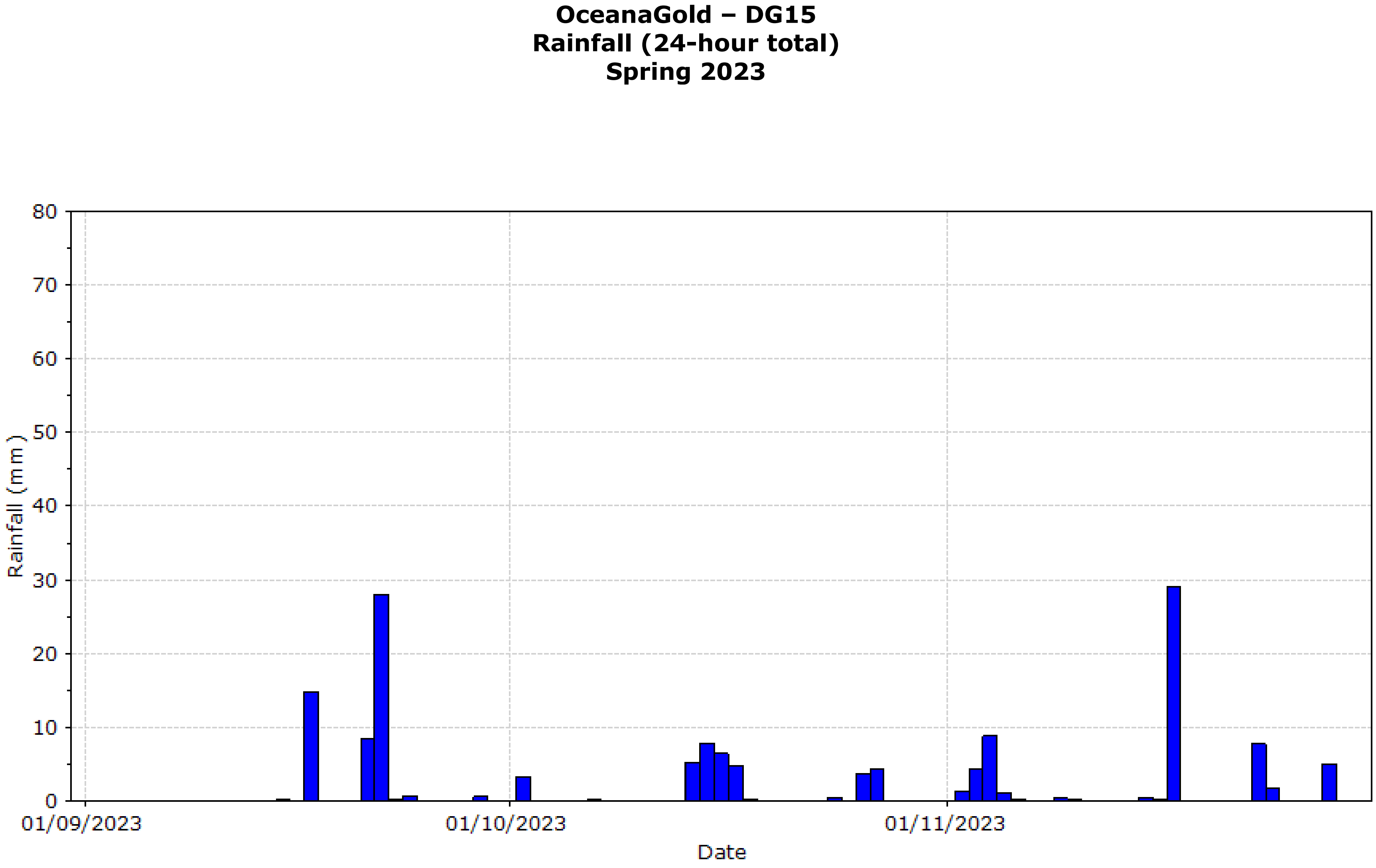

Figure 10: OceanaGold – DG15: Rainfall (24-hour total)

6.3.2. OceanaGold – DG03

Ambient temperature at 1.5 m, ambient temperature at 6 m, relative humidity wind, rainfall and solar radiation from Spring 2023 at the OceanaGold station DG03 are summarised below in Table 9 to Table 18. Meteorological parameters are graphically displayed in Figure 11 to Figure 17.

Table 9: Hourly Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	-1.0	7.9	20.6
October 2023	-1.7	9.2	21.8
November 2023	0.6	9.6	21.7
Spring 2023	**-1.7** **27/10/2023 06:00**	**8.9**	**21.8** **18/10/2023 12:00**

Table 10: Hourly Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	0.1	8.1	20.0
October 2023	-1.6	9.3	19.5
November 2023	1.6	9.7	21.3
Spring 2023	**-1.6** **27/10/2023 07:00**	**9.0**	**21.3** **22/11/2023 15:00**

Table 11: Hourly Relative Humidity statistics – DG03

Period	Minimum (%)	Average (%)	Maximum (%)
September 2023	22.0	70.1	100.0
October 2023	13.8	70.3	100.0
November 2023	26.8	80.9	100.0
Spring 2023	**13.8**	**73.7**	**100.0**

Table 12: Daily Ambient Temperature at 1.5 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	2.7	7.9	16.9
October 2023	1.0	9.2	15.8
November 2023	5.1	9.6	15.8
Spring 2023	**1.0 28/10/2023**	**8.9**	**16.9 21/09/2023**

Table 13: Daily Ambient Temperature at 6 m statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	2.7	8.1	17.2
October 2023	1.1	9.3	16.2
November 2023	5.1	9.7	16.1
Spring 2023	**1.1 28/10/2023**	**9.0**	**17.2 21/09/2023**

Table 14: Daily Relative Humidity statistics – DG03

Period	Minimum (°C)	Average (°C)	Maximum (°C)
September 2023	39.4	70.1	100.0
October 2023	30.2	70.4	93.5
November 2023	46.5	80.9	98.8
Spring 2023	**30.2**	**73.7**	**100.0**

Table 15: Hourly Wind characteristics – DG03

Period	Predominate Wind Direction(s)*	Wind calm (%)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)
September 2023	WNW	2.8	4.8	19.0
October 2023	NW	3.4	4.6	17.9
November 2023	ESE	1.7	3.4	13.6
Spring 2023	**NW**	**2.6**	**4.3**	**19.0**

*Magnetic North – data not corrected to true north

Table 16: Daily Rainfall characteristics – DG03

Period	Average (mm)	Maximum (mm)	Total (mm)	Days of rain
September 2023	2.0	30.6	59.6	7
October 2023	1.0	7.6	32.4	8
November 2023	2.2	26.8	64.8	12
Spring 2023	**1.7**	**30.6**	**156.8**	**27**

Table 17: Daily Solar Radiation characteristics – DG03

Period	Minimum (W/m²)	Average (W/m²)	Maximum (W/m²)
September 2023	38.0	137.0	225.9
October 2023	45.7	203.8	308.1
November 2023	71.9	210.5	357.0
Spring 2023	**38.0 23/09/2023**	**184.0**	**357.0 26/11/2023**

Table 18: Wind Speed and Wind Direction summary – DG03 (1-hour average, Spring 2023)

	Wind speed time (hours)							
Wind Direction	0.5 – 2.0m/s	2.0 – 4.0m/s	4.0 – 6.0m/s	6.0 – 8.0m/s	8.0 – 10.0m/s	>10.0m/s	**Total (hours)**	**% of total**
N	23	30	8	1	0	0	62	2.8
NNE	28	29	6	0	0	0	63	2.9
NE	48	38	16	3	0	0	105	4.8
ENE	46	58	14	1	0	0	119	5.5
E	54	104	47	0	0	0	205	9.4
ESE	33	91	87	11	0	0	222	10.2
SE	31	13	3	0	0	0	47	2.2
SSE	17	7	0	0	0	0	24	1.1
S	26	12	5	0	0	0	43	2.0
SSW	25	34	37	21	6	1	124	5.7
SW	28	49	62	58	26	10	233	10.7
WSW	30	41	33	20	6	0	130	6.0
W	30	32	19	16	11	6	114	5.2
WNW	31	19	32	38	53	76	249	11.4
NW	33	57	63	45	27	38	263	**12.0**
NNW	26	49	29	12	3	5	124	5.7
All	**509**	**663**	**461**	**226**	**132**	**136**	**2127**	**97**
Calm	57						57	2.6

*Magnetic North – data not corrected to true north

Table 18 shows the proportion of wind strengths at each wind direction. Strong winds, greater than 10 m/s, were observed from south-southwest to north-northwest. The majority of the wind speed was between 0.5 to 6.0 m/s. The predominant wind direction was from the northwest.

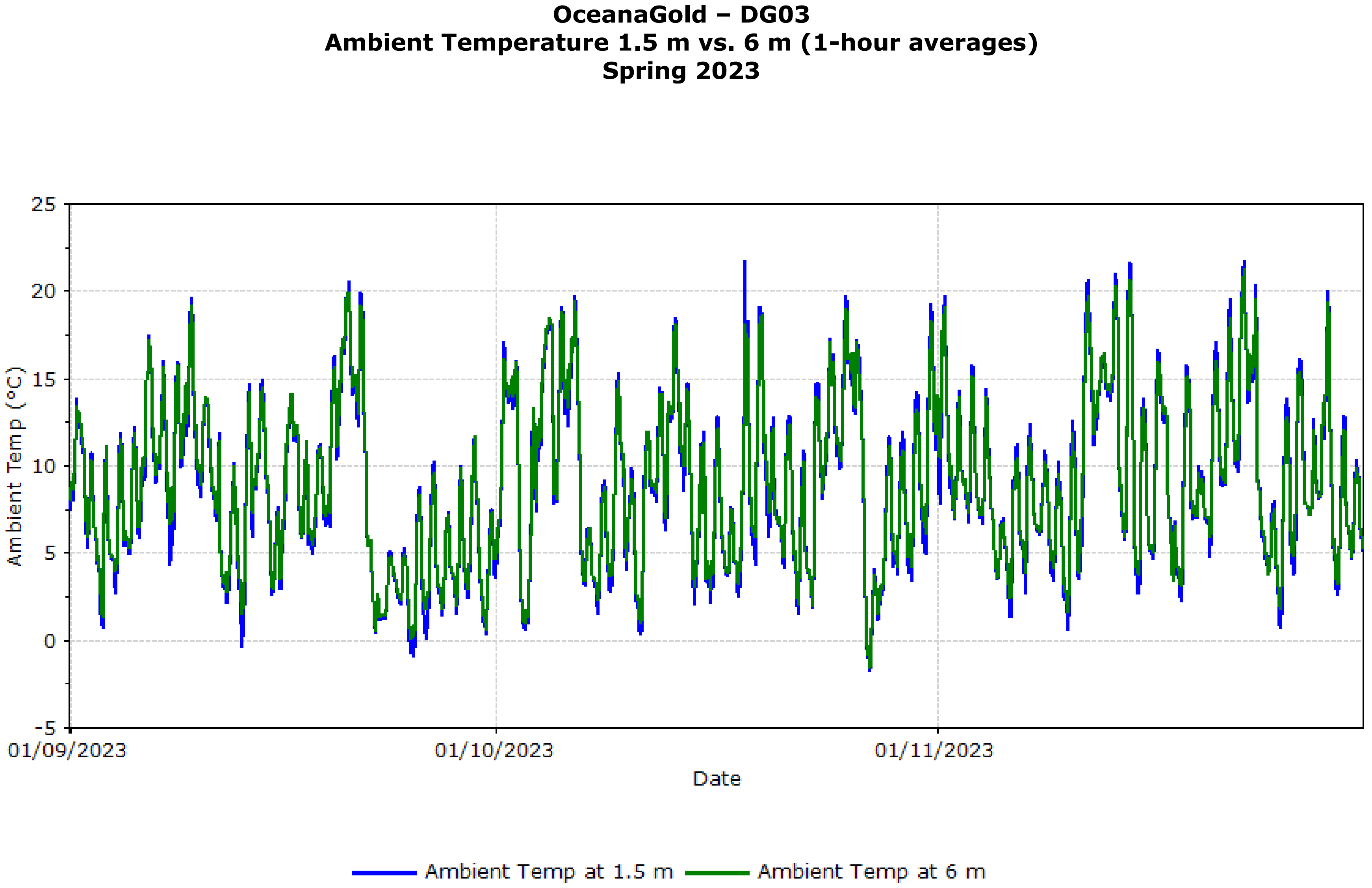

Figure 11: OceanaGold – DG03: Temperature 1.5 m and 6 m (1-hour averages)

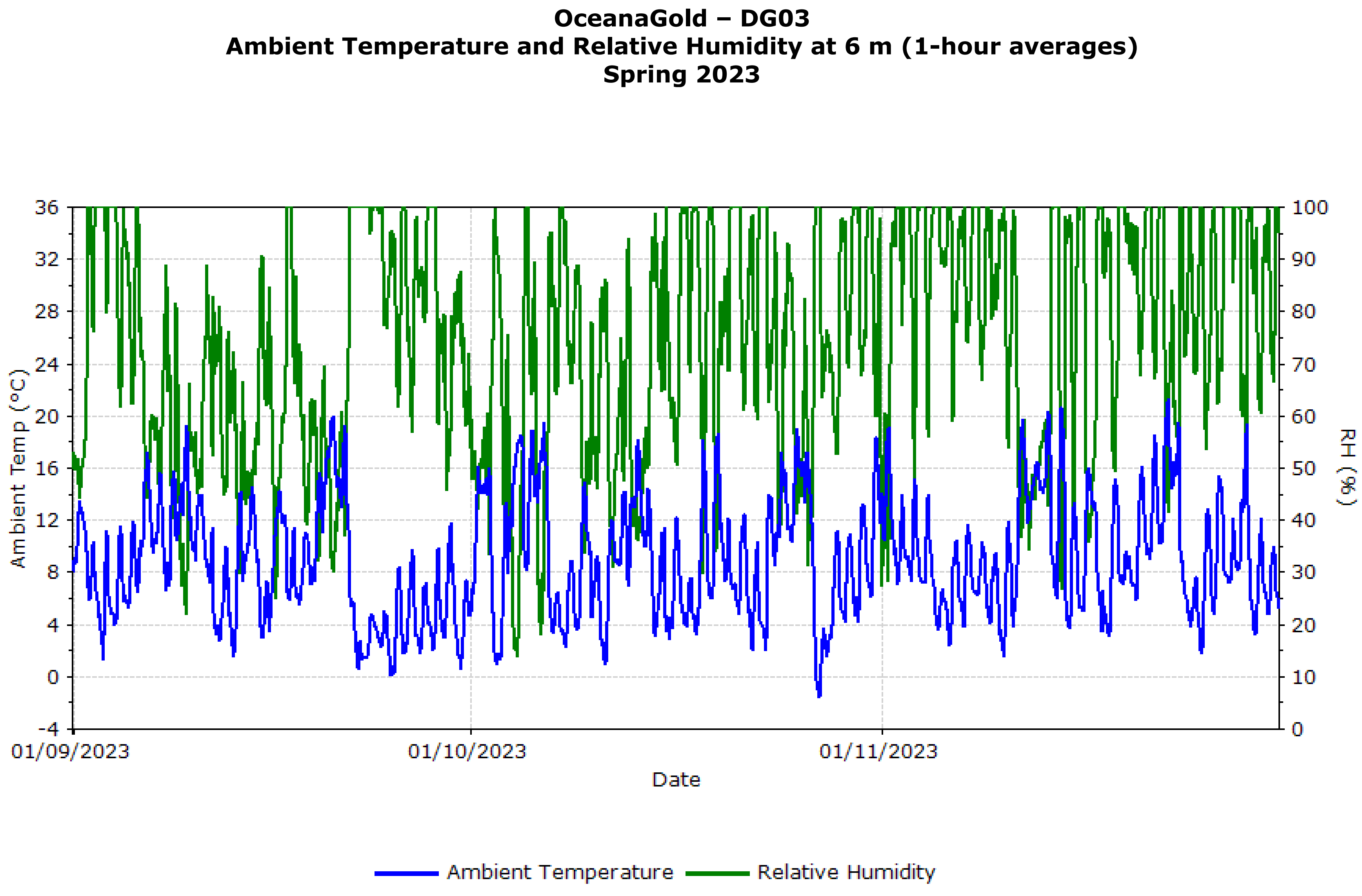

Figure 12: OceanaGold – DG03: Temperature and Relative Humidity (1-hour averages)

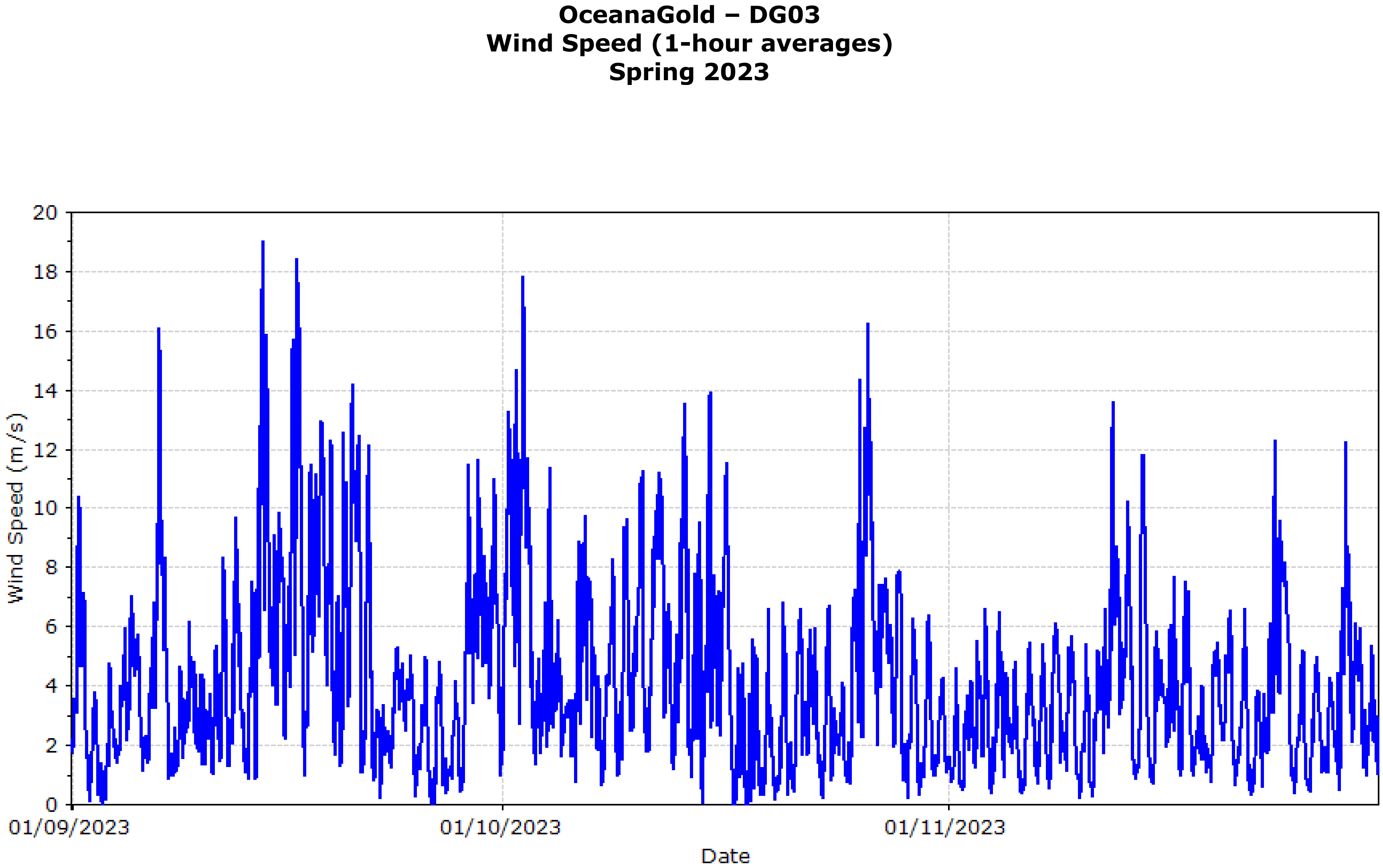

Figure 13: OceanaGold – DG03: Wind Speed (1-hour averages)

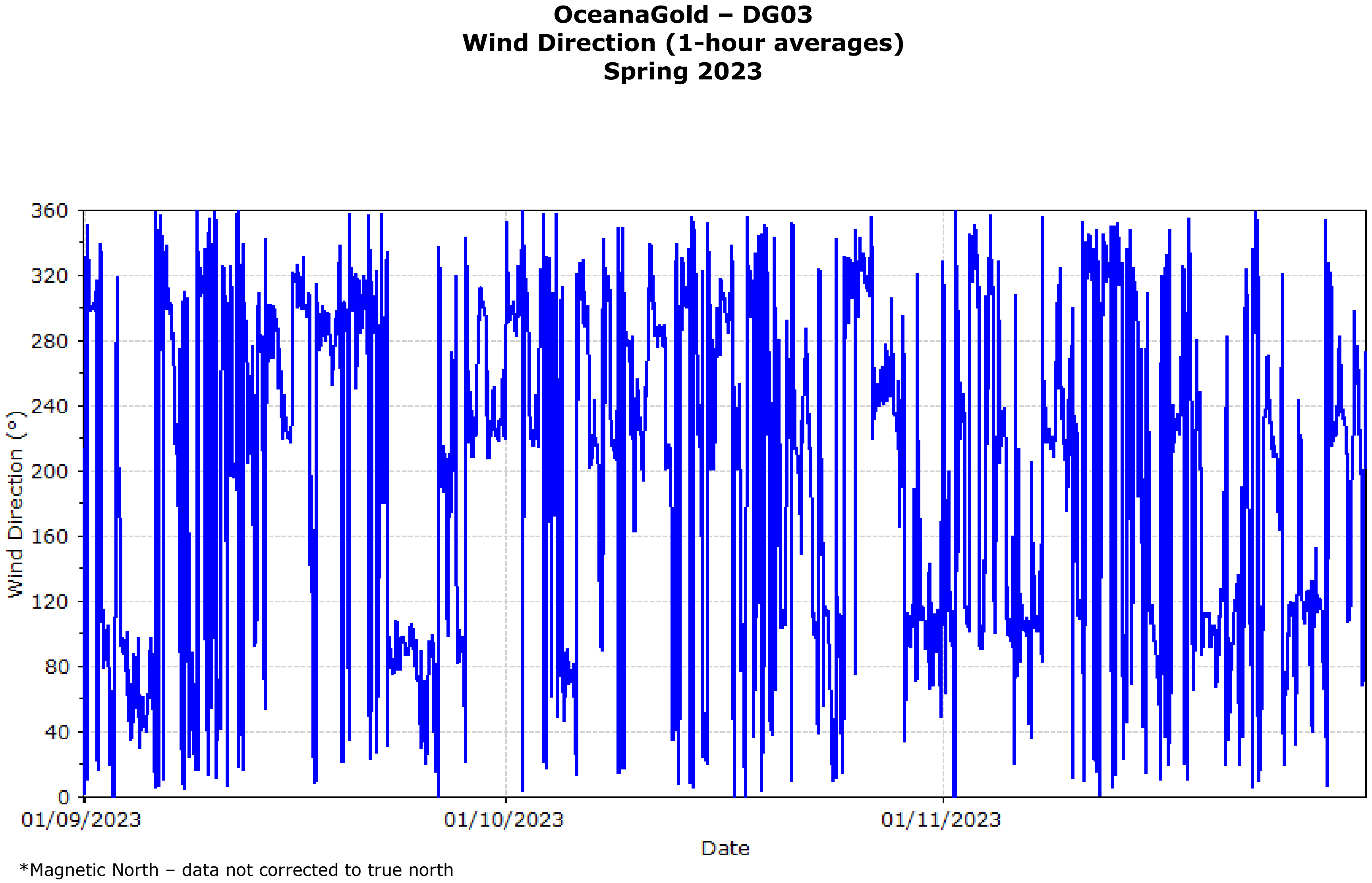

Figure 14: OceanaGold – DG03: Wind Direction (1-hour averages)

OceanaGold – DG03
Wind Rose (1-hour averages)
Spring 2023

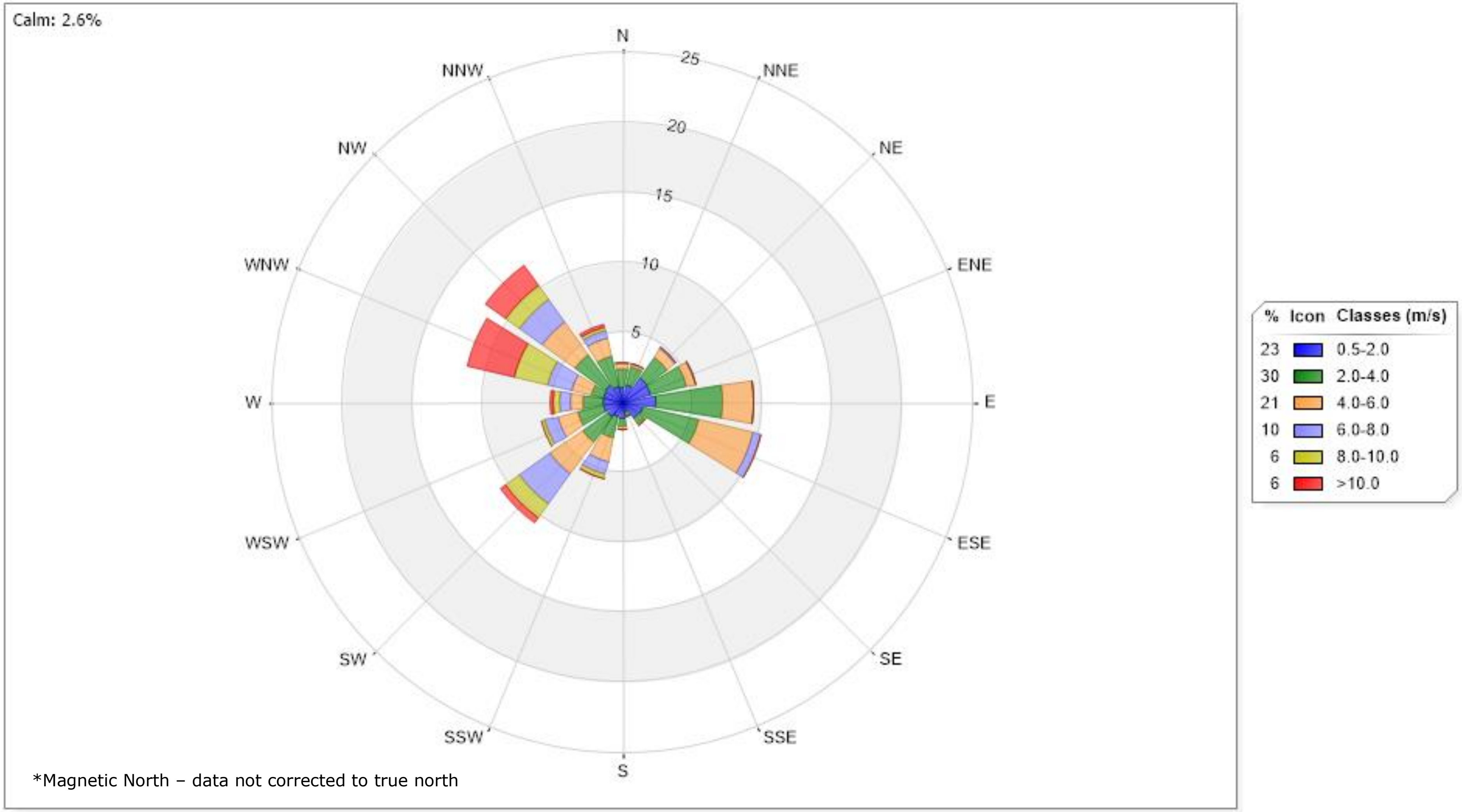

Figure 15: OceanaGold – DG03: Wind Rose (1-hour averages)

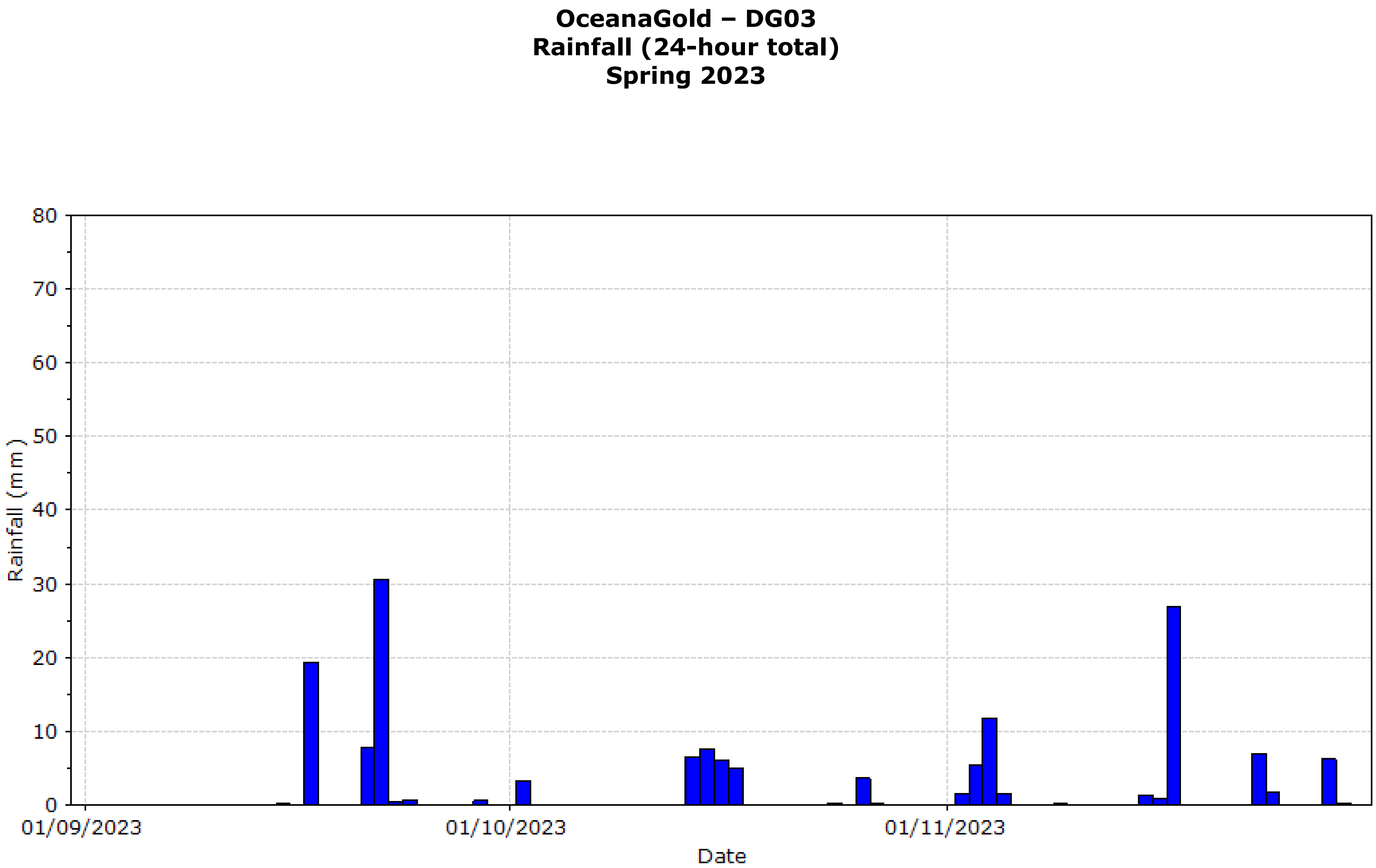

Figure 16: OceanaGold – DG03: Rainfall (24-hour total)

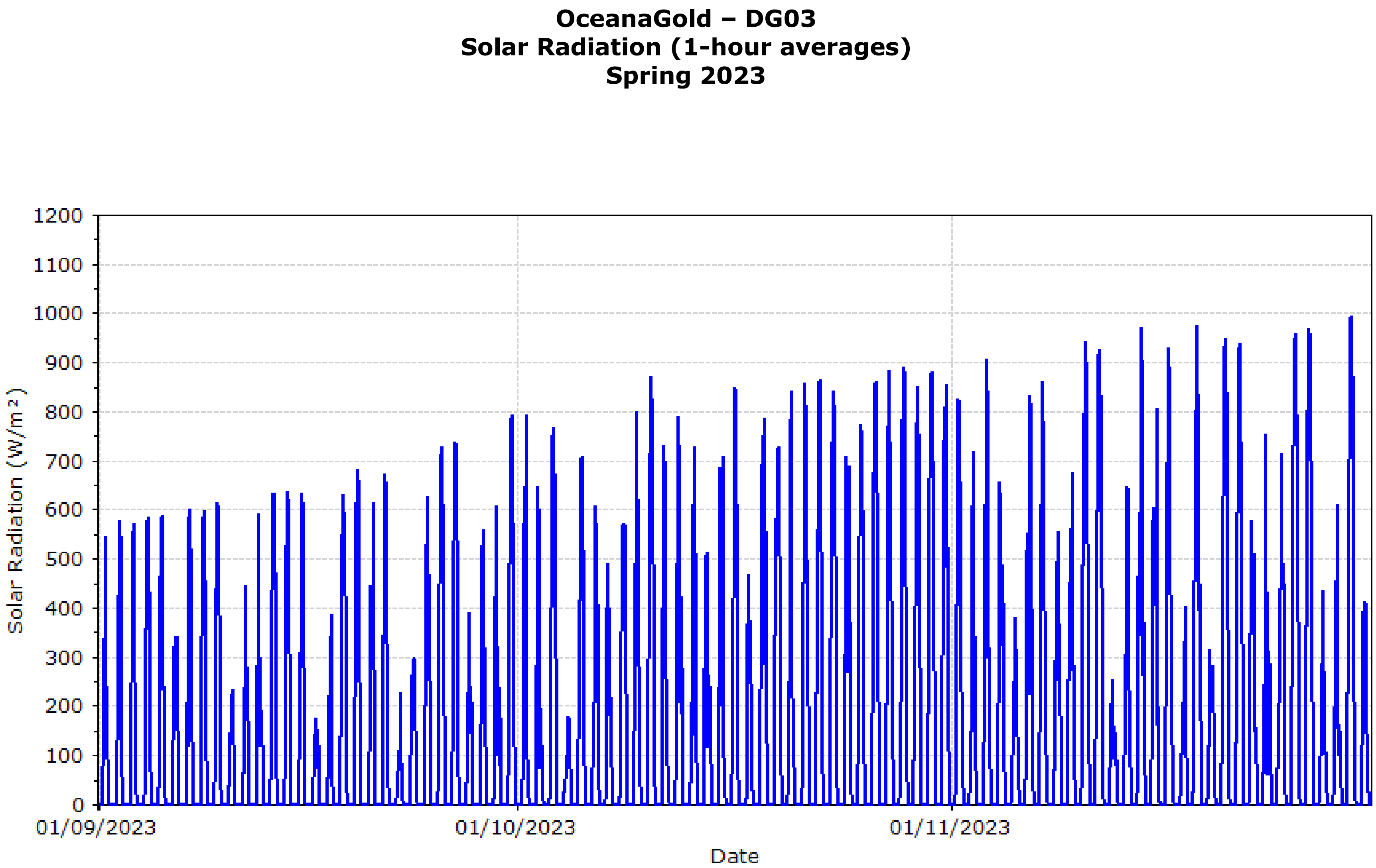

Figure 17: OceanaGold – DG03: Solar Radiation (1-hour averages)

References

Ministry for the Environment (2002). *2002a. Ambient Air Quality Guidelines*. MfE, Wellington, New Zealand.

Ministry for the Environment (2009). *Good practice guide for assessing and managing the environmental effects of dust emissions*. MfE, Wellington, New Zealand

Standards Australia and Standards New Zealand (2014). AS/NZS *3580.14–2014 Meteorological monitoring for ambient air quality monitoring applications.* Standards Australia, Sydney, Australia.

Standards Australia and Standards New Zealand (2016). AS/NZS 3580.1.1 -2016 *Ambient Air – Guide for the Siting of Sampling Units.* Wellington, New Zealand.

Appendix A: Instrument History

Instrument maintenance history of the air quality monitoring stations for the previous 12-months:

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
OceanaGold DG15:					
TSP – Met One E-Sampler					
	23-03-23	2415	Six-Monthly Maintenance	Parameter Check	J Abraham
	19-04-23	2415	Maintenance & Repair	Callout	J Abraham
	14-06-23	2415	Quarterly Maintenance	Parameter Check	J Abraham
	11-12-23	2415	Annual Maintenance	Audit Calibrations	J Abraham
Temperature sensor – Campbell Scientific 107					
	14-09-22	2418	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
	11-12-23	2418	Six-Monthly Maintenance	Parameter Check	J Abraham
Anemometer – Vector A101M					
	14-09-22	2417	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
	11-12-23	2417	Six-Monthly Maintenance	Parameter Check	J Abraham
Wind vane – Vector W200P					
	14-09-22	2416	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
	11-12-23	2416	Six-Monthly Maintenance	Parameter Check	J Abraham
Rain gauge – TB3-0.2/P					
	14-09-22	2419	Six-Monthly Maintenance	Parameter Check	R Hodgkinson
	23-03-23	2419	Six-Monthly Maintenance	Parameter Check	J Abraham
	11-12-23	2419	Six-Monthly Maintenance	Parameter Check	J Abraham

D

Appendix D – Monitoring Instrumentation

Monitoring Instrumentation

The Ministry for the Environment Good Practice Guide for Monitoring and Data 2009 recommends the following specifications for meteorological instruments. Both the DG03 and DG15 sites are maintained by Scott Technical instruments company. The equipment used at both sites is compared to the MfE recommendations in Table D1. No changes to the monitors or configuration has been reported by Watercare.

Table D1. Meteorological Monitoring Equipment Specifications

Monitoring Parameter	Monitoring Requirement
Meteorological Mast GPG	6 m minimum, 10 m preferable
Scott tech Comment	Historically, there was a 5 m climbable mast at the Mine Site. Due to H&S issues associated with the climbable nature of the mast, OGNZL requested a replacement mast. It was recently replaced with a 6 m tiltable mast. The option of installing a 10 m mast was offered at this time but not taken up. The village site (DG15) is a 6 m tiltable mast as supplied to Watercare around 2012.
Wind speed	Resolution 0.1 m/s, accuracy ± 0.2 m/s, start-up speed 0.2 m/s
Scott tech Comment	Both the mine and village sites have a Vector A101M anemometers installed. The resolution and start-up specifications meet the above requirements. The accuracy is 1% of the full-range of 10-55 m/s or 0.1 m/s to 0.55 m/s (at full range).
Wind direction	Resolution 1°, accuracy ± 2°, referenced to true north
Scott tech Comment	Both the mine and village sites have a Vector W200P wind vane installed. The wind direction resolution is better than 1° and it has an accuracy of +/-3° in steady winds over 5 m/s with +/- 2% accuracy if calibrated. Our standard policy is to align wind vanes to True North. For the mine site (DG03), when the new 6 m mast was installed, the wind vane alignment was matched to the old 5 m mast to maintain consistency in the data. The alignment of the boom on the old 5 m mast is noted as being magnetic North in the most recent service report. It is no problems for us to update the datalogger program to apply an offset to correct the wind direction data to True North, or we could re-align the boom on the next site visit. The wind vane boom at the village site (DG15) has been recorded as aligned to True North in the most recent service report (2020) and site check report (2021).
Air temperature	MfE state the resolution should be 0.1°C and accuracy 0.2°C. The Guide to Instruments and Methods of Observation Volume I – Measurement of Meteorological Variables, World Meteorological Organization, 2021 states “For general meteorological work, the observed air temperature should be representative of the free air conditions surrounding the station over as large an area as possible, at a height of between 1.25 and 2 m above ground level”
Scott tech Comment	Both sites meet the above specification. Mine Site (DG03) – Temperature sensor is an EE181 Village Site (DG15) – Temperature sensor is a Campbell 107

Monitoring Parameter	Monitoring Requirement
Automated logging system	Reliable power with battery back-up.
Scott tech Comment	Both sites meet the above specification
Coordinate system	The use of the Cartesian coordinate system is recommended whereby data is converted to its x and y components. This data can then be accumulated in a vector form. This solves averaging and unweighted direction problems. Results may subsequently be converted to polar coordinates if required.
Scott tech Comment	Both the Mine Site and Village Sites are currently programmed to calculate wind speed and direction using the Wind Vector calculation with Output Option 0 on the logger used. This setting uses mean windspeed and unit vector wind direction averaging.
Desirable measurements are:	
Humidity (or dew point)	Resolution 1% relative humidity (rh), accuracy ± 5% rh
Scott tech Comment	Humidity is measured at the Mine Site using the EE181 sensor which meets the above specification. Humidity monitoring is not required at the Village Site.
Solar radiation (for stability estimates)	Resolution 1 W/m^2, accuracy 10 W/m^2
Scott tech Comment	The Mine Site has an Apogee SP-110 pyranometer sensor installed which meets the above specification. Solar radiation monitoring is not required at the Village Site.
Rainfall	Resolution 1 mm
Scott tech Comment	Both sites have 0.2 mm resolution rain gauges installed.
Temperature profile	Temperature at two heights, 1.5 m and 10 m, needs 0.1°C accuracy using identical sensors at both heights.
Scott tech Comment	The lower sensor is the EE181 temp/RH sensor (accuracy ±0.2ºC at 23ºC), and the upper sensor is a Campbell 107 thermistor (accuracy ±0.2ºC from 0 - 50ºC). Only one height is required for temperature monitoring at the Village Site.
Specific siting requirements	The site must be free of influence of trees buildings structures, should be at least two times the height away from the obstacle and for wind sensors it should be at least 10 times the height away from obstacles. (Refer to Part I sections 5.9.2 and 6.2 of the Guide to Meteorological Instruments and Methods of Observation (World Meteorological Organization 1996 Oke TR 2006)).
Comment	The Village site is in an open paddock away from obstructions. The mine site monitor (DG03) is beside the large mixed tailings dam which will shelter some winds from northerly directions.
Required time resolution	Data should be collected at the same minimum time resolution as air quality data resolution should be at least hourly.
Comment	Continuous TSP dust monitoring data is recorded on the same frequency as this data.
Period of monitoring	For atmospheric modelling and trend analysis a minimum of one year's data is recommended.
Comment	The monitoring programme has been in place for many years.

E

Appendix E – Additional Wind Roses

DG03 Windroses

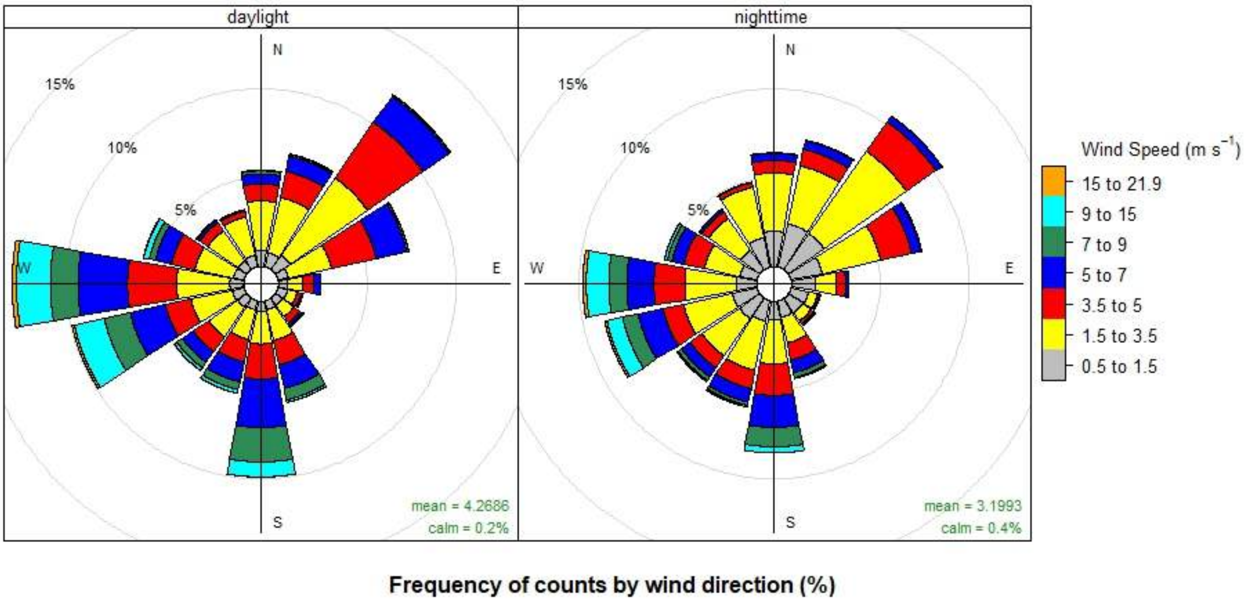

Figure E 1. Diurnal Windrose (hourly average) for DG03 from 01 January 2023 to 31 December 2023

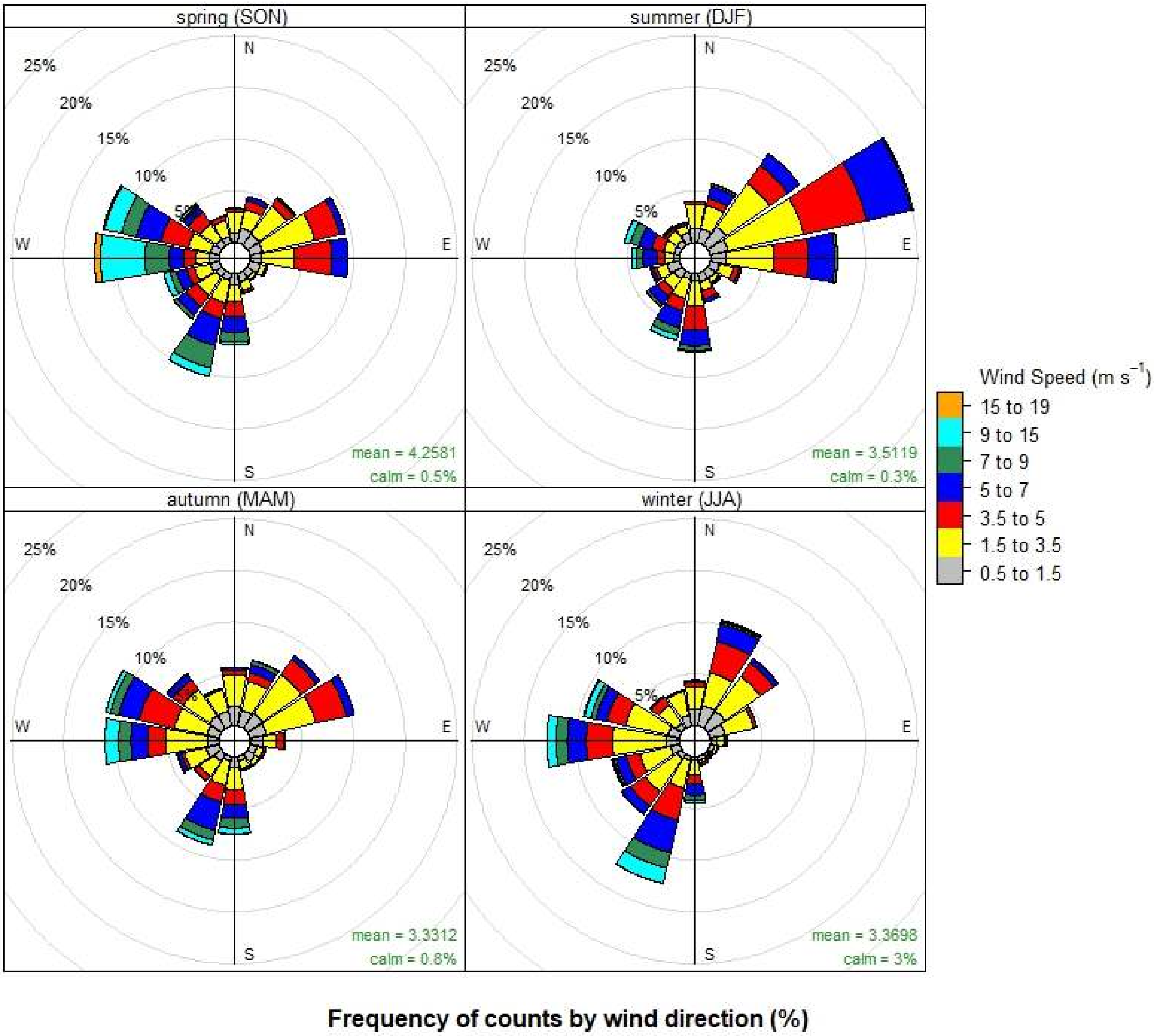

Figure E 2. Seasonal Windrose (hourly average) for DG03 from 01 January 2023 to 31 December 2023

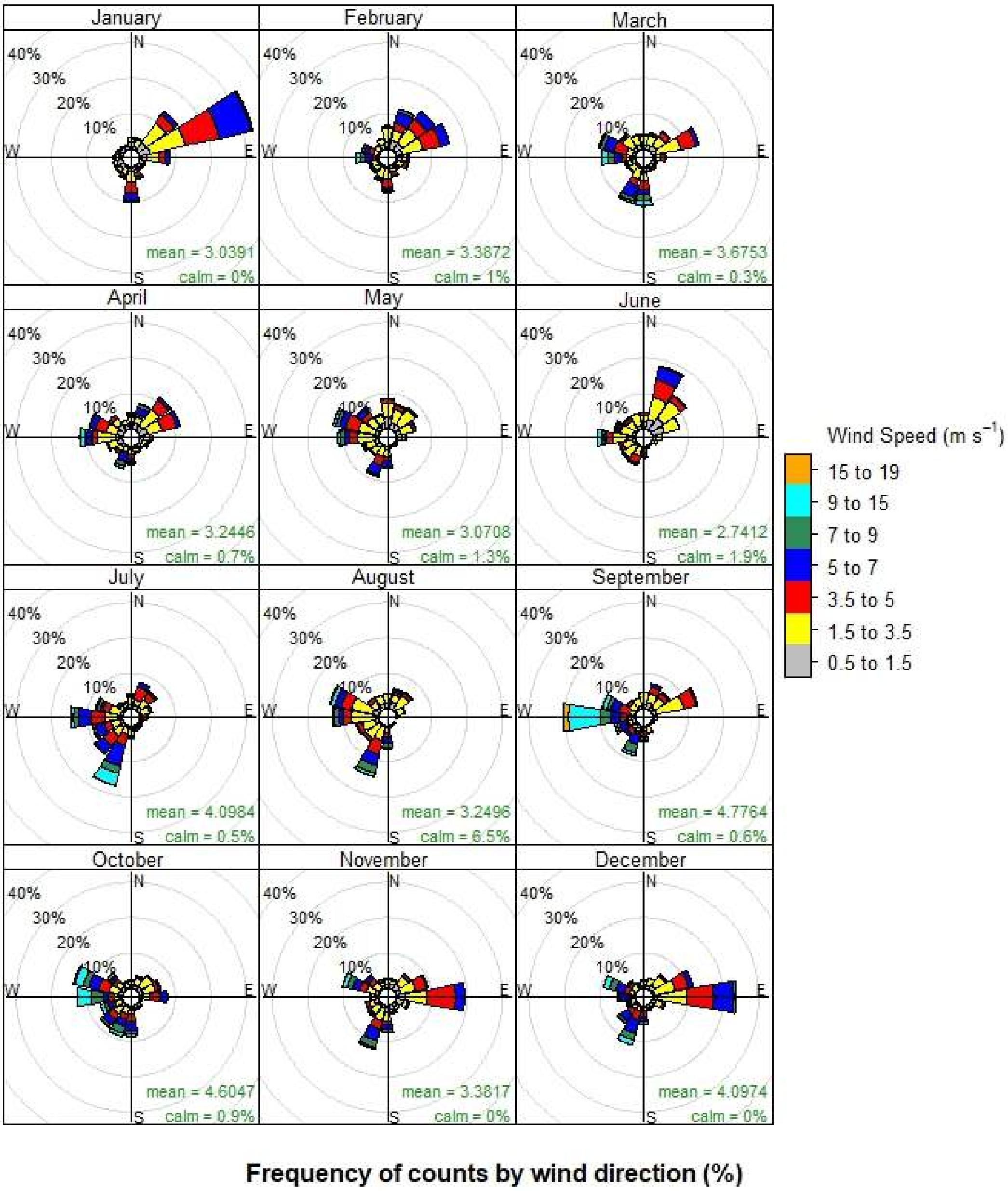

Figure E 3. Monthly Windrose (hourly average) for DG03 from 01 January 2023 to 31 December 2023

DG15 Windroses

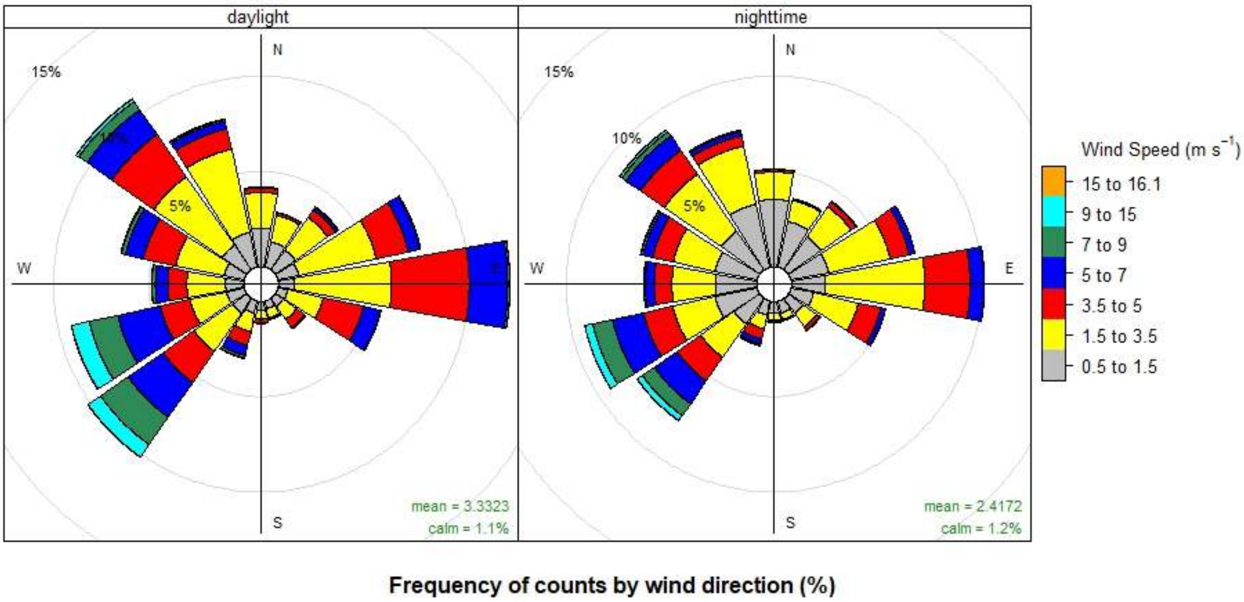

Figure E 4. Diurnal Windrose (hourly average) for DG15 from 01 January 2023 to 31 December 2023

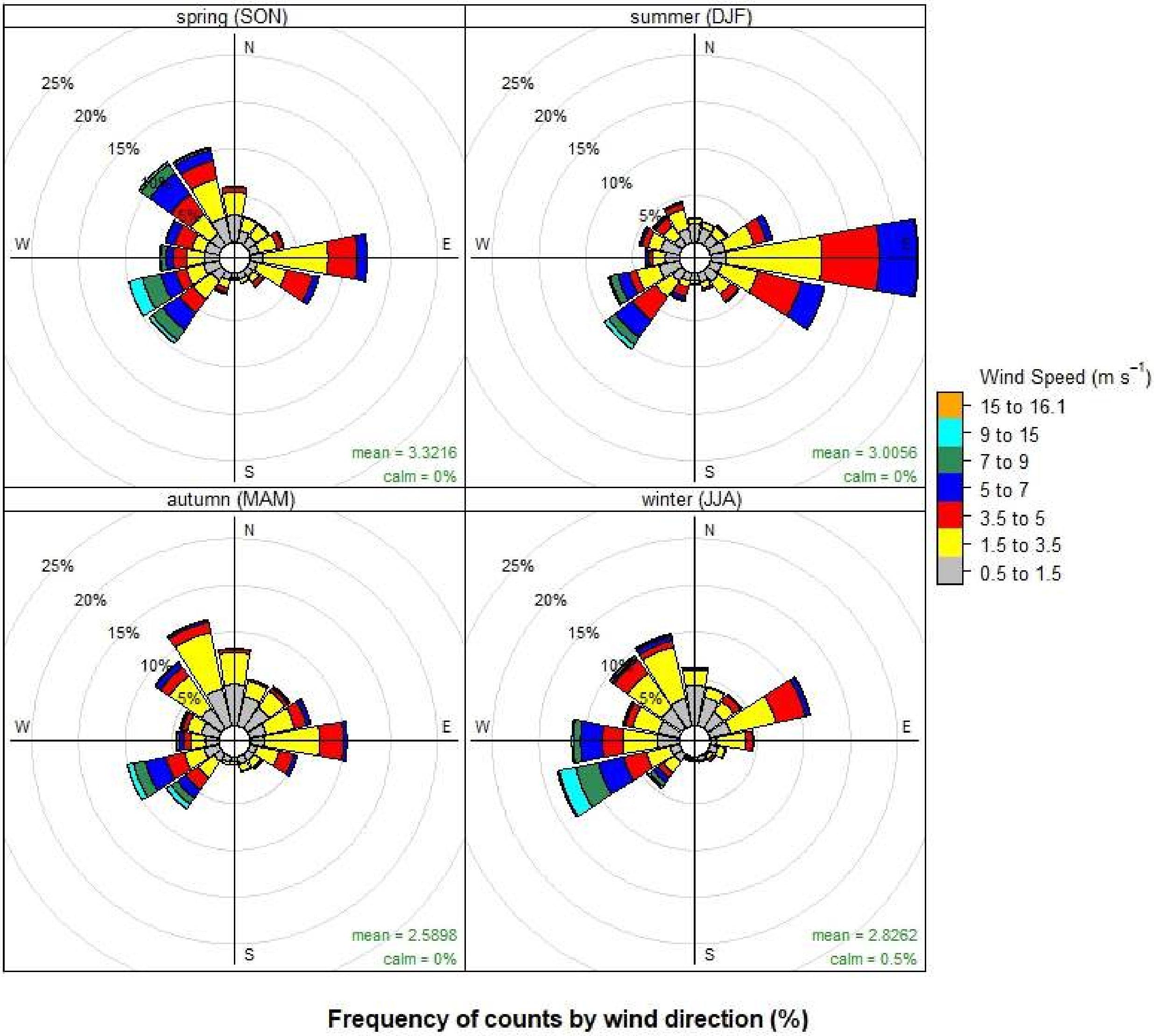

Figure E 5. Seasonal Windrose (hourly average) for DG15 from 01 January 2023 to 31 December 2023

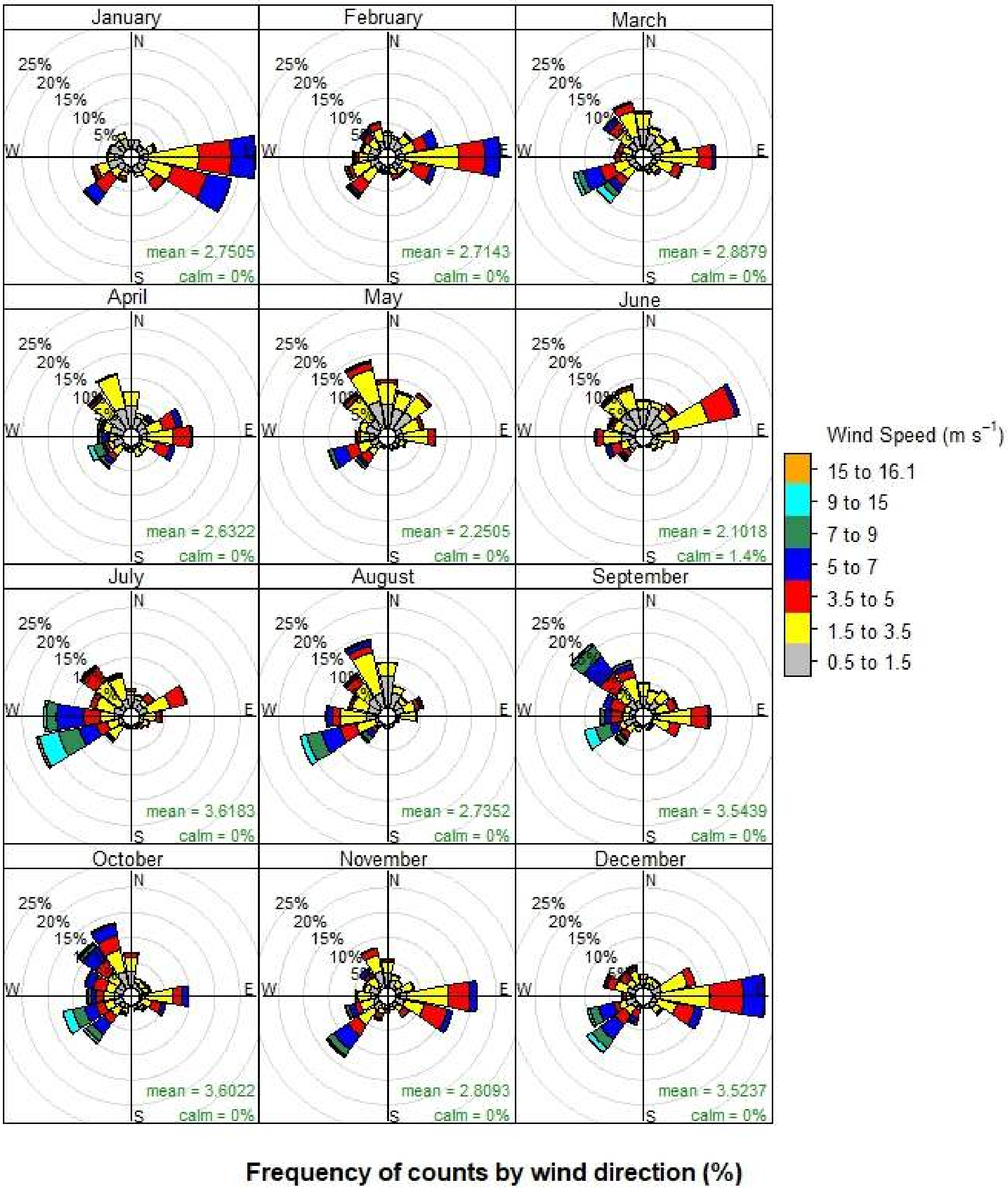

Figure E 6. Monthly Windrose (hourly average) for DG15 from 01 January 2023 to 31 December 2023

F

Appendix F – TSP Exceedances

Table F 1. TSP exceedance of the hourly consent limit at DG07 compared to DG03 relative humidity 2023.

Date and Time	DG07 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
10/01/2023 1:00	303.0	100.0
17/01/2023 23:00	886.0	100.0
18/01/2023 0:00	311.0	100.0
19/01/2023 3:00	944.0	100.0
19/01/2023 5:00	387.0	100.0
25/01/2023 5:00	302.0	100.0
26/01/2023 4:00	401.0	100.0
9/03/2023 22:00	389.0	99.9
12/03/2023 2:00	359.0	99.9
16/03/2023 1:00	357.0	100.0
16/03/2023 2:00	335.0	100.0
16/03/2023 6:00	257.0	100.0
31/03/2023 3:00	281.0	100.0
31/03/2023 4:00	320.0	100.0
31/03/2023 19:00	376.0	100.0
31/03/2023 20:00	750.0	100.0
31/03/2023 21:00	353.0	100.0
31/03/2023 22:00	652.0	100.0
31/03/2023 23:00	321.0	100.0
1/04/2023 0:00	397.0	100.0
1/04/2023 1:00	701.0	100.0
1/04/2023 2:00	1182.0	100.0
1/04/2023 3:00	993.0	100.0
1/04/2023 4:00	923.0	100.0
1/04/2023 5:00	446.0	100.0
18/04/2023 22:00	515.0	100.0
19/04/2023 23:00	260.0	100.0
20/04/2023 1:00	381.0	100.0
20/04/2023 2:00	265.0	100.0
20/04/2023 7:00	500.0	100.0
20/04/2023 20:00	433.0	100.0
20/04/2023 21:00	359.0	100.0
20/04/2023 22:00	326.0	100.0
28/04/2023 23:00	251.0	100.0
29/04/2023 0:00	593.0	100.0
29/04/2023 1:00	820.0	100.0
29/04/2023 2:00	457.0	100.0
29/04/2023 3:00	1048.0	100.0
29/04/2023 4:00	349.0	100.0
1/05/2023 17:00	325.0	100.0
1/05/2023 18:00	695.0	100.0
1/05/2023 19:00	1218.0	100.0
1/05/2023 20:00	1422.0	100.0
1/05/2023 21:00	1907.0	100.0
1/05/2023 22:00	1741.0	100.0
1/05/2023 23:00	1429.0	100.0
2/05/2023 0:00	824.0	100.0
2/05/2023 1:00	251.0	100.0
5/05/2023 7:00	381.0	100.0
5/05/2023 10:00	301.0	100.0
7/05/2023 18:00	359.0	100.0
7/05/2023 19:00	319.0	100.0
7/05/2023 20:00	257.0	100.0
9/07/2023 9:00	330.0	100.0
9/07/2023 17:00	337.0	100.0
9/07/2023 18:00	427.0	100.0
9/07/2023 19:00	317.0	100.0
9/07/2023 20:00	259.0	100.0
9/07/2023 21:00	350.0	100.0
10/07/2023 1:00	282.0	100.0
10/07/2023 2:00	253.0	100.0

Table F 2. TSP exceedance of the hourly consent limit at DG11 compared to the DG03 relative humidity 2023.

Date and Time	DG11 TSP Reading (µg/m³)	Relative Humidity at DG03 (%)
17/01/2023 4:00	429	100.0
17/01/2023 22:00	561	100.0
17/01/2023 23:00	268	100.0
18/01/2023 6:00	258	100.0
18/01/2023 16:00	363	100.0
18/01/2023 17:00	781	100.0
18/01/2023 18:00	266	100.0
18/01/2023 19:00	322	100.0
19/01/2023 4:00	276	100.0
19/01/2023 5:00	280	100.0
25/01/2023 4:00	698	100.0
25/01/2023 5:00	401	100.0
3/03/2023 4:00	280	98.9
16/03/2023 1:00	329	100.0
16/03/2023 2:00	386	100.0
31/03/2023 19:00	337	100.0
31/03/2023 20:00	592	100.0
31/03/2023 21:00	741	100.0
31/03/2023 22:00	380	100.0
1/04/2023 0:00	402	100.0
1/04/2023 1:00	656	100.0
1/04/2023 2:00	836	100.0
19/04/2023 23:00	305	100.0
9/06/2023 9:00	268	100.0
9/07/2023 22:00	278	100.0